 

ORIGINAL ARTICLE

# Epidemiology and risk factors for healthcare-associated maternal peripartum infections in Ukraine: results a multicenter study

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## ABSTRACT

**Aim:** To estimate the frequency of different types of healthcare-associated maternal peripartum infections and their risk factors among women in Ukraine.
**Materials and Methods:** Multicenter prospective cohort study was conducted in nine regional perinatal centers of Ukraine between January 1, 2021, to December 31, 2023. The criteria for specific healthcare-associated maternal peripartum infections (endometritis, episiotomy infection, and maternal sepsis) site were adapted from the CDC/NHSN case definitions. Surveillance was performed during the hospitalization period and up to 30 days after hospital discharge.
**Results:** A total of 3600 deliveries by the vaginal route were performed during the study period, 600 (16.7%) maternal peripartum infections were observed. Of all maternal peripartum infection cases, 79.7% were detected after hospital discharge. The most common maternal peripartum infections include endometritis (54.8%), episiotomy infections (34.4%), and maternal sepsis (10.8%). According to the multivariate logistic regression analysis, the body mass index >25, placenta previa, premature rupture of membrane, prolonged rupture of membranes, manual removal of the placenta, multiple vaginal examinations, bacterial vaginosis, aerobic vaginitis, gestational diabetes mellitus, and anemia during pregnancy were independent risk factors for maternal peripartum infections.
**Conclusions:** Results this study suggest a high prevalence of healthcare-associated maternal peripartum infections in Ukraine. Several factors have been associated with increased risk of maternal peripartum infections, including pre-existing maternal conditions, placenta previa, prolonged rupture of membranes, and spontaneous or provider-initiated conditions during labour and childbirth.

**KEY WORDS:** vaginal delivery, healthcare-associated maternal peripartum infections, prevalence, risk factors, Ukraine

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## INTRODUCTION

Healthcare-associated infections in the puerperal period can pose a significant risk of morbidity and morbidity to women [1, 2]. These infections comprise a wide range of entities that can occur after vaginal and cesarean delivery or during breastfeeding. In addition to trauma sustained during the birth process or cesarean procedure, physiologic changes during pregnancy contribute to the development of postpartum infections. Infection also contributes significantly to deaths from other causes and leads to serious consequences, including chronic pelvic inflammatory disease, ectopic pregnancy, and infertility [3].

According to the literature, the most common healthcare-associated puerperal and post-partum infections include endometritis, mastitis, puerperal sepsis, urinary tract infections (UTI), bloodstream infections (BSI), and surgical site infections (SSI) [4, 5]. Puerperal infectious morbidity affects 5–10% of pregnant women [6].

WHO estimates that direct obstetric bacterial infections, including maternal sepsis, are the third most common cause of maternal mortality, representing 10.7% of all deaths worldwide. This is more common in Low-Middle-Income Countries (LMICs) but is also a direct cause of maternal deaths in high-income countries. [1, 7]. The number of cases of puerperal sepsis per year shows wide variations among published literature - this may be related to different definitions, recordings etc.

Worrying levels of resistance have been reported in all countries, but with a disproportionately higher burden in LMICs [8, 9]. Due to the rising incidence of multidrug-resistant pathogens, especially in LMICs, post-partum infections represent a significant treatment challenge, because most

they are caused by an alarmingly increasing rate of pathogens resistant to the commonly used antibiotics. [4, 10, 11].

According to the literature, the body mass index >25, placenta previa, placenta accreta, postpartum hemorrhage, premature rupture of membrane, gestational diabetes mellitus, cesarean section, and anemia during pregnancy were relevant and independent risk factors for puerperal infection [12, 13].

The epidemiology of healthcare-associated puerperal and postpartum infections is not well understood and remains underestimated because surveillance systems are often limited to the acute care setting. The true incidence is not fully understood as outpatient surveillance data are lacking. Despite infection are one is direct causes of maternal mortality in Ukraine, few studied examined prevalence of healthcare-associated postpartum maternal infections.

## AIM

The aim this study to estimate the frequency of different types of healthcare-associated maternal peripartum infections and their risk factors among women in Ukraine.

## MATERIALS AND METHODS

### STUDY DESIGN, SETTING AND POPULATION

We conducted a multicentre prospective cohort study of patients who delivered in nine regional perinatal centers of Ukraine between January 1, 2021, to December 31, 2023. During a 36-month period, patients attending the obstetrics service in labor were recruited for a observational study on the incidence of puerperal infections. Inclusion criteria: any women who underwent vaginal delivery, and had relevant medical data. Exclusion criteria: subjects who took antibacterial drugs or immunosuppressors within 48 hours before enrollment, or complicated with malignant tumor, severe dysfunction in the heart, lung, liver, kidney, mental diseases, fever due to medical causes, surgical site infection after cesarean section, mastitis, urinary tract infection or thrombophlebitis.

### DEFINITIONS

In this study, maternal peripartum infection is defined as bacterial infection of the genital tract or its surrounding tissues occurring at any time between the onset of rupture of membranes or labour and the 42nd day postpartum in which two or more of the following are present: pelvic pain, fever, abnormal vaginal discharge, abnormal smell/foul odour discharge or delay in uterine involution [7].

The criteria for specific healthcare-associated maternal peripartum infections (endometritis, episiotomy infection, and maternal sepsis) site were adapted from the Centers for Disease Control and Prevention's (CDC) and National Healthcare Safety Network's (NHSN) case definitions [14]. An incident healthcare-associated puerperal infections was defined by microbiologically confirmed CDC/NHSN HAI epidemiological case definitions.

### DATA COLLECTION

Examinations to detect healthcare-associated maternal peripartum infections were performed daily during the hospitalization period and up to 30 days after hospital discharge. The stratification of risk-factors and the criteria for the diagnosis of healthcare-associated peripartum infections were done in accordance with the methods described by the Centers for Disease Control and Prevention. The incidence of peripartum infections detected by post-discharge outpatient surveillance was compared with that from in-hospital surveillance, for vaginal delivery. Data were collected by a questionnaire given to the women in ambulatory setting and combined with data from general practitioner and hospital records. Clinically relevant data of subjects with puerperal infection were analyzed, and all clinical data were collected by obstetricians and related investigators receiving unified training. Patients and their authorizers should be fully cooperated in the collection of investigation data, the investigation was conducted anonymously, the patients' privacy should be protected during the process, and the question raised by patients was answered. The relevant investigation results obtained should not be disclosed to any organization or individual without the permission of subjects enrolled and their authorizers. To ensure that questionnaire responses were accurately collected, the investigator did not conduct more than three interviews in a day. The investigator clarified any item in a simplified language and ensured that all items were answered.

### ETHICS

Before enrollment, all subjects signed and agreed to be enrolled, and this research was approved by the Ethics Committee of Shupyk National Healthcare University of Ukraine.

### STATISTICAL ANALYSIS

SPSS 21.0 (IBM) statistical software was used. Univariate analysis was performed first for healthcare-associated puerperal and postpartum infections, followed by multivariate logistic regression analysis. Univariate and multivariate analyses were performed for relevant clinical data, such as age, body mass index, gestational week, placenta previa, placenta accreta, postpartum hemorrhage, premature rupture of membrane, gestational hypertension, gestational diabetes mellitus, and anemia during pregnancy, and the infection sites and pathogen distribution in subjects with puerperal infection were recorded. Measurement data were presented as mean ± standard deviation, and chi-square test was used for the intergroup comparison of rate. $P < 0.05$ suggested that the difference was statistically significant.

## RESULTS

### PREVALENCE OF MATERNAL PERIPARTUM INFECTIONS

A total of 3600 deliveries by the vaginal route were performed during the study period, 600 maternal peripartum infections were observed. The prevalence of healthcare-associated maternal peripartum infection after deliveries by the vaginal route in Ukraine was 16.7% (95% CI: 16.5-16.9). Among 600 cases of maternal peripartum infection, there were 329 cases (54.8%) of endometritis, 206 cases (34.4%) of episiotomy infection, and 65 cases (10.8%) of

maternal sepsis. Examinations to detect maternal peripartum infection were performed daily during the hospitalization period and up to 30 days after hospital discharge. Of the total maternal peripartum infection cases, 79.7% (478/600) were detected after hospital discharge. The incidence of maternal peripartum infection detected by post-discharge outpatient surveillance was compared with that from in-hospital surveillance. The incidence of maternal peripartum infections detected by in-hospital surveillance was 3.4%. When maternal peripartum infections detected by post-discharge surveillance were included, the total number of peripartum infection was 600 cases (16.7%), a value much higher than that for the peripartum infection detected by in-hospital surveillance alone (Table 1).

RISK FACTORS

According to the univariate analysis, the incidence rate of maternal peripartum infection was significantly increased in subjects with the body mass index >25, placenta previa, premature rupture of membrane, prolonged rupture of membranes, manual removal of the placenta, multiple vaginal examinations, bacterial vaginosis, aerobic vaginitis, gestational diabetes mellitus, and anemia during pregnancy ($P < 0.05$), and they were relevant risk factors for puerperal infection (Table 2).

We performed multivariate logistic regression analysis of relevant risk factors in maternal peripartum infection group. According to the multivariate logistic regression analysis, the body mass index >25, placenta previa, premature rupture of membrane, prolonged rupture of membranes, manual removal of the placenta, multiple vaginal examinations, bacterial vaginosis, aerobic vaginitis, gestational diabetes mellitus, and anemia during pregnancy were independent risk factors for maternal peripartum infections (Table 3).

## DISCUSSION

This study's primary objective was to determine the prevalence of various of healthcare-associated maternal peripartum infections and the risk factors associated with them among women in Ukraine. Our study showed that a high prevalence of healthcare-associated maternal peripartum infections in Ukraine. Examinations to detect maternal peripartum infection were performed daily during the hospitalization period and up to 30 days after hospital discharge. The results of our study demonstrate that most of maternal peripartum infection following deliveries were detected only after patient's discharge from the hospital and seems to indicate that failing to do follow-up evaluation of these patients could result in a substantial mis-calculation of the authentic maternal peripartum infections rates. Therefore, data on post-discharge surveillance should be included to realistically estimate the true rates of peripartum infection in obstetric patients and to allow the implementation of measures to reduce maternal infection. Our study showed that the most common maternal peripartum infections in Ukraine include endometritis, episiotomy infections, and maternal sepsis.

In present study several factors have been associated with increased risk of maternal peripartum infections, including pre-existing maternal conditions (e.g. gestational diabetes mellitus, obesity, anemia during pregnancy, bacterial vaginosis, and aerobic vaginitis), placenta previa, prolonged rupture of membranes, and spontaneous or provider-initiated conditions during labour and childbirth (e.g. prolonged rupture of membranes, multiple vaginal examinations, and manual removal of the placenta. These findings suggest considerable gaps in the quality of care and the need for development and implementation of evidence-based guidance for prevention and treatment of maternal infection in Ukraine. However, the few available guidelines on maternal infections are limited in scope or specific to particular context and cannot serve the interests of populations that could benefit the most.

This study expands upon the previous reports that focused on maternal morbidity associated with childbirth in Ukraine [4, 10, 11, 13].

According to the literature, in clinic, puerperal infection mainly refers to the reproductive tract infection occurring after delivery, which, as a kind of complication seriously threatening delivery quality and life safety of puerperae, has a certain influence on postpartum recovery and even neonatal feeding [15]. Birth canal injury is caused due to fetal delivery via reproductive tract during the puerperium, and the body's immunity of pregnant women significantly declines during the puerperium. As a result, pathogenic microorganisms invade the human body, leading to infection, and even septicopyemia and threatening the maternal life [16]. At the same time, the drug resistance of pathogenic bacteria of puerperal infection has significantly increased nowadays [10, 11, 13].

Globally, the most common intervention for preventing morbidity and mortality related to maternal infection is the

**Table1.** Distribution of 600 healthcare-associated maternal peripartum infections in Ukraine, 2021-2023

| Type of infection | Maternal peripartum infections | | | | Total | |
|---|---|---|---|---|---|---|
| | Detected in-hospital | | Detected after hospital discharge | | | |
| | n | % | n | % | n | % |
| Endometritis | 31 | 5.1 | 298 | 49.7 | 329 | 54.8 |
| Episiotomy infection | 27 | 4.5 | 179 | 29.8 | 206 | 34.4 |
| Maternal sepsis | 64 | 10.7 | 1 | 0.2 | 65 | 10.8 |

**Table 2.** Univariate analysis of relevant risk factors in maternal peripartum infection group in Ukraine

| Variable | All women (n=3,600) | Maternal peripartum infections | | | | P value |
|---|---|---|---|---|---|---|
| | | No (n=3,000) | | Yes (n=600) | | |
| | | n | % | n | % | |
| Age | | | | | | |
| >30 y old | 1,725 | 1,440 | 48.0 | 285 | 47.5 | 0.954 |
| <30 y old | 1,875 | 1,560 | 52.0 | 315 | 52.5 | |
| Body mass index | | | | | | |
| >25 | 2,025 | 1,560 | 52.0. | 465 | 77.5 | 0.003 |
| <25 | 1,575 | 1,440 | 48.0 | 135 | 22.5 | |
| Gestational week | | | | | | |
| >38 wk | 1,950 | 1,635 | 54.5 | 315 | 52.5 | 0.817 |
| <38 wk | 1,650 | 1,365 | 45.5. | 285 | 47.5 | |
| Placenta previa | | | | | | |
| Yes | 1,740 | 1,215 | 40.5 | 525 | 87.5 | 0.000 |
| No | 1,860 | 1,785 | 59.5 | 75 | 12.5 | |
| Manual removal of the placenta | | | | | | |
| Yes | 1,680 | 1,170 | 39.0 | 510 | 85.0 | 0.000 |
| No | 1,920 | 1,860 | 62.0 | 60 | 15.0 | |
| Premature rupture of membrane | | | | | | |
| Yes | 2,032 | 1,573 | 52.4 | 459 | 76.5 | 0.002 |
| No | 1,568 | 1,427 | 47.6 | 141 | 23.5 | |
| Prolonged rupture of membranes | | | | | | |
| Yes | 2,037 | 1,574 | 52.5 | 463 | 77.2 | 0.001 |
| No | 1,563 | 1,426 | 47.5 | 137 | 22.8 | |
| Multiple vaginal examinations | | | | | | |
| Yes | 2,018 | 1,559 | 51.9 | 459 | 74.8 | 0.004 |
| No | 1,582 | 1,441 | 48.1 | 141 | 25.2 | |
| Bacterial vaginosis | | | | | | |
| Yes | 1,950 | 1,515 | 50.5 | 435 | 72.5 | 0.003 |
| No | 1,650 | 1,485 | 49.5 | 165 | 27.5 | |
| Aerobic vaginitis | | | | | | |
| Yes | 2,023 | 1,584 | 52.8 | 439 | 73.2 | 0.003 |
| No | 1,577 | 1,416 | 47.2 | 161 | 26.8 | |
| Gestational hypertension | | | | | | |
| Yes | 1,650 | 1,365 | 45.5 | 285 | 47.5 | 0.817 |
| No | 1,950 | 1,635 | 54.5 | 315 | 52.5 | |
| Gestational diabetes mellitus | | | | | | |
| Yes | 1,680 | 1,200 | 40.0 | 480 | 80.0 | 0.000 |
| No | 1,920 | 1,800 | 60.0 | 120 | 20.0 | |
| Anemia during pregnancy | | | | | | |
| Yes | 1,845 | 1,395 | 46.5 | 450 | 75.0 | 0.001 |
| No | 1,755 | 1,605 | 53.5 | 150 | 25.0 | |

**Table 3.** Multivariate Logistic regression analysis of relevant risk factors in maternal peripartum infection group in Ukraine, 2021-2023

| Variable | OR | P value | 95% CI |
|---|---|---|---|
| Body mass index | 12.82 | 0.01 | 1.22-34.41 |
| Placenta previa | 6.85 | 0.04 | 1.58-49.23 |
| Manual removal of the placenta | 4.82 | 0.01 | 1.59-14.37 |
| Prolonged rupture of membranes | 1.96 | 0.04 | 1.03-7.45 |
| Premature rupture of membrane | 2.45 | 0.00 | 1.39-4.32 |
| Multiple vaginal examinations | 4.88 | 0.01 | 1.91-14.24 |
| Gestational diabetes mellitus | 3.08 | 0.00 | 1.77-5.35 |
| Anemia during pregnancy | 5.53 | 0.00 | 3.11-9.82 |
| Bacterial vaginosis | 1.89 | 0.04 | 1.21-8.42 |
| Aerobic vaginitis | 1.81 | 0.04 | 1.12-7.91 |

**OR, odds ratio; CI, confidence interval.*

use of antibiotics for prophylaxis and treatment. However, the misuse of antibiotics for obstetric conditions and procedures that are thought to carry risks of maternal infection is common in clinical practice. Such inappropriate use of antibiotics among women giving birth has implications on global efforts to contain the emergence of resistant bacteria strains and, consequently, on global health [7].

Bacterial infections during labour and the puerperium are among the leading causes of maternal mortality worldwide, accounting for about one tenth of the global burden of maternal deaths [1, 17]. Although the reported incidence in high-income countries is relatively low (between 0.1 and 0.6 per 1000 births), it is nonetheless an important direct cause of maternal mortality [6, 18]. Maternal infections around childbirth also have a considerable impact on newborn mortality, and an estimated 1 million newborn deaths are associated with such infections annually [19]. In addition, infection-related morbidities and prolonged hospitalization can interfere with mother–infant bonding in the first days after birth [7].

The WHO technical consultation in 2015 adopted 20 recommendations covering prioritized questions related to the prevention and treatment of maternal peripartum infections. The prevention aspect of the recommendations is focused on routine use of minor procedures (e.g. perineal/pubic shaving), antiseptic agents for vaginal and caesarean birth, and antibiotic prophylaxis for preventing bacterial infection in infection-prone conditions and obstetric procedures prelabour rupture of membranes, meconium-stained amniotic fluid, perineal tears, manual removal of the placenta, operative vaginal birth and caesarean section [7].

Prevention measures of maternal infection should be taken before pregnancy and during pregnancy, delivery, and puerperium. First, before pregnancy, it is suggested that women of child-bearing age pay attention to nutritional regulation, actively prevent and control the reproductive system diseases, especially inflammatory diseases, reduce the frequency of uterine curettage, and make good preparation for pregnancy [20].

During delivery, sterile operations should be strictly performed, the digital anal examination is strictly forbidden [21], the frequency of vaginal examination should be reduced as far as possible to reduce the incidence rate of retrograde infection, indications of cesarean section and lateral episiotomy should be strictly grasped, antibacterial drugs can be used for a short time for those undergoing cesarean section to prevent the infection, and the maternal management should be strengthened [22] to improve the hospital delivery rate [23], and reduce the injury of birth canal due to delivery as far as possible [24].

During puerperium, it is recommended that puerperae get enough strengthen nutrition reasonably, and improve the body's immunity, and prevention measures be actively taken for puerperae with high-risk factors, thereby improving the prognosis of patients and reducing the incidence of puerperal infection [25].

## STRENGTHS AND LIMITATIONS

This study, to the best of our knowledge the first prospective, controlled study to date, we evaluated the prevalence of various of healthcare-associated maternal peripartum infections and the risk factors associated with them among women. Another strength in this study is that it is e prospective, multicentre cohort study, based on in-hospital and post-discharge surveillance data. The results of our investigation clearly show the important differences between in-hospital and post-discharge surveillance for detecting maternal peripartum infections in the obstetric population. The high incidence of maternal peripartum infections following deliveries by the vaginal route detected only after patients' discharge from the hospital seems to indicate that failing to do follow-up evaluation of these patients could result in an substantial miscalculation of the authentic peripartum infections rates.

This study expands upon the previous reports that focused on maternal morbidity associated with childbirth.

This study has some limitations. The survey data recorded the information of deliveries by the vaginal route, and

did not include cesarean section. In this study, we only specialized hospitals were selected, excluding general hospitals, there may be admission rate bias. These aspects need to be further improved. For relatively larger study population from different regions requires to be included to confirm our finding and even reflect data at national level, which may provide fundamental leads for the diagnosis and treatment of maternal peripartum infection.

## CONCLUSIONS

Results this study suggest a high prevalence of healthcare-associated maternal peripartum infections in Ukraine. The most of maternal peripartum infections were detected only after patient's discharge from the hospital and seems to indicate that failing to do follow-up evaluation of these patients could result in a substantial mis-calculation of the authentic peripartum infections rates. Therefore, data on post-discharge surveillance should be included to realistically estimate the true rates of peripartum infection in obstetric patients and to allow the implementation of measures to reduce infection. The most common maternal infections include endometritis, episiotomy infections, and maternal sepsis. Women in peripartum period are risky to develop different types healthcare-associated infections. In present study several factors have been associated with increased risk of maternal peripartum infections, including pre-existing maternal conditions (e.g. gestational diabetes mellitus, obesity, anemia during pregnancy, bacterial vaginosis, and aerobic vaginitis), placenta previa, prolonged rupture of membranes, and spontaneous or provider-initiated conditions during labour and childbirth (e.g., prolonged rupture of membranes, multiple vaginal examinations, and manual removal of the placenta). Rigorous analysis of levels and trends in exposure to leading risk factors for maternal peripartum infection and quantification of their effect on women health are important to identify where public health is making progress and in which cases current efforts are inadequate.

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**CONFLICT OF INTEREST**
The Authors declare no conflict of interest

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