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Perinatal outcome in women with bacterial sepsis

A cross-sectional study from West China

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Abstract

Maternal bacterial sepsis during pregnancy and the postpartum period is a common cause of maternal mortality and fetal morbidity and mortality. This study was performed to analyze perinatal prognosis and related factors of maternal bacterial sepsis in west China.

We conducted a cross-sectional study of pregnant women with bacterial sepsis who were admitted into a tertiary care center in western China between 2011and 2015. Data from these cases were collected and analyzed.

Eighty six women were identified with bacterial sepsis in our hospital, and the incidence of maternal bacterial sepsis was 1.7 per 1000 maternities, the incidence of septic shock was 1.8 per 10,000 maternities, and 1 maternal death occurred. Among the 86 pregnant women with bacterial sepsis, genital tract infection was the most common source of infection (41/86, 47.7%). The most common bacteria in the Gram-positive bacteria group was *Listeria monocytogenes* and in the Gram-negative bacteria group was *Escherichia coli*. The premature delivery rate (65.7%) was substantially higher in the Gram-negative bacteria group ($P = .011$), and the miscarriage rate (31.3%) was higher in the Gram-positive bacteria group ($P = .042$). The fetal/neonatal mortality rate was 20% (21/105) and higher in the Gram-positive bacteria group ($P = .008$), and the infant mortality rate in 1 year was 7.1% (6/84).

Bacterial sepsis remains an alarming cause of both maternal and fetal morbidity and mortality, and infant mortality. Key treatment involves a multi-disciplinary group of clinicians with experience in all aspects of the care of pregnant women with sepsis and early initiation of appropriate antibiotics according to the type of bacterial infection. The effect of maternal sepsis on long-term fetal outcome should be investigated.

Abbreviations: ACCP = the American College of Chest Physicians, ATS = the American Thoracic Society, CS = cesarean section, ESICM = the European Society of Intensive Care Medicine, GDM = gestational diabetes mellitus, ICU = intensive care unit, NICU = neonatal intensive care unit, NRDS = neonatal respiratory distress syndrome, PROM = premature rupture of the membrane, RCOG = Royal College of Obstetricians and Gynaecologists, SCCM = the Society of Critical Care Medicine, SIS = the Surgical Infection Society, UK = United Kingdom.

Keywords: bacterial sepsis, fetal outcome, maternal outcome, pregnancy

1. Introduction

Sepsis occurs as a result of a systemic maladaptive inflammatory response to an infectious insult. The incidence of sepsis has continued to increase recently, and the economic burden, mortality, and morbidity are remarkable.[1–4] Sepsis is a common cause of death in developed countries. During pregnancy, pregnant women undergo physiological changes, anatomical changes and a complicated modulated immune response, which increases the risk of infection.[5,6] Maternal bacterial sepsis is a common pregnancy-related disease. It is a leading cause of maternal mortality worldwide, making up a relatively significant share of maternal deaths and maternal admissions to the intensive care unit (ICU).[7–9] In the United States, sepsis accounts for up to 28% of maternal deaths and up to 15% of maternal admissions to the ICU.[10–14] In the United Kingdom, the incidence of severe sepsis in 2011 to 2012 was 4.7/10,000 maternities, incidence of maternal septic shock was 19.5%, and 1.4% women died.[15] Diagnosis and clinical management of maternal sepsis must be

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RD and XX contributed equally to this work.

This study was approved by the Institutional Review Board of West China Second University Hospital and informed consent was obtained from each patient.

Written informed consent was obtained from the patient or relatives for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor of this journal.

The dataset supporting the conclusions of this article is included within the article and its additional files.

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performed in a timely manner and can mitigate maternal and fetal morbidity and mortality. However, there have been few reports on maternal bacterial sepsis, especially regarding developing countries and fetal outcome, and fetal survival after birth in maternal sepsis. We conducted a retrospective study in 1 West China center to analyze the related factors, causative microorganisms, and maternal, fetal, and neonatal outcomes of maternal bacterial sepsis.

2. Methods

This was a retrospective study. Ethical approval was acquired from the Institutional Review Board of West China Second University Hospital, and informed consent was obtained from each patient. Medical records were reviewed of pregnant and postpartum women with bacterial sepsis who were admitted from 2011 to 2015 to the regional tertiary referral center by referral from maternal-fetal medicine specialists, critical care specialists, and maternal and neonatal ICUs of the West China Second University Hospital. Neonatal medical records were also reviewed. The study definition of sepsis was based on consensus definitions introduced by the American College of Chest Physicians and the Society of Critical Care Medicine 1992[16] and the 2001 SCCM/ESICM/ACCP/ATS/SIS International Sepsis Definitions Conference.[17] Peripheral blood cultures were immediately collected, when possible, before administration of antibiotics. Bacterial agents were also confirmed by cultures of other sites as clinically indicated, including urine culture, vaginal swabs, amniotic fluid, placental swabs, episiotomy wound swabs, and caesarean wound swabs. A consultant obstetrician, a physician experienced in the management of infection, an intensive care physician, and neonatologists were involved.

Patients with acute pulmonary embolism, amniotic fluid embolism, adverse drug reactions, drug fever, viral infection, autoimmune conditions, and transfusion reactions were excluded from this study.

Details of the data were reviewed. Maternal information included demographic characteristics at the time of admission, gestational age, obstetric history, complications, laboratory values, infection source, culture of microbial agents, delivery information, duration of hospital stay in days, and relevant information to anesthetic and intensive care treatment. Neonatal data included gestational age at delivery, Apgar scores, and long-term survival during the first year after childbirth.

2.1. Statistical analyses

Descriptive statistical analyses were made using means with standard deviations and medians with ranges and frequencies. Parameters were analyzed using the Fisher exact test, Chi-Squared test, and *t* test. To determine whether maternal and fetal outcomes changed between microbiological ingredients, 2 study groups were compared using non-parametric tests. All *P* values were two-sided, and $P < .05$ was considered statistically significant. Statistical analyses were performed with SPSS version17.0.

3. Results

Between 2011 and 2015, 49,496 women gave birth in our hospital. Eighty six women were diagnosed with bacterial sepsis, including 70 cases caused by Gram-negative bacteria and 16 cases caused by Gram-positive bacteria, according to microbiological cultures. The incidence of maternal bacterial sepsis was 1.7 per 1000 maternities (86/49,496). The mean maternal age of the 86 patients was 30.0 years (range 16–42 years). The mean hospital stay was 17.38 days. Twenty one percent (18/86) of cases were multiparous women, and 34.9% (30/86) of cases were rural residents. Maternal characteristics of these bacterial sepsis patients are shown in Table 1.

Among these women with bacterial sepsis, there were 23 cases of severe sepsis, of which 9 cases eventually turned into septic shock. The incidence of septic shock was 1.8 per 10,000 maternities (9/49,496). In the present study, antepartum sepsis was the most common. Forty three cases occurred during the antenatal period, 11 cases during the intrapartum period, and 32 cases during the postpartum period (all occurring within the first week after delivery). In the antepartum sepsis group, 25.6% (11/43) cases were induced with Gram-positive bacteria and 74.4% (32/43) cases were due to Gram-negative bacteria. The infection time of bacterial sepsis in the 2 groups is displayed in Table 2.

For cases of antepartum sepsis with intrauterine infection, timing of the deliveries was considered. Corticosteroids were used for fetal lung maturation in preterm delivery. For cases with sepsis due to extra-uterine infection or gestational age remote from term, effective efforts were applied to treat maternal sepsis and prolong pregnancy as much as possible. Among 32 postpartum sepsis patients, 25 cases (25/32, 78.1%) were delivered by CS, 7 cases (7/32, 21.9%) were delivered vaginally including 4 cases (4/32, 12.5%) delivered with instrumental assistance. Postpartum sepsis all happened within 1 week after delivery.

The median diagnosis-to-delivery interval for women with antenatal sepsis was 6.64 days in the Gram-positive bacteria group and 8.06 days in the Gram-negative bacteria group. No statistical difference was found between 2 groups. In 32 postpartum sepsis cases, 3 cases (9.4%, 3/32) were caused by Gram-positive bacteria and 29 cases (90.6%, 29/32) were caused by Gram-negative bacteria. In 11 intrapartum sepsis cases, 2 cases (18.2%, 2/11) were caused by Gram-positive bacteria and 9 cases (81.8%, 9/11) were caused by Gram-negative bacteria. The median time between delivery and occurrence of sepsis in these cases was 0.67 days in the Gram-positive bacteria group and 1.45

Table 1

Characteristics of cases with bacterial sepsis.

	Gram positive bacteria group (n = 16)	Gram negative bacteria group (n = 70)	*P* value	Statistical method
Age (years)	29.75	30.07	.856	*t* test
hospital stays (days)	13.63	18.24	.174	*t* test
Multipara	3 (18.75%)	15 (21.43%)	.558	Chi-Squared
Rural residence	7 (43.75%)	23 (32.86%)	.409	Chi-Squared
CS delivery	7 (43.75%)	40 (57.14%)	.332	Chi-Squared

CS = cesarean section.

Table 2

Perinatal data of 86 pregnant women.

	All (n = 86)	Gram-positive bacteria group (n = 16)	Gram-negative bacteria group (n = 70)	*P* value	Statistical method
Sepsis timing					
Antepartum	43	11	32	.096	Chi-Squared
Postpartum	32	3	29	.090	Chi-Squared
Intrapartum	11	2	9	.969	Chi-Squared
Pregnancy termination timing					
Preterm deliveries	51	5	46	**.011**	Chi-Squared
Term deliveries	23	6	17	.349	Chi-SquareD
Miscarriage	12	5	7	**.042**	Chi-Squared
Site of infection					
Genital tract	41	9	32	.447	Chi-Squared
Urinary tract	17	5	12	.294	Chi-Squared
Lung	16	4	12	.485	Chi-Squared
Other	12	3	9	.689	Chi-Squared
Maternal complications					
PROM	27	5	22	.989	Chi-Squared
Placenta previa	16	4	12	.485	Chi-Squared
GDM	13	2	11	1	Chi-Squared
Severe preeclampsia	11	0	11	.116	Chi-Squared
Abnormal labor	2	1	1	.339	Chi-Squared
Postpartum hemorrhage	2	0	2	1	Chi-Squared
Maternal ICU admission	32	7	25	.549	Chi-Squared
Maternal death	1	0	1	1	Chi-Squared
Fetal/neonatal outcome					
Mean Apgar score		6.33	7.58	.339	*t*-test
NICU admission	17	4	13	.511	Chi-Squared
Fetal/neonatal death	21	8	13	**.008**	Chi-Squared
Infant death within one year	6	2	4	.336	Chi-Squared

GDM = Gestational diabetes mellitus, ICU = intensive care unit, NICU = neonatal intensive care unit, PROM = Premature rupture of the membrane.

days in the Gram-negative bacteria group. No statistical difference was found between 2 groups.

3.1. Source of infection

The source of infection was investigated in all cases. Genital tract infection was the most common source of infection (41/86, 47.7%). Of these cases, 36 (36/41, 87.8%) cases were complicated with chorioamnionitis by pathological investigation. In addition, out of 86 cases, infections were caused by urinary tract infections in 17 (19.8%, 17/86) cases, lung infections in 16 (18.6%, 16/86) cases, and other sources in 12 (14.0%) cases (3 abdominal incision infections, 1 necrotic appendicitis, 1 inflammatory ileus, and 7 of unknown origin). Characteristics of the infections in 2 study groups are shown in Table 2.

3.2. Bacterial organism

In the Gram-negative bacteria group, *Escherichia coli* was the most frequently isolated microorganism (n = 38) responsible for sepsis, which was responsible for 54.3% (38/70) of cases. Other infections from Gram-negative bacteria included *Acinetobacter baumannii* in 13 cases, *Pseudomonas putida* in 7 cases, *Klebsiella pneumoniae* in 4 cases, *Acinetobacter lwoffii* in 3 cases, *Pseudomonas fluorescens* in 2 cases, *Pseudomonas alcaligenes* in 1 case, *Acinetobacter junii* in 1 case and *Enterobacter cloacae* in 1 case. In the Gram-positive bacteria group, *Listeria monocytogenes* was the most common bacterial organism, which was responsible for 43.8% (7/16) of cases. Other infections from Gram-positive bacteria included *Enterococcus faecalis* in 4 cases, *Staphylococcus epidermidis* in 3 cases, and *Staphylococcus aureus* in 2 cases. Bacterial organisms of these bacterial sepsis patients are shown in Table 3.

3.3. Maternal complications

Maternal complications were investigated. Premature rupture of the membrane (PROM) was the most common complication in all cases of maternal bacterial sepsis. In the Gram-positive bacteria group, there were 5 cases with PROM, 4 cases with placenta previa, 2 cases with gestational diabetes mellitus (GDM), and 1 case with abnormal labor. However, in the Gram-negative bacteria group, there were 22 cases with PROM, 12 cases with placenta previa, 11 cases with GDM, 11 cases with severe preeclampsia, 2 cases with postpartum hemorrhage, and 1 case with abnormal labor. There was no statistically significant difference between the 2 groups of the variable maternal complications.

In our study, after positive treatments with fluid resuscitation, correction of hypoxia, antibiotics, vasopressors, mechanical ventilation or hemodialysis, and admission into ICU, there was only 1 maternal death. This patient was a 34-year-old pregnant woman with severe preeclampsia in the third trimester and was admitted into our ICU at 35 weeks' gestation and 2 days for chronic cardiac functional insufficiency due to dilated cardiomyopathy. CS was performed at 35 weeks' gestation and 5 days. One day after operation, acute heart failure and sepsis occurred suddenly. Although positive treatments were given to the patient,

Table 3

Bacterial organisms with bacterial sepsis.

Gram positive bacteria group (n = 16)		Gram negative bacteria group (n = 70)	
Bacterial organisms	**Number of cases**	**Bacterial organisms**	**Number of cases**
Listeria monocytogenes	7	*Escherichia coli*	38
Enterococcus faecalis	4	*Acinetobacter baumannii*	13
Staphylococcus epidermidis	3	*Pseudomonas putida*	7
Staphylococcus aureus	2	*Klebsiella pneumoniae*	4
		Acinetobacter lwoffii	3
		Pseudomonas fluorescens	2
		Pseudomonas alcaligenes	1
		Acinetobacter junii	1
		Enterobacter cloacae	1

she died 2 days after the operation due to uncontrollable heart failure. *A baumannii* was found in her blood culture. Her baby is healthy as of this writing.

3.4. Fetal and neonatal outcome

Among the 86 women with sepsis, there were 51 cases with preterm births (67 premature infants including 14 cases of twins and 1 case of triplets), 12 cases with miscarriages (14 lost fetuses including 2 cases of twins) and 23 cases with full-term births (24 babies including 1 case of twins). For premature infants and miscarriages, there were 46 premature infants (including 12 cases of twins and 1 case of triplets) and 10 fetuses lost to miscarriage (including 2 cases of twins) among women with antenatal sepsis. There were 13 premature infants and 1 loss to miscarriage among women with postpartum sepsis. There were 8 premature infants (including 2 cases of twins) and 3 fetuses lost to miscarriage among women with intrapartum sepsis.

In the Gram-positive bacteria group, there were 5 cases of preterm delivery and 5 cases of miscarriage. However, there were 46 cases with preterm deliveries and 7 cases with miscarriages in the Gram-negative bacteria group. There was a higher tendency of preterm deliveries in the Gram-negative bacteria group ($P = .011$) and higher incidence of miscarriages in the Gram-positive group ($P = .042$). Seventeen live-born neonates were transferred to the neonatal ICU (NICU). No statistical difference was found in the Apgar score at 5 minutes and the incidence of NICU admissions between the 2 groups. Detailed information is given in Table 2.

The outcome of 105 fetuses in the patients of this study was as follows: 67 premature infants, 14 miscarriages, and 24 full-term babies. Detailed information is provided in Table 4.

There were 7 fetal deaths and 1 neonatal death 2 minutes after delivery in the Gram-positive bacteria group, due to intrauterine infection, septic abortion, and twin transfusion syndrome. There were 9 fetal deaths and 4 neonatal deaths within the first week after delivery in the Gram-negative bacteria group, due to sepsis and various maternal complications. Detailed information is shown in Table 4. In this study, the rate of fetal/neonatal death among all fetuses in women with sepsis was 20.0% (21/105) as indicated in Table 2. The incidence of fetal/neonatal death was substantially higher in the Gram-positive bacteria group than in the Gram-negative bacteria group ($P = .008$).

Table 4

Detailed information of fetal death and neonatal death.

Case	Mode of delivery	Delivery weeks	Infecting weeks	Infecting time	Infection site	Infecting bacteria	singleton/multiple pregnancy	Fetal outcome
1	Induction	29^{+5}	29^{+5}	Postpartum	Pelvic	Listeria	singleton	FD
2	Induction	25^{+4}	25^{+3}	Antepartum	Pelvic	Listeria	singleton	FD
3	Induction	24^{+5}	24^{+1}	Antepartum	Respiratory	Listeria	twin	one FD, one died 2 minutes after delivery
4	Abortion	20^{+3}	20	Antepartum	Pelvic	Listeria	twin	two FD
5	Induction	21^{+4}	20^{+3}	Antepartum	Pelvic	G+ streptococcus	singleton	FD
6	Abortion	17^{+1}	17	Antepartum	unknown	G+ short Bacillus	singleton	FD
7	Induction	24^{+3}	22^{+6}	Antepartum	Unknown	Pseudomonas putida	singleton	FD
8	Abortion	18^{+3}	18^{+3}	Postpartum	Pelvic	Enterobacter cloacae	singleton	FD
9	Delivery	41	2 days	Postpartum	Pelvic	Escherichia coli	singleton	died 5 minutes after delivery
10	Induction	21^{+2}	1day	Postpartum	Pelvic	staphylococcus aureus	singleton	FD
11	Induction	23^{+2}	20^{+6}	Antepartum	Unknown	Pseudomonas fluorescens	singleton	FD
12	CS	32^{+6}	32^{+6}	Antepartum	Pelvic	Escherichia coli	twin	one FD, one died 2 days after delivery
13	CS	29^{+1}	29^{+1}	Antepartum	Pelvic	Escherichia coli	twin	both died 1 day after delivery
14	Abortion	18^{+3}	18^{+3}	Postpartum	Pelvic	Escherichia coli	singleton	FD
15	Abortion	20	20	Antepartum	Pelvic	Escherichia coli	singleton	FD
16	Abortion	17^{+2}	16^{+5}	Antepartum	Pelvic	Acinetobacter lwoffii	singleton	FD
17	Induction	40^{+2}	1day	Postpartum	Pelvic	Escherichia coli	singleton	FD

CS = cesarean section, FD = fetal death.

From the analysis given in Table 4, the fetal perinatal mortality rate (from 24 gestational weeks to 1 week after delivery) in this study was 10.5% (11/105).

One week after birth, only 84 neonates survived. Surviving neonates were followed-up until 1 year. There were 6 infant deaths during this period, all of whom were premature infants delivered before 32 gestational weeks. The infant mortality rate was 7.1% (6/84). Among them, 4 cases did not survive due to severe neonatal pneumonia and neonatal respiratory distress syndrome (NRDS), and 2 cases did not survive due to multiple organ failure and severe sepsis. Within this period, there were 2 infant deaths in the Gram-positive bacteria group and 4 infant deaths in the Gram-negative bacteria group. No statistically significant difference was found in the infant death rate between the 2 groups, as shown in Table 2.

4. Discussion

Sepsis is broadly defined as life-threatening organ dysfunction caused by a dysregulated host response to infection. Septic patients may progress to develop septic shock, multi-organ failure, or death. Despite an overall decline in maternal mortality in developed countries with medical infrastructure, the maternal mortality rate from sepsis has increased recently. The maternal mortality rate from sepsis has increased from 0.6 per 100 000 in 2003 to 2005 to 0.8 per 100 000 in 2008 to 2012 in Australia.[18] In the UK, the incidence of severe sepsis in 2011 to 2012 was 4.7 per 10,000 maternities; maternal septic shock affected 19.5% of these women and 1.4% died.[15] During 2005 to 2012 in Ireland, the sepsis rate was 1.81 per 1000 pregnant women.[19] In this study, the incidence of sepsis in West China from 2011 to 2015 was 1.7 per 1000 maternities, the incidence of septic shock was 1.8 per 10,000 maternities, and the mortality rate in maternal sepsis was 1.16%. These are consistent with the reported rates.

Sepsis can appear at any stage of pregnancy and can be serious and potentially life-threatening. Maternal bacterial sepsis is a significant type of sepsis caused by certain bacteria during pregnancy or the postpartum period. Sepsis, especially maternal bacterial sepsis, remains the main contributor to maternal morbidity and mortality. However, during pregnancy, pregnant women undergo physiological changes, anatomical changes, and a complicated modulated immune response, which increase the risk of infection and may mask early signs of sepsis.[5,6,20,21] Timely diagnosis and treatment of maternal sepsis are crucial for preventing morbidity and mortality and ensuring healthy pregnancy and delivery. In microbiology, bacteria are divided into Gram-positive bacteria and Gram-negative groups according to Gram staining.[22] In bacterial sepsis treatment, this has important clinical significance in the selection of antibiotics according to the type of pathogenic bacteria.

Several studies have reported that infections in maternal sepsis are commonly polymicrobial, reflecting the anatomic continuity with the vaginal flora or from Gram-negative bacteria, which arises from a urinary source.[15,23,24]*Escherichia coli*, Group B *Streptococcus*, anaerobes, and *S aureus* are the predominant pathogens in maternal sepsis.[15,19] Sepsis-related maternal death is most commonly caused by Group A *Streptococcus*, which results in 25% of maternal deaths from sepsis in both Australia and the UK and resulted in 50% of maternal sepsis deaths in New Zealand between 2006 and 2013.[8,25]

In this study, *E coli* (44.19%, 38/86), *A baumannii* (15.12%, 13/86), and *Listeria monocytogenes* (8.14%, 7/86) were the predominant pathogens in maternal bacterial sepsis. We compared the maternal and fetal outcomes of maternal bacteria sepsis in bacteria with different Gram stains. As demonstrated in previous research, inflammation induced by sepsis can reduce maternal immunological tolerance to the fetus, which can result in abortion or premature birth.[5] Our data revealed that the incidence of premature deliveries in the Gram-negative bacteria group was as high as 65.7%, premature deliveries were substantially higher in sepsis due to Gram negative bacteria ($P = .011$), and abortion was substantially higher due to Gram positive bacteria ($P = .042$). Our results are consistent with recent epidemiological studies[26,27] and can be explained by timely completion of pregnancy and the lower maternal death rates.

Sepsis at any stage of pregnancy can be serious and potentially life-threatening and is associated with preterm delivery and a high perinatal mortality rate in sepsis before delivery. From 2005 to 2012 in Ireland, 17% of sepsis episodes occurred during the antenatal period, 36% occurred in the intrapartum period, and 47% occurred during the postpartum period.[19] In this study, antepartum infection was still the most common and accounted for 50.0% (43/86) of cases, with no obvious difference between the 2 study groups. Maternal complications such as PROM, placenta previa, GDM, and severe preeclampsia may contribute to antepartum sepsis.

The data used in this study revealed the most frequent distribution of infection sources was pelvic, and most cases were complicated with chorioamnionitis. This was consistent with the data given in previous research.[26] Cases of pelvic infection had higher incidence of PROM, placenta previa, and GDM and were more susceptible to infection by genital tract bacteria. In cases with extra-pelvic infections, most were found due to the urinary tract or lung infection. Acosta et al reported in the UK between 2011 and 2012, the largest proportion of cases was due to a genital tract infection (31.0%) and the most common organism causing infection was *E coli* (21.1%).[15] During 2005 to 2012 in Ireland, the source of infection was the genital tract in 61% of patients, the urinary tract in 25% of cases, miscellaneous etiology in 4% of cases, and primary infections in 10% of cases.[19]

Based on the published literature, maternal sepsis remains a significant reason for ICU admission and maternal mortality.[25,28–31] In our study, empirical treatment included fluid resuscitation, correction of hypoxia, hemodynamic monitoring, and intravenous antibiotics as appropriate. A consultant obstetrician and a physician experienced in the management of maternal sepsis were involved in the care of these cases. The patients with aggressive conditions in our study were all immediately transferred to the ICU of our tertiary care center. The ratio of ICU admission was up to 37.2% (32/86), and there was no statistically significant difference between the 2 study groups. This could be partially explained by the country's recent efforts toward reduction in maternal mortality as well as improvements such as equipping a special ICU for critically ill pregnant women in our unit. In this study, there was only 1 maternal death. This patient exhibited severe preeclampsia and dilated cardiomyopathy. Sepsis occurred due to *A baumannii* 1 day after surgery. Despite positive rescue treatments administered by a multidisciplinary team, she eventually died 2 days after surgery due to uncontrollable heart failure and sepsis. Her baby was followed-up, is growing normally, and is in good health.

According to the guidelines issued by RCOG, in a critically ill pregnant woman, birth of the baby may be considered if it would be beneficial to the mother, the baby, or both. If preterm delivery

is anticipated, cautious consideration should be given to the use of antenatal corticosteroids for fetal lung maturity in women with sepsis. The decision on the mode of delivery should be individualized by the consultant obstetrician with consideration of severity of maternal illness, duration of labor, gestational age, and viability. In this study, we performed labor induction, abortion, vaginal delivery, and CS according to the maternal condition and fetal condition. Maternal sepsis with or without hemodynamic instability may present with fetal distress, as uteroplacental circulation is not autoregulated.[32] To the best of our knowledge, fetal outcomes in maternal sepsis, especially long-term outcomes, have rarely been studied.[26,33,34] In this study, we found that mean Apgar scores and the incidence of neonatal ICU admission were worse in the Gram-positive bacteria group, though the difference was not statistically significant. Of note, the incidence of fetal/neonatal death was significantly higher in the Gram-positive bacteria group. Fetal outcomes in the Gram-positive bacteria group were more unsatisfactory, and this requires further investigation. Among microbiological cultures, *Listeria monocytogenes* was the most common species of the Gram-positive bacteria group and accounted for 6/8 fetal deaths. For early diagnosis and improvement of the fetal outcome, it is very important to detect *Listeria* in high risk pregnant women. In addition, no statistically significant difference was found in the incidence of fetal long-term deaths between the groups. When a mother has been found to have bacterial sepsis during the peripartum period, the neonatologist should be informed and prophylactic antibiotics should be considered to administer to the baby. Further follow-up and investigation of infants of women with maternal sepsis should be performed in the future.

Studies of maternal sepsis are made more challenging due to the normal physiological changes of pregnancy, and blood cultures are the key investigative tool and should be obtained prior to antibiotic administration. The limitations of our study include its retrospective nature.

5. Conclusion

Bacterial sepsis remains an alarming cause of both maternal and fetal morbidity and mortality, and infant mortality. Key treatment involves a multi-disciplinary group of clinicians with experience in all aspects of the care of pregnant women with sepsis and early initiation of appropriate antibiotics according to the type of bacterial infection. Prospective multicenter studies would be useful to investigate the effect of maternal sepsis on long-term fetal outcome.

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