Original Article

Rates of maternal infections in 15 health care facilities in Almaty region, Kazakhstan.

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ABSTRACT

Background

Maternal infections are a significant cause of mortality in Central Asia [1]. We present detailed information on maternal mortality for the Almaty region in Kazakhstan using data collected in the framework of the WHO GLOSS(World Health Organization, the global maternal sepsis study and awareness campaign). The purpose of this secondary data analysis and study was to characterize and assess the incidence of maternal infections in health facilities in Kazakhstan with the ultimate goal of improving practices for early detection and management, critical to comprehending the early care techniques.

Methods

Data was obtained in a one-week prospective cohort study in 15 facilities in the Republic of Kazakhstan using hospital records for all pregnant or recently pregnant women hospitalized with suspected or confirmed infections. The ratio of infections and infection-related severe maternal outcomes/1000 live births was calculated, and the distribution of demographic, obstetric, clinical characteristics and outcomes were analyzed using descriptive statistics. Chi-square tests were used to assess associations between demographic and clinical characteristics and infection severity.

Results

Information was collected on 137 pregnant or recently pregnant women with suspected or confirmed infection. This sample was characterized into three groups by infection severity: Group A, “less severe” (73%), group B, moderately severe (17.5%), and group C, most severe (9.5%). The rate of suspected or confirmed maternal infections in Kazakhstan was 93.7 pregnant and postpartum women per 1,000 live births, which is higher than the global rate (70.4) and comparable to upper-middle income countries (106.4), which also includes Kazakhstan[2].

Conclusions

In this first investigation of maternal sepsis in Kazakhstan, we found that the frequency of maternal infections requiring treatment is higher than in other LMICs. Results show that maternal infections contribute substantially to maternal mortality. Introducing effective evidence-based preventive practices will improve early detection and management of infections in health facilities[3].

INTRODUCTION

Obstetric sepsis is the third leading cause of maternal mortality (10.7%) in low and middle income countries (LMICs), compared to high income countries (HICs) at 4.7%[1,4]. Obstetric sepsis is “a life-threatening condition defined as organ dysfunction resulting from infection

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during pregnancy, labor, delivery, post-abortion, or the postpartum period"[4]. This definition is consistent with the definition of sepsis-3 for adults [5] and includes both direct and indirect infections related to labor and delivery[7,8].

The incidence of maternal sepsis ranges from 0.1 to 2.0 cases per 1000 live births globally, with 1-2 cases in LMICs [8] and 0.1-0.6 per 1000 live births in HICs [9]. While a recent study by Chen indicated that several countries in Central Asia may be suffering from high maternal mortality ratios, to our knowledge, there are no publications specific to maternal sepsis rates in the Republic of Kazakhstan. Zhamantayev et.al. suggested that mortality rates in Kazakhstan may have been impacted by the recent pandemic of COVID-19[9,11].

In accordance with the World Health Assembly resolution on sepsis, the "Global Initiative on Maternal and Neonatal Sepsis"[4,5], and within the framework of the WHO project "Global Study of Maternal Sepsis" (GLOSS), a prospective study to help quantify the true burden and assess the current management of maternal and neonatal sepsis has been implemented in 52 countries in 2017. While the overall results have been published[11], there were no regional publications highlighting the data specific to the Republic of Kazakhstan.

To improve understanding of the epidemiology and predictors of maternal infections and sepsis in healthcare facilities, a detailed analysis of regional GLOSS results in Kazakhstan was conducted to identify the rate of maternal infections in relation to demographic, obstetric, clinical characteristics and outcomes. The paper also evaluated key methods for the early detection and treatment of maternal infections in the 15 medical institutions of Kazakhstan that provided data for the study. The overarching aim of this study is to harness the information on maternal infection rates to build a primary prevention system to lower the rate of maternal infection in Kazakhstan.

METHODS

Study design and participants

The present study is a one-week (from 00 h. 00 a.m. Tuesday, November 28, 2017, to 24 a.m. Monday, November 4, 2017. 00 a.m. Monday, December 4, 2017) inception prospective cohort study [12] of women with suspected infections, conducted in 15 public health and medical facilities in the Almaty region and Almaty city[2,5].

In the Republic of Kazakhstan, the region of Almaty district and Almaty city (3650963 residents) was selected for inclusion in the global study, as the population size met the requirement of GLOSS project. The number of inhabitants is known and at least two million, the institutional birth coverage is at least 30%,the sum of all childbirths that took place in health facilities located in candidate geographical area is at least 15,000 births per year and a minimal coverage of about 95% of all facility-based births in the geographical area - which covered 1461 births in one week and suspected or diagnosed infection was reported for 137 women (9.3%).

The healthcare facilities participating in the study were state-owned, with ten urban locations (66.7%), four suburban (26.6%), and one rural (6.7%). The distribution by level of perinatal care in these medical facilities was as follows: tertiary level (hospitalization of women with complicated pregnancy, premature birth in gestation periods from 22 to 34 weeks, as well as pregnant women, women in labor and postpartum women who have a high risk of perinatal pathology) - six facilities (40%); secondary level (with an uncomplicated pregnancy, risk of premature birth in gestational ages of 34 weeks or more, as well as for pregnant women, women in labor and postpartum women with moderate risks of perinatal pathology) - nine (60%); 0% hospitalized women in facilities of first level of perinatal care (pregnant women, women in labor and postpartum women who have no risk of perinatal pathology).

Inclusion criteria

All women were admitted or already hospitalized with suspected or confirmed infection at any gestational age and up to 42 days after abortion or delivery. Inclusion criteria for the study were a list of infections accompanied by systemic complications during pregnancy, labor, delivery, post-abortion and postpartum[7]. All 137 eligible women agreed to participate. Participants were divided into three groups according to the severity of infection (Figure 1):

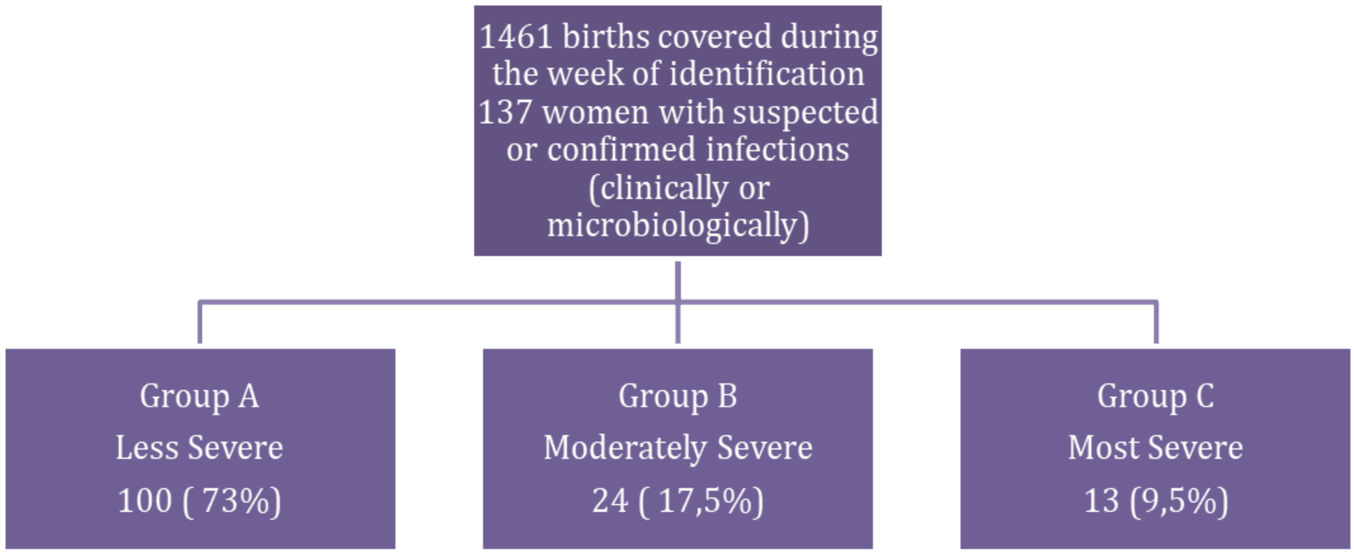

Figure 1: Profile of research in Republic of Kazakhstan

- Group A-less severe maternal infections (Conservative treatment)
- Group B-moderately severe maternal infections with complications (Includes women who have undergone an invasive procedure to treat the source of infection like vacuum aspiration, dilatation & scraping, wound management, drainage, laparotomy & lavage, other surgeries, ICU hospitalization)
- Group C-most severe infection-related maternal near-miss (at least one WHO critical condition criterion)

Data on clinical conditions, physical examination results, preventive and treatment measures, were collected according to the approved study protocol [4].

Follow-up of the study participants continued throughout their stay in the health care facility. Follow-up of participants' newborns continued until their discharge from the hospital or until seven days after their birth.

The individual data form included information on the demographic, obstetric, and clinical characteristics of the women. This information covered the infections and infection management during the health facility stay, as well as pregnancy, maternal, and neonatal outcomes.

Statistical analysis

Descriptive statistics were used to summarize key study variables, including proportions and 95% confidence interval for categorical variables and medians and interquartile ranges (IQRs) for continuous variables. Chi-square tests were used to assess the associations between demographic and clinical characteristics and infection severity. Statistical analysis was performed using SAS version 9.4[13].

Ethical approval

Approval for this study was obtained from the WHO Ethics Committee (№9 09.22.2017 A-ID 65787) of the Central Ethics Commission under the Ministry of Health of the Republic of Kazakhstan.

RESULTS

During the analyzed observation period, out of 1461 deliveries, 137 women had suspected or confirmed infections, thus the incidence of maternal infections was 9.4% and the rate of maternal infections was 93.8 per 1000 live births. Characterization of maternal infections according to infection severity group are presented in Figure 1. The rate of hospital-acquired maternal infections (suspected or confirmed) was 68.4 per 1,000 live births with less severe infections, 16.4 per 1,000 live births with moderately severe infections, and 8.9 per 1,000 live births with severe infection-related maternal outcomes. No maternal deaths were registered in Kazakhstan during the study period. Participant demographic and clinical characteristics and associations with infection severity group are presented in Table 1.

Table 1. Sample demographic, obstetric, and clinical characteristics and the association with infection severity

Characteristic	WholeSample (N = 137)	InfectionSeverityStatus			
		Group A Less Severe (n = 100)	Group B Moderately Severe (n = 24)	Group C Most Severe (n = 13)	P value[1]
	n (%)	n (%)	n (%)	n (%)	
Age, years					0.11
< 20	4 (2.9)	3 (3.0)	1(4.2)	0 (0)	
20 to 35	105 (76.6)	82 (82.0)	14 (58.3)	9 (69.2)	
> 35	28 (20.4)	15 (15.0)	9 (37.5)	4 (30.8)	
Living with spouse or partner	133 (97.1)	97 (97.0)	24 (100.0)	12 (92.3)	>0.05
Number ofpreviousbirths					0,34
0	55 (40.1)	42 (42.0)	9 (37.5)	4 (30.8)	
1 to 2	55 (40.1)	41(41.0)	7 (29.2)	7 (53.8)	
> 2	27 (19.7)	17 (17.0)	8 (33.3)	2 (15.4)	
Pregnancy status at the time of infection					0.001
Pregnant, not in childbirth process	51 (37.2)	45 (45.0)	1 (4.2)	5 (38.5)	
Pregnant, inchildbirthprocess	8 (5.8)	8 (8.0)	0 (0)	0 (0)	
Post-partum	61 (44.5)	35 (35.0)	20 (83.3)	6 (46.2)	
Post-abortion	17 (12.4)	12 (12.0)	3 (12.5)	2 (15.4)	
Location at the time of infection suspected or confirmed					>0.05
Delivered to hospital from home	67 (48.9)	56 (56.0)	5 (20.8)	6 (46.2)	
Hospitalized, non-ICU	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Hospitalized, non-ICU	70 (51.1)	44 (44.0)	19 (79.2)	7 (53.8)	
Hospitalized, ICU	8 (5.8)	0 (0)	7 (79.2)	1 (7.7)	
Othercomplications					0,23
Anemia during pregnancy, Hb <11 g/dL	79 (57.7)	54 (54.0)	15 (62.5)	10 (76.9)	
Pregnancy-relatedhypertension	12 (8.8)	5 (5.0)	5 (20.8)	2 (15.4)	
Pre-existingmedicalcondition	5 (3.6)	2 (2.0)	2 (8.3)	1 (7.7)	
Post-partumhemorrhage	6 (4.4)	2 (2.0)	2 (8.3)	2 (15.4)	
Obstructedlabor	1 (0.7)	- (0.0)	1 (4.2)	-	

[1]Derived from Chi-square tests.

This table provides a comprehensive summary of demographic, obstetric, and clinical characteristics of the study population, stratified by the severity of maternal infections into three groups: Group A (less severe infections), Group B (moderately severe infections), and Group C (most severe infections). The data is presented as counts and percentages for each subgroup, along with P values derived from Chi-square tests to assess statistical significance. Below, the key sections of the table are described, along with what each reveals about the study population and the association with infection severity.

1. Age Distribution

This section categorizes participants by age groups (<20, 20–35, and >35 years) and compares the distribution across the severity groups. While the majority of the sample fell within the 20–35 age range (76.6%), there is a notable increase in the proportion of women over 35 years in the moderately and most severe groups (37.5% and 30.8%, respectively). Although the P value (0.11) is not statistically significant, the trend suggests advanced maternal age may predispose women to more severe infections.

2. Marital and Partner Status

Nearly all participants (97.1%) reported living with a spouse or partner. No significant differences were observed between infection severity groups (P > 0.05), suggesting marital or partner status did not influence the severity of maternal infections.

3. Number of Previous Births (Parity)

Parity is presented as three categories (0, 1–2, and >2 births). Women with >2 previous births showed a higher rate of moderately severe infections (33.3%), but there was no significant association between parity and infection severity (P = 0.34). This suggests parity alone may not be a primary risk factor but could interact with other factors to influence outcomes.

4. Pregnancy Status at the Time of Infection

This section identifies the participants' pregnancy status at the time of infection:

- Pregnant (not in labor)
- Pregnant (in labor)
- Postpartum
- Post-abortion

A statistically significant association was found between pregnancy status and infection severity (P = 0.001). Postpartum women constituted a disproportionate share of the moderate (83.3%) and severe (46.2%) groups, indicating the postpartum period is particularly high-risk for severe infections.

5. Location at Time of Infection Diagnosis or Suspicion

The location of the participants at the time of infection diagnosis (home, non-ICU hospital ward, or ICU) highlights the clinical context of their care. ICU admissions were strongly associated with infection severity. While no women with less severe infections (Group A) required ICU care, 79.2% of those with moderately severe infections and 7.7% of those with the most severe infections (Group C) were admitted to the ICU. This underscores the critical role of ICU care in managing severe maternal infections.

6. Other Complications

This section lists complications frequently associated with maternal infections, including anemia during pregnancy (hemoglobin <11 g/dL), pregnancy-related hypertension, pre-existing medical conditions, postpartum hemorrhage, and obstructed labor.

- Anemia: Present in 57.7% of the sample, anemia rates increased with infection severity, reaching 76.9% in the most severe group, though this trend did not achieve statistical significance (P = 0.23).
- Other Complications: Pregnancy-related hypertension (20.8%), pre-existing conditions (7.7%), and postpartum hemorrhage (15.4%) were more common in severe cases.

This table reveals critical insights into the factors associated with the severity of maternal infections:

1) Advanced maternal age (>35 years) and postpartum status are more prevalent among women with severe infections.

2) ICU admission is strongly linked to severe outcomes, indicating its necessity for managing critical cases.

3) Anemia and other obstetric complications, such as postpartum hemorrhage, are increasingly prevalent as infection severity worsens.

DISCUSSION

This was the first study in Kazakhstan to provide data on the frequency and hospital-acquired management of infections and their complications throughout pregnancy and the postpartum period. Conducted according to the WHO uniform methodology [4], this study provides an overview of the frequency of maternal infections according to obstetric, clinical characteristics, and laboratory results, as well as the use of basic methods of prevention, early detection, and treatment of maternal infections.

According to our data, the rate of suspected or confirmed maternal infections in Kazakhstan was 93.7 pregnant and postpartum women per 1,000 live births, which is higher than the global rate (70.4) and comparable to upper-middle income countries (106.4), which also includes Kazakhstan[2].

The rate of complicated maternal infections in Kazakhstan was 16.4 per 1,000 live births, which is higher than worldwide average (10.9) and in upper-middle income countries (15.0). The rate of infections with critical outcomes amounted to 8.9 per 1000 live births, which is lower than the similar rate in the world (10.2) and in upper-middle income countries (14.9), but higher compared to high income countries (0.6). This is due to different approaches in diagnosing septic complications in pregnant and postpartum women in the Republic of Kazakhstan than in upper-middle-income countries, where health facilities may have lower criteria for hospitalization of women with infection.

It should be noted that almost half (57.7%) of patients with maternal infections had anemia, the figure is higher than worldwide data (36.3%) [2]. Patients with maternal infections were detected much more frequently (51.1%) among those already hospitalized in non-intensive care units, while in the world - much less frequently (32.6%) [2]. Hypertensive conditions of pregnant women were registered more often in patients with complicated infections (20.8%), while a similar indicator worldwide was 12.9% [2].

In 100% of cases, identification of infection was performed by clinical and laboratory tests, 16.1% by clinical and imaging (USD, CT scan), and in 11.7% by clinical, laboratory, and imaging methods.

Severe complications of maternal infection developed in 37 women (27%), while the full set of vital signs recorded on the day of suspicion or confirmation of infection was assessed only in 8 women (5.8%), in world practice this figure is 63.9% [2], and sampling for culture was performed in 21% of patients, in the world - 46.6%[2]. Meanwhile, 86.9% of women in Kazakhstan received antibiotics or other antimicrobials on the day of suspected or diagnosed infection, indicating their irrational use in clinical practice due to the absence of information about the pathogen at the time of treatment[12].

The results in the Republic of Kazakhstan show that additional measures to control the source of infection in the group of critically ill patients were applied in the form of hysterectomy (23.1%), which is much higher than the global practice (14.4%) in this group [2].

When analyzing the outcomes of pregnancy in the Republic of Kazakhstan, it is noteworthy that at the end of observation, 46.5% of newborns in patients with detected infection during pregnancy and delivery were discharged in satisfactory condition, while in world practice this figure is much higher (84.6%). In Kazakhstan, in patients with complicated infections and in critical condition, stillbirths were registered much more often (8.7% and 12.5%), while this trend is similar to the corresponding world indicators (7.5% and 12.2%).

A full set of vital signs on the day of suspicion or diagnosis of infection was not recorded in more than 90% of women in Kazakhstan, and only one in four in the group with severe outcomes, which calls for systematic changes in the assessment of women seeking care for pregnancy related issues. The timing of treating suspected infection with antibiotics suggests the need to improve methods of laboratory bacterial diagnostics. This can be donetrough the implementation of modern laboratory diagnostic methods into medical practice such as time-of-flight mass spectrometry capable of detecting in one sample of biological material any microorganism from more than 4,500 species available in its database within a few minutes[14]. Mass spectrometry and determination of sensitivity to antimicrobial drugs by disco-diffusion methods will eliminate the human factor when identifying the pathogen and choosing a treatment method. Therefore, an important aspect of reducing maternal infections is good practice in the identification of the causative agent bacteria, viruses, fungi) and the justified use of antibiotics (only for bacterial infections).

Implementation of surveillance algorithms that include monitoring of temperature, systolic BP, pulse rate, level of consciousness, urine output, and mode of delivery, which are widely applicable for clinical use in resource-limited settings is very important for women with

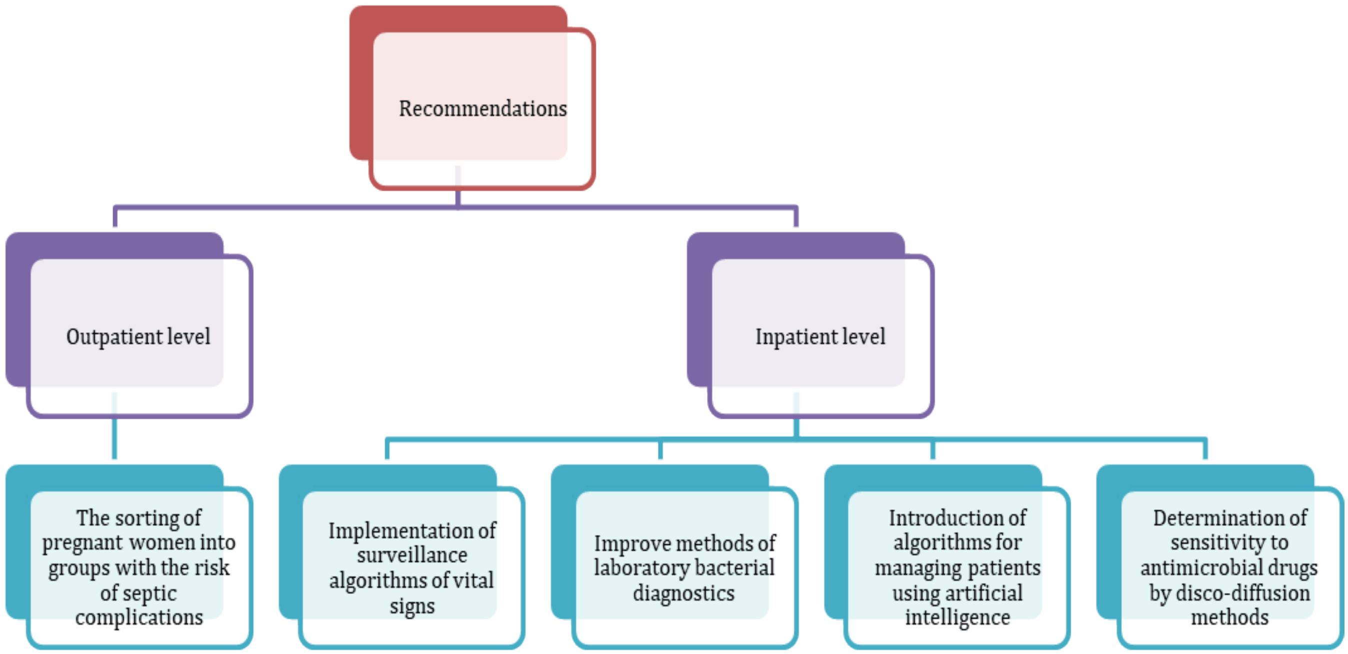

Figure 2. Suggested recommendations

suspected infection[15]. Timely and complete delivery of the emergency algorithm (one-hour and three-hour packages) also contributes to mortality reduction. Every hour antibacterial therapy initiative delay increases the risk of mortality from septic conditions [16]. The sorting of pregnant women into risk groups for septic complications based on anamnestic data (chronic sources of infection in pregnant women) will help to increase the alertness of medical workers. An auxiliary tool may be the introduction of algorithms for managing patients using artificial intelligence into existing integrated medical information systems, based on the fact that artificial intelligence can quickly analyze large amounts of clinical data to identify early signs of sepsis, sometimes even before the symptoms become apparent to medical personnel. By analyzing a huge amount of clinical data, AI algorithms can identify predictors of sepsis[15,16]. Despite the advantages of implementation AI in healthcare, there may be difficulties along the way associated with the risks of cyber-attacks, legal liability in case of actions leading to deterioration of the condition or death, as well as distrust of medical workers[19,20,21].

Thus, the incidence of maternal infections in Almaty region of Kazakhstan is higher than previously thought, warranting further research studies and potentially policy adjustments. The most common sources of infections identified in this study were respiratory and urinary tract infections, endometritis, chorioamnionitis, and others. This calls for increased infection control measures for pregnancy, labor and delivery, as well as postpartum period. A summary of recommendations is provided in Figure 2. The weakness of this study was it is limited samples size and this study being limited to one region, potentially limiting generalizability to the rest of Kazakhstan. The strength of the study was to capitalize on the infrastructure of the larger GLOSS study and its uniform data collection methods. In the future, we intend to expand our investigations to include other regions of Kazakhstan and Central Asia.

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