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CLINICAL ARTICLE

A clinical review of maternal bacteremia

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ABSTRACT

Objective: To carry out a 4-year review of cases of bacteremia among obstetric patients. *Methods:* In a retrospective review, all cases of maternal bacteremia between 2009 and 2012 were identified from the laboratory database of Coombe Women and Infants University Hospital, Dublin, Ireland. The clinical records of each case were assessed. *Results:* During the study period, 37 584 obstetric patients attended the hospital. There were 58 cases of bacteremia: 19 were diagnosed prepartum, 20 intrapartum, and 19 postpartum. There were no maternal deaths. Two cases resulted in septic shock. Four cases were associated with early pregnancy loss, and 2 with stillbirth. Fifty-four cases occurred among 34 956 women who delivered a neonate weighing 500 g or more (0.15%). *Escherichia coli* most frequently caused prepartum and postpartum bacteremia, whereas *Streptococcus agalactiae* (β-hemolytic, Lancefield group B) most frequently caused intrapartum bacteremia. There was no association between the development of bacteremia and maternal risk factors including employment status, obesity, parity, smoking status, and maternal age. Most organisms cultured were sensitive to first-line antibiotics; there were no cases of bacteremia caused by multi-drug resistant organisms. *Conclusion:* The incidence of maternal bacteremia in the study population was low and was usually associated with good maternal and fetal outcomes.

1. Introduction

Sepsis has emerged as an important preventable cause of maternal death and serious morbidity [1]. Despite a decline in maternal deaths in the United Kingdom from eclampsia, thromboembolism, early pregnancy causes, and hemorrhage, there has been an increase in deaths related to sepsis from 0.73 deaths per 100 000 maternities in the period 1994–1996 to 1.13 deaths per 100 000 maternities during the period 2006–2008. Half of these deaths (13/26) were due to infection with *Streptococcus pyogenes* (β-hemolytic, Lancefield group A) [2]. However, a lack of robust data on maternal sepsis has led to calls for further reviews [1,3,4].

In view of the serious clinical implications for the woman and the fetus, the aim of the present study was to examine all cases of maternal bacteremia over a 4-year period in a large maternity hospital in a high-resource country. Coombe Women and Infants University Hospital, Dublin, Ireland, is a tertiary referral university maternity hospital in the capital of Ireland and is one of the largest maternity hospitals in Europe, delivering over 8500 infants weighing over 500 g per annum.

2. Materials and methods

In a retrospective review, all cases of maternal bacteremia between January 1, 2009, and December 31, 2012, were identified from the laboratory database of Coombe Women and Infants University Hospital, Dublin, Ireland. Because this was an internal clinical review, permission was not required from the Research Ethics Committee of the hospital and informed consent was not required.

Cases of maternal bacteremia were identified from the Department of Microbiology's database, which collected data via the Hospitals in Europe Link for Infection Control through Surveillance (HELICS). The laboratory has category A accreditation from the Irish National Accreditation Board. Data from cases of blood culture contamination, defined by laboratory protocol, were excluded from the study.

Diagnosis of bacteremia was based on the laboratory finding of bacterial growth on blood culture. Septicemia refers to a systemic disease associated with the presence of pathogenic microorganisms or their toxins in the blood. The hospital's policy is that all women with pyrexia of 37.9 °C or higher or with suspected clinical septicemia have a blood sample taken for culture and sensitivity. Other clinically relevant samples are taken concurrently for culture. Intra-operative antibiotic prophylaxis is routinely given to women undergoing cesarean delivery. Women are not screened routinely for *Streptococcus agalactiae* (β-hemolytic, Lancefield group B) carriage, but there are hospital guidelines for intrapartum prophylaxis for the fetus at risk of vertical transmission.

Obstetric and neonatal details were obtained from the hospital's computerized databases and from individual medical records. Cases

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were defined as maternal bacteremia if the blood culture was taken at any time during pregnancy or within 42 days of the end of pregnancy. The genital tract was confirmed as the route of infection if the same bacterium was cultured from the blood and from either a vaginal or placental sample, and the urinary tract was confirmed as the source if the same bacterium was cultured from the blood and from a urine sample. The route of infection was classed as "not confirmed" if no other cultured samples confirmed the presence of the bacterium.

Demographic data recorded included maternal date of birth, country of birth, parity, smoking status, and employment status. Maternal age was defined as the age at the time of the positive blood culture. Communication difficulties at the time of the first prenatal visit and the need for an interpreter were routinely recorded for all patients. The history and clinical course of the index illness was obtained from review of the medical notes for both the mother and the neonate. The characteristics of the general hospital population were based on data published annually; only mean values were available for this population.

Data were analyzed via Excel version 14.0 (Microsoft, Redmond, WA, USA). Differences between means were tested via a *t* test, and differences between proportions via χ^2 analysis. A *P* value of 0.05 or less was considered to be significant.

3. Results

During the 4-year study period, 37 584 obstetric patients attended the hospital, 2366 women had a blood culture performed, and 58 had maternal bacteremia confirmed. Fifty-four cases of bacteremia (0.2%) occurred among 34 956 women who delivered an infant weighing 500 g or more, and 4 cases (0.2%) occurred among 2628 women who experienced early pregnancy loss. The age profile, parity, employment status, smoking status, and prevalence of obesity among patients who developed bacteremia were similar to those of the total obstetric population (Table 1).

Among the women with bacteremia, there were no maternal deaths. Two women were diagnosed with septic shock and required treatment in the intensive care unit (ICU), but both recovered fully. Notably, 53% of the women were born outside the country compared with 31% in the rest of the obstetric population ($P < 0.001$) (Table 2). Among the 58 women with maternal bacteremia, 4 needed an interpreter to communicate with hospital staff.

The organisms cultured are shown in Table 3 according to the stage of pregnancy. The urinary tract was the most common route of infection for prenatal bacteremia. The genital tract was the most common route of infection for intrapartum and postpartum bacteremia. There was an equal incidence of infection with Gram-positive and Gram-negative organisms. *Escherichia coli* was the most frequently found microorganism. There were no cases of infection with multi-drug resistant organisms.

Table 1
Characteristics of the study population and general obstetric population.[a]

	Bacteremia cases (n = 58)	Total obstetric population (n = 37 584)	*P* value
Mean age, y	29.8 ± 6.1	31.4 (SD not available)	0.13
Nulliparous	37.9	41.1	0.62
Current smoker	3.4	14.2	<0.001
Born outside Ireland	53.4	31.3	<0.001
Unemployed	22.4	26.4	0.49
Mean BMI	26.3 ± 5.6	data not available	–
BMI ≥30.0	15.5	16.1	0.9
Loss of index pregnancy	6.9	7.0	0.96
Preterm birth in index pregnancy	13.8	6.7	0.03
Cesarean delivery in index pregnancy	27.8	26.2	0.81

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters).
[a] Values are given as mean ± SD or percentage unless stated otherwise.

Table 2
Area of origin of the study population and general obstetric population.

Area of origin	Percentage of bacteremia cases (n = 58)	Percentage of obstetric population (n = 37 584)
Ireland	46.6	68.7
Rest of Europe	12.1	16.8
Africa	15.5	4.4
Asia (excluding Middle East)	24.1	6.5
Other	0	3.6

Fig. 1 shows the neonatal outcomes among women with prepartum, intrapartum, and postpartum bloodstream infections.

Serum C-reactive protein was analyzed for 35 of the 58 women with maternal bacteremia and was within the normal reference range for pregnancy for 1 woman (3%). Only 38% (15/39) of women with prepartum or intrapartum bacteremia had a white cell count outside the normal reference range [5]. A white cell count outside the normal reference range was more prevalent among women with postpartum bacteremia: 79% (15/19) of women with postpartum bacteremia had a concurrent raised white cell count.

Nineteen cases of bacteremia were diagnosed prepartum, 4 of which were associated with early pregnancy loss. Two occurred among women who presented unwell with bacteremia in the first trimester and experienced spontaneous pregnancy loss while undergoing treatment. One was due to infection with *Listeria monocytogenes*, and 1 was due to infection with *Haemophilus influenzae*; the source of infection was not confirmed in either case. The other 2 spontaneous losses were associated with *E. coli* infection of the genital tract: 1 occurred after repeated vaginal misoprostol administration during medical management of abortion; and 1 occurred in a woman who presented with bacteremia while aborting spontaneously at 20 weeks of gestation in a twin pregnancy. The latter woman subsequently developed septic shock and required treatment in the ICU.

Of the remaining 15 prepartum cases of bacteremia, 12 were due to *E. coli* infection. Of these, 10 were associated with urinary tract infection; the other 2 were of genital tract origin and occurred in the third trimester among women who had preterm, pre-labor rupture of membranes (PPROM). The second case of septic shock occurred in one of these women, who developed *E. coli* chorioamnionitis at 31 weeks of gestation after PPROM. She delivered by emergency cesarean and was transferred to the ICU. The neonate recovered well. The remaining 3 cases of prepartum bacteremia were due to an infection of urinary tract origin: 1 with *Enterococcus faecalis*, 1 with *Streptococcus pyogenes*, and 1 with *Klebsiella pneumoniae*.

Among the 15 prepartum cases not associated with early pregnancy loss, 4 women (26.7%) required emergency pre-labor cesarean delivery for septic complications and 1 woman required induction of labor for complications of the infection. The remaining 10 women (66.7%) recovered from their bacteremia and subsequently delivered without complications.

Of the 20 cases of bacteremia diagnosed intrapartum, all occurred after 37 weeks of gestation. One woman with *Streptococcus gallolyticus* ssp. *pasteurianus* (β-hemolytic, Lancefield group D) sepsis presented with a stillbirth at term while in spontaneous labor; in this case, the bacterium was also cultured from the vagina and placenta. In the remaining 19 cases, the neonate was live born; only 3 neonates were transferred directly from the delivery suite to the pediatric ward, the other 16 remained with the mother. The characteristics of the intrapartum bacteremia cases are shown in Table 4. Streptococcal and enterococcal species were responsible for 80.0% (16/20) of the cases of intrapartum bacteremia. The other organisms isolated were *Staphylococcus aureus*, *Clostridium perfringens*, *Haemophilus influenza*, and *Proteus mirabilis*.

Of the 19 cases diagnosed postpartum, *E. coli* was the most prevalent organism found, causing 53% of infections (10/19). There were 5 postpartum cases of *S. agalactiae* bacteremia, all of which had a confirmed