

# Neonatal Antibiotic Exposure and Neonatal Unit Admission in Infants Born to Mothers with Peripartum Bacteraemia: An Eight-Year Retrospective Cohort Study

Meadhbh Collison

collism2@gmail.com

National Maternity Hospital

Kainat Amin

National Maternity Hospital

Eoin O'Curraín

National Maternity Hospital

Susan J Knowles

National Maternity Hospital

---

## Research Article

**Keywords:** Maternal bacteraemia, Early-onset neonatal sepsis, Neonatal antibiotic exposure, Antimicrobial stewardship, Neonatal unit admission, Mother-infant separation

**Posted Date:** October 22nd, 2026

**DOI:** <https://doi.org/10.21203/rs.3.rs-11241724/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.  
[Read Full License](#)

**Additional Declarations:** No competing interests reported.

---

# Abstract

**Background:** As maternal peripartum bloodstream infection can lead to early-onset neonatal sepsis, infants born to affected mothers are frequently separated from their mothers for monitoring, investigation and treatment. Our aim was to determine the risk of neonatal sepsis in infants born to mothers with microbiologically confirmed peripartum bacteraemia by examining the microbiology, maternal severity, neonatal management and outcomes of peripartum maternal bacteraemia.

**Methods:** We conducted a single-centre, retrospective, observational study at a tertiary referral maternity hospital over eight years (2018–2025). We identified all clinically significant maternal bloodstream infections with a blood culture taken between 24 hours before and 4 hours after delivery, and reviewed maternal and neonatal characteristics, management and outcomes. Categorical variables were compared using Fisher's exact test and continuous variables using the Mann–Whitney U test, with relative risks (RR) and 95% confidence intervals (CI).

**Results:** There were 104 episodes among 64,436 births (1.61 per 1,000). The most common isolates were *Escherichia coli* (21.2%), group B streptococcus (19.2%) and viridans group streptococci (17.3%); Enterobacterales were more common before 37 weeks than at term (RR 2.67, 95% CI 1.45–4.89). Maternal sepsis or septic shock occurred in 11 women (10.6%), with no maternal deaths, and was most strongly associated with *E. coli* (RR 6.52, 95% CI 2.10–20.29).

Among 94 liveborn infants there were no neonatal deaths and no culture-confirmed early-onset sepsis. Thirty-nine had clinical symptoms, of whom five (four preterm) developed clinical early-onset sepsis; the remaining 55 remained clinically well throughout. Nonetheless, 84 infants (89.4%) received antibiotics. Of the 55 infants who remained clinically well, 46 (83.6%) received antibiotics and 29 (52.7%) were separated from their mothers on the basis of the maternal bacteraemia rather than neonatal illness.

**Conclusions:** In this microbiologically confirmed cohort, peripartum maternal bacteraemia caused substantial maternal morbidity but no culture-confirmed early-onset neonatal sepsis, despite high neonatal antibiotic exposure. These findings identify a clear opportunity for neonatal antimicrobial stewardship and for reducing neonatal unit admission and mother-infant separation, particularly in well, term infants.

## Background

Maternal bacteraemia in the peripartum period is uncommon, complicating approximately 2 per 1,000 births [1] and is an important cause of maternal morbidity [2]. It is a recognised risk factor for early-onset neonatal sepsis [3], alongside preterm birth, group B streptococcal colonisation and prolonged rupture of membranes [4]. Because of this risk, infants born to mothers with peripartum bacteraemia are frequently admitted to neonatal units (NNU) for monitoring, investigation and treatment with empiric antibiotics.

Isolation of a pathogen from a normally sterile site is the diagnostic gold standard for early-onset neonatal sepsis; however, culture-confirmed sepsis is rare, and the inability to isolate a pathogen does not exclude sepsis [5]. There is no consensus definition of culture-negative neonatal sepsis, and clinical signs and inflammatory markers lack the specificity to confirm or exclude infection reliably [4]. This diagnostic uncertainty leads to many infants being separated from their mothers and treated with antibiotics on the basis of perceived risk in the absence of clinical illness [6], contributing to antimicrobial resistance [7] and disruption of the developing microbiome, with potential long-term consequences [8].

Studies have shown that well-appearing infants born to mothers with clinical chorioamnionitis (intra-amniotic infection) can be safely managed by structured observation, with selective rather than universal antibiotic treatment and early discontinuation of antibiotics when cultures remain negative [9, 10]. However, clinical chorioamnionitis is a non-specific diagnosis and is frequently over-applied, such that a proportion of these mothers may not have had true infection [11]. It is uncertain whether the same reassurance extends to infants born to mothers with a microbiologically confirmed bloodstream infection at the time of delivery – a smaller, higher-acuity and objectively defined population in whom the rationale for neonatal investigation and treatment is considerably stronger, and in whom clinicians may be less willing to withhold treatment. Studies of peripartum maternal bacteraemia have reported neonatal infection and intensive care admission in these infants [2, 3], but not, to our knowledge, the management of those who remain clinically well.

We aimed to describe the microbiology, source and severity of peripartum maternal bacteraemia across gestation, and to examine the neonatal investigation, antibiotic treatment and management of the exposed infants, together with their infection outcomes, in order to assess the burden of neonatal intervention relative to confirmed infection.

## Methods

### Study design and setting

This was a retrospective cohort study conducted at the National Maternity Hospital, Dublin, a tertiary referral maternity hospital with a 35-bed NNU. We identified all cases of clinically significant peripartum maternal bacteraemia over an eight-year period, from 2018 to 2025. Peripartum bacteraemia was defined as a blood culture growing a significant pathogen taken between 24 hours before and 4 hours after delivery, chosen to capture bacteraemia most directly related to the intrapartum period and the exposed neonate. Organisms classically regarded as pathogens were included; those regarded as contaminants (for example, coagulase-negative staphylococci and diphtheroids) were excluded.

## Definitions

Pregnancy loss before 23 weeks' gestation and below 400 g birth weight was classified as miscarriage. Stillbirth was defined as a baby of birthweight  $\geq 400$  g and/or  $\geq 23$  weeks' gestation with no signs of life at delivery, in accordance with hospital definitions. Gestational age at bacteraemia was grouped as pre-viable ( $< 23$  weeks), preterm ( $23 + 0$  to  $36 + 6$  weeks) and term ( $\geq 37$  weeks). Preterm prelabour rupture of membranes (PPROM) was defined as prelabour rupture of membranes before 37 weeks. Prolonged rupture of membranes was defined as rupture exceeding 18 hours.

Maternal sepsis was defined according to the World Health Organization consensus definition [12] as life-threatening organ dysfunction resulting from infection. Culture-confirmed early-onset neonatal sepsis was defined as a positive blood or cerebrospinal fluid (CSF) culture with a clinically significant pathogen within the first 72 hours of life. Clinical early-onset neonatal sepsis was defined, adapted from the European Centre for Disease Prevention and Control (ECDC) NEO-CSEP case definition [13], as at least two clinical signs of sepsis without another apparent cause, treated with at least five days of antimicrobial therapy, in the absence of a positive blood culture or infection at another site.

## Source of bacteraemia

The source of bacteraemia was categorised as intra-amniotic infection, urinary, or unknown. Suspected intra-amniotic infection was defined by clinical criteria as maternal intrapartum fever with one or more of maternal leucocytosis (white cell count  $> 15,000/\text{mm}^3$ ), purulent cervical drainage, or fetal tachycardia [11]; confirmed intra-amniotic infection required histological confirmation. A urinary source was defined as significant growth of the blood-culture organism, with pyuria, in a midstream urine specimen.

## Microbiology

Blood cultures were processed using the BacT/ALERT system (bioMérieux, France). Organism identification was performed by matrix-assisted laser desorption/ionisation time-of-flight (MALDI-TOF) mass spectrometry (bioMérieux, France) and antimicrobial susceptibility testing using the VITEK automated system (bioMérieux, France). Within the viridans group streptococci, the anginosus group was distinguished from other members owing to its distinct clinical associations.

## Statistical analysis

Categorical variables are presented as counts and percentages, and continuous variables as medians with interquartile ranges (IQR). Denominators differ by outcome: outcomes applying to all women use a denominator of 104; delivery-specific outcomes (mode of delivery, induction of labour, postpartum haemorrhage and prolonged rupture of membranes) use the 95 women who delivered  $\geq 23$  weeks' gestation; and neonatal outcomes use the 94 live births. Categorical variables were compared using Fisher's exact test and continuous variables using the Mann–Whitney U test; relative risks (RR) with 95% confidence intervals (CI) are reported for comparisons between groups. A two-sided p value of less than

0.05 was considered statistically significant. Data were managed in Microsoft Excel and analyses were performed in Python, using the pandas and SciPy libraries.

## Results

### Cohort and microbiology

During the eight-year study period there were 64,436 births, among which 104 episodes of peripartum bacteraemia were identified, an incidence of 1.61 per 1000 births. The characteristics of the 104 women are shown in Table 1. Bacteraemia occurred at term ( $\geq 37$  weeks) in 80 (76.9%), between 23 + 0 and 36 + 6 weeks in 15 (14.4%), and before 23 weeks in 9 (8.7%). There were 94 live births (90.4%), 9 miscarriages (8.7%) and 1 stillbirth (1.0%).

Table 1  
Baseline maternal and obstetric characteristics (n = 104)

| Characteristic                                                               | n (%)      |
|------------------------------------------------------------------------------|------------|
| <b>Maternal age, years</b>                                                   |            |
| 20–24                                                                        | 2 (1.9%)   |
| 25–29                                                                        | 10 (9.6%)  |
| 30–34                                                                        | 30 (28.8%) |
| 35–39                                                                        | 46 (44.2%) |
| ≥ 40                                                                         | 16 (15.4%) |
| <b>Body mass index, kg/m<sup>2</sup></b>                                     |            |
| 15.5–24.9                                                                    | 49 (47.1%) |
| 25.0–29.9                                                                    | 32 (30.8%) |
| ≥ 30                                                                         | 23 (22.1%) |
| <b>Parity</b>                                                                |            |
| Nulliparous                                                                  | 62 (59.6%) |
| Multiparous                                                                  | 42 (40.4%) |
| <b>Penicillin allergy</b>                                                    |            |
| Yes                                                                          | 8 (7.7%)   |
| <b>Group B Streptococcus status</b>                                          |            |
| Negative                                                                     | 60 (57.7%) |
| Unknown                                                                      | 37 (35.6%) |
| Positive                                                                     | 7 (6.7%)   |
| <b>Gestation at bacteraemia</b>                                              |            |
| < 23 weeks                                                                   | 9 (8.7%)   |
| 23 + 0–36 + 6 weeks                                                          | 15 (14.4%) |
| ≥ 37 weeks                                                                   | 80 (76.9%) |
| BMI, body mass index; PPRM, preterm prelabour rupture of membranes.          |            |
| <sup>a</sup> PPRM defined as prelabour rupture of membranes before 37 weeks. |            |
| <sup>b</sup> Denominator = 95 women who delivered (excludes 9 miscarriages). |            |

| Characteristic                                                               | n (%)      |
|------------------------------------------------------------------------------|------------|
| Maternal age, years                                                          |            |
| Obstetric characteristics                                                    |            |
| PPROM (< 37 weeks) <sup>a</sup>                                              | 15 (14.4%) |
| Prolonged rupture of membranes > 18 h <sup>b</sup>                           | 52 (54.7%) |
| BMI, body mass index; PPRM, preterm prelabour rupture of membranes.          |            |
| <sup>a</sup> PPRM defined as prelabour rupture of membranes before 37 weeks. |            |
| <sup>b</sup> Denominator = 95 women who delivered (excludes 9 miscarriages). |            |

The most common isolates were *Escherichia coli* in 22 episodes (21.2%), group B streptococcus in 20 (19.2%) and viridans group streptococci in 18 (17.3%) (Table 2). Enterobacterales were more common before 37 weeks than at term (12/24 [50%] vs 15/80 [18.8%]; RR 2.67, 95% CI 1.45–4.89; p = 0.004). Term bacteraemia was predominantly gram-positive.

Table 2  
Blood culture isolates by gestational group (n = 104)

| Organism                          | < 23 wk (n = 9) | 23 + 0–36 + 6 wk (n = 15) | ≥ 37 wk (n = 80) | Total (%)  |
|-----------------------------------|-----------------|---------------------------|------------------|------------|
| <i>Escherichia coli</i>           | 5               | 5                         | 12               | 22 (21.2%) |
| Group B Streptococcus             | 2               | 1                         | 17               | 20 (19.2%) |
| Viridans group streptococci       | 0               | 6                         | 12               | 18 (17.3%) |
| <i>Enterococcus faecalis</i>      | 0               | 0                         | 14               | 14 (13.5%) |
| Anaerobes                         | 0               | 1                         | 6                | 7 (6.7%)   |
| Anginosus group streptococci      | 0               | 0                         | 5                | 5 (4.8%)   |
| Other Enterobacterales            | 1               | 1                         | 3                | 5 (4.8%)   |
| <i>Staphylococcus aureus</i>      | 0               | 0                         | 4                | 4 (3.8%)   |
| Polymicrobial                     | 0               | 0                         | 3                | 3 (2.9%)   |
| Group C/G Streptococcus           | 0               | 0                         | 2                | 2 (1.9%)   |
| Group A Streptococcus             | 0               | 1                         | 0                | 1 (1.0%)   |
| <i>Listeria monocytogenes</i>     | 0               | 0                         | 1                | 1 (1.0%)   |
| <i>Streptococcus gallolyticus</i> | 0               | 0                         | 1                | 1 (1.0%)   |
| <i>Streptococcus pneumoniae</i>   | 1               | 0                         | 0                | 1 (1.0%)   |
| Total                             | 9               | 15                        | 80               | 104        |

Data are n, and n (%) in the total column. Within the viridans group streptococci, the anginosus group is reported separately; see Methods. wk, weeks.

Table 3  
Maternal outcomes (n = 104)

| Outcome                                            | n (%)       |
|----------------------------------------------------|-------------|
| <b>Delivery</b>                                    |             |
| Induction of labour <sup>a</sup>                   | 57 (60.0%)  |
| Caesarean section <sup>a</sup>                     | 56 (58.9%)  |
| Vaginal delivery <sup>a</sup>                      | 39 (41.1%)  |
| <b>Maternal illness severity</b>                   |             |
| Sepsis                                             | 10 (9.6%)   |
| Septic shock                                       | 1 (1.0%)    |
| High-dependency unit admission                     | 13 (12.5%)  |
| Intensive care admission                           | 2 (1.9%)    |
| Postpartum haemorrhage > 1000 mL <sup>a</sup>      | 17 (17.9%)  |
| Maternal death                                     | 0 (0.0%)    |
| <b>Antibiotic treatment</b>                        |             |
| Guideline-adherent regimen                         | 93 (89.4%)  |
| Regimen microbiologically effective                | 100 (96.2%) |
| Total duration, days - median (IQR)                | 10 (8–10)   |
| Intravenous duration, days - median (IQR)          | 3 (2–3)     |
| <b>Other outcomes</b>                              |             |
| Postnatal length of stay, days - median (IQR)      | 4 (3–5)     |
| Re-presentation with infection ≤ 42 days           | 6 (5.8%)    |
| IQR, interquartile range.                          |             |
| <sup>a</sup> Denominator = 95 women who delivered. |             |

Antimicrobial resistance was uncommon. Among Enterobacterales, one extended-spectrum beta-lactamase (ESBL)-producing isolate, two AmpC-producing isolates, and one gentamicin-resistant isolate were identified. Two viridans group streptococci were penicillin-resistant, and 4/20 (20%) group B streptococcus isolates were clindamycin-resistant. The hospital's recommended empiric regimen for suspected intrapartum infection was benzylpenicillin, gentamicin and metronidazole, and for early-onset neonatal sepsis was benzylpenicillin and gentamicin.

Intra-amniotic infection was histologically confirmed in 17 episodes (16.3%) and clinically suspected, without histological confirmation, in a further 42 (40.4%). Placental culture grew the blood-culture organism in 46 of 60 episodes tested (76.7%). A urinary source was identified in 10 (9.6%), all at term, each with pyuria and isolation of the blood-culture organism from urine (seven had a clinical urinary tract infection, including two with pyelonephritis). No source was identified in the remaining 35 episodes (33.7%).

## Maternal outcomes

Maternal sepsis or septic shock occurred in 11/104 (10.6%) women (10 sepsis, 1 septic shock); there were no maternal deaths. Fifteen women (14.4%) required higher-level care (13 high-dependency, 2 intensive care). Sepsis was caused by *E. coli* in 7 cases, viridans group streptococci in 3 (all *S. mitis/oralis*) and group A streptococcus in 1. *E. coli* bacteraemia was strongly associated with maternal sepsis (7/22, 31.8%; RR 6.52, 95% CI 2.10–20.29;  $p = 0.0015$ ). Sepsis was more frequent in pregnancies ending before 37 weeks than at term (6/24, 25.0% vs 5/80, 6.2%; RR 4.00, 95% CI 1.34–11.96;  $p = 0.017$ ).

Among the 95 women who delivered  $\geq 23$  weeks' gestation, intrapartum fever ( $> 38^{\circ}\text{C}$ ) occurred in 85 (89.5%). The onset of infective signs occurred before labour in 24 (25.3%), after induction but before established labour in 30 (31.6%), during labour in 33 (34.7%), and within four hours of delivery in eight (8.4%).

Eighty-three women (87.4%) received broad-spectrum intrapartum antibiotics and two received group B streptococcus-targeted prophylaxis; the 10 (10.5%) who received none comprised six whose signs developed only after delivery and four in whom delivery occurred before antibiotics could be given. Only seven women (7.4%) received broad-spectrum antibiotics more than 4 hours before delivery. All women were subsequently treated for bacteraemia. Antimicrobial treatment was guideline-adherent in 93/104 (89.4%) and microbiologically effective in 100/104 (96.2%). Median total antibiotic duration was 10 days (IQR 8–10), with 3 intravenous days (IQR 2–3).

Induction of labour occurred in 57 women (60.0%) and 56 (58.9%) were delivered by caesarean section. Postpartum haemorrhage  $> 1000$  mL occurred in 17/95 (17.9%). Median postnatal stay was 4 days (IQR 3–5) and six women (5.8%) re-presented within 42 days with infection.

## Neonatal outcomes

There were 94 live births and no neonatal deaths or culture-confirmed early-onset neonatal sepsis (Table 4). Blood cultures were taken in 86 (91.5%) and were all negative (53 taken shortly after birth and 33 more than 4 hours after birth, prompted either by clinical status or by identification of the positive maternal blood culture). Lumbar puncture was performed in 18, all with negative cerebrospinal fluid, in neonates whose mothers had beta-haemolytic streptococci (10), Enterobacterales (7), or *Listeria monocytogenes* (1).

Table 4  
Neonatal outcomes by gestational group (n = 94 live births)

| Neonatal outcome                                                                                                                                    | Preterm (n = 14) | Term (n = 80) | All (n = 94) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------|---------------|--------------|
| <b>Investigation and infection</b>                                                                                                                  |                  |               |              |
| Blood culture performed                                                                                                                             | 14 (100.0%)      | 72 (90.0%)    | 86 (91.5%)   |
| Blood culture positive                                                                                                                              | 0 (0.0%)         | 0 (0.0%)      | 0 (0.0%)     |
| Lumbar puncture (all CSF negative)                                                                                                                  | 3 (21.4%)        | 15 (18.8%)    | 18 (19.1%)   |
| Culture-confirmed sepsis                                                                                                                            | 0 (0.0%)         | 0 (0.0%)      | 0 (0.0%)     |
| Clinical early-onset sepsis (< 72 h)                                                                                                                | 4 (28.6%)        | 1 (1.3%)      | 5 (5.3%)     |
| Neonatal death                                                                                                                                      | 0 (0.0%)         | 0 (0.0%)      | 0 (0.0%)     |
| <b>Intervention</b>                                                                                                                                 |                  |               |              |
| Received antibiotics                                                                                                                                | 14 (100.0%)      | 70 (87.5%)    | 84 (89.4%)   |
| Antibiotic duration, days - median (IQR)                                                                                                            | 5 (5–5)          | 4 (1–5)       | 5 (2–5)      |
| NNU admission                                                                                                                                       | 13 (92.9%)       | 54 (67.5%)    | 67 (71.3%)   |
| NNU stay, days - median (IQR) <sup>a</sup>                                                                                                          | 6 (4–16)         | 4 (2–5)       | 5 (2–5)      |
| Data are n (%) unless stated. Term ≥ 37 weeks; preterm 23 + 0–36 + 6 weeks. CSF, cerebrospinal fluid; IQR, interquartile range; NNU, neonatal unit. |                  |               |              |
| <sup>a</sup> Among neonates admitted to NNU (term, n = 54; preterm, n = 13; all, n = 67).                                                           |                  |               |              |

Overall, 84 neonates (89.4%) received antibiotics and 67 (71.3%) were separated from their mothers and admitted to the NNU. Both were more frequent in preterm than term infants: all 14 preterm neonates received antibiotics (vs 70/80 term, 87.5%), and 13/14 preterm were admitted to the NNU. NNU stay was longer in preterm infants (median 6 days, IQR 4–16, vs 4, IQR 2–5).

Of the 94 liveborn infants, 39 were clinically unwell – symptomatic at birth or subsequently deteriorating. Five (5.3%) developed clinical early-onset sepsis, all symptomatic from birth. Clinical early-onset sepsis was more common in preterm than term neonates (4/14, 28.6% vs 1/80, 1.3%; RR 22.9, 95% CI 2.8–189.8; p = 0.0015). Fifty-five infants remained clinically well throughout (Table 5). Of the 55 well infants, 46 (83.6%) received antibiotics and 29 (52.7%) were admitted to the NNU for antibiotics or observation prompted by the maternal bacteraemia. Antibiotic courses were shorter in well than unwell infants (median 3 vs 5 days; p < 0.001), as was duration of maternal separation (median 3 vs 5 days; p = 0.002). Eight well infants remained in hospital after their mothers' discharge (median 2 additional days) to complete antibiotic treatment. The remaining nine well infants had no antibiotics, seven of whom also did not have a blood culture taken. Most were managed conservatively with regular observation because the maternal organism was a low-virulence organism (viridans group streptococci or anaerobes), while in

one case the parents declined both investigation and treatment. One unwell infant, admitted for jaundice rather than suspected infection, had neither a septic work-up nor antibiotics.

Table 5  
Characteristics and management of well versus unwell neonates

| Characteristic                                                                                                                                                                                                                                                                                                                                                                  | Well (n = 55) | Unwell (n = 39) |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------|
| Preterm, n (%)                                                                                                                                                                                                                                                                                                                                                                  | 2 (3.6%)      | 12 (30.8%)      |
| Admitted to NNU, n (%)                                                                                                                                                                                                                                                                                                                                                          | 29 (52.7%)    | 38 (97.4%)      |
| Received antibiotics, n (%)                                                                                                                                                                                                                                                                                                                                                     | 46 (83.6%)    | 38 (97.4%)      |
| Antibiotic duration, days, median (IQR) <sup>a</sup>                                                                                                                                                                                                                                                                                                                            | 3 (1.5–5)     | 5 (5–5)         |
| NNU length of stay, days, median (IQR) <sup>b</sup>                                                                                                                                                                                                                                                                                                                             | 3 (2–5)       | 5 (3–9)         |
| Data are n (%) or median (IQR). Data comprise all 94 live births. 'Well' (n = 55) denotes neonates who remained clinically well – asymptomatic at birth and throughout, including two not formally reviewed at birth who remained well; 'unwell' (n = 39) denotes neonates symptomatic at birth or who subsequently deteriorated. IQR, interquartile range; NNU, neonatal unit. |               |                 |
| <sup>a</sup> Among neonates who received antibiotics (well, n = 46; unwell, n = 38).                                                                                                                                                                                                                                                                                            |               |                 |
| <sup>b</sup> Among neonates admitted to NNU (well, n = 29; unwell, n = 38).                                                                                                                                                                                                                                                                                                     |               |                 |

## Discussion

Maternal morbidity was substantial: sepsis or septic shock occurred in approximately one in ten women, and rates of induction of labour and caesarean section were 1.7 times the hospital's mean annual rates over the same 2018–2025 period (60.0% vs 35.7% and 58.9% vs 33.6%, respectively) [14], reflecting the acuity of these presentations. *E. coli* was the organism most strongly associated with maternal sepsis, and caused sepsis at a similar rate at term and before 37 weeks (4 of 12 [33%] and 3 of 10 [30%]). The occurrence of sepsis with viridans group streptococci (all *S. mitis/oralis*) is notable given their reputation as low virulence organisms. Empiric maternal therapy was largely appropriate, being guideline-adherent in 89% and microbiologically effective in 96%, with low antimicrobial resistance.

Neonatal outcomes were reassuring: there were no neonatal deaths and no culture-confirmed neonatal infections, with all 86 neonatal blood cultures and 18 CSF samples remaining negative. Maternal intrapartum antibiotics and the small blood volumes obtainable from neonates may reduce the sensitivity of neonatal blood cultures [15]; however, intrapartum antibiotic exposure does not appear to delay time to positivity when bacteraemia is present [16], supporting the discontinuation of empirical antibiotics once cultures remain negative.

Clinical illness, antibiotic exposure and NNU admission were concentrated in preterm infants, in whom four of the five cases of clinical early-onset sepsis occurred. In the absence of a positive culture,

however, the diagnosis of neonatal sepsis rests on non-specific signs that are especially difficult to interpret in preterm infants. Without a robust consensus definition of culture-negative neonatal sepsis, empiric antibiotics may be continued by default rather than targeted towards true infection. A consensus definition would help to support more targeted neonatal antimicrobial stewardship [5, 17].

Most clinically well infants received antibiotics (46/55, 84%) and over half were admitted to the NNU (29/55, 53%), on the basis of the maternal bacteraemia rather than neonatal illness. In our practice, infants exposed to peripartum maternal bacteraemia generally receive a 5-day antibiotic course, with some exceptions for less virulent organisms. For a well, term infant with neither confirmed nor clinical sepsis, this represents considerable antibiotic exposure. Observation-based, risk-stratified management of well-appearing infants exposed to clinical chorioamnionitis has been shown to reduce antibiotic use and NNU admission without evident harm [9, 18]. Further evaluation is warranted to determine whether a similar approach could be applied to the well, term infant of a mother with confirmed peripartum maternal bacteraemia. This study has several limitations. It was a single-centre, retrospective, observational study without a comparison group, and the modest sample size precluded multivariable adjustment. In the absence of a consensus definition of culture-negative neonatal sepsis, cases were defined on clinical rather than microbiological criteria, which remain imperfect, particularly in preterm infants.

## Conclusions

Peripartum maternal bacteraemia was uncommon but caused substantial maternal morbidity. There were no neonatal deaths and no culture-confirmed early-onset neonatal sepsis, with a low rate of clinical early-onset sepsis, predominantly in preterm neonates. These findings identify neonatal antimicrobial stewardship and the avoidance of unnecessary neonatal unit admission as priorities in this population and support the prospective evaluation of a more selective, risk-stratified approach to the well, term infant.

## Abbreviations

BMI

body mass index

CI

confidence interval

CSF

cerebrospinal fluid

ECDC

European Centre for Disease Prevention and Control

ESBL

extended-spectrum beta-lactamase

IQR

interquartile range  
MALDI-TOF  
matrix-assisted laser desorption/ionisation time-of-flight  
NEO-CSEP  
neonatal clinical sepsis (ECDC case definition)  
NNU  
neonatal unit  
PPROM  
preterm prelabour rupture of membranes  
RR  
relative risk

## Declarations

## Conclusions

In this microbiologically confirmed cohort, peripartum maternal bacteraemia caused substantial maternal morbidity but no culture-confirmed early-onset neonatal sepsis, despite high neonatal antibiotic exposure. These findings identify a clear opportunity for neonatal antimicrobial stewardship and for reducing neonatal unit admission and mother-infant separation, particularly in well, term infants.

## Declarations

## Ethics approval and consent to participate

Ethical approval was obtained from the National Maternity Hospital Audit Steering Committee (Ref: 203). The study was conducted retrospectively using routinely collected clinical data. Individual informed consent was not obtained. Clinical trial number: not applicable.

## Consent for publication

Not applicable.

## Competing interests

The authors declare that they have no competing interests.

# Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

# Author Contribution

MC and SJK conceived and designed the study. MC collected and analysed the data. All authors contributed to the interpretation of the results. MC wrote the first draft of the manuscript. KA, EO'C and SJK critically revised the manuscript for important intellectual content. SJK supervised the study. All authors read and approved the final manuscript.

# Acknowledgements

Not applicable.

# Data Availability

Available with restricted access: The datasets analysed during the current study are not publicly available due to patient confidentiality but are available from the corresponding author on reasonable request.

# References

1. Drew RJ, Fonseca-Kelly Z, Eogan M. A retrospective audit of clinically significant maternal bacteraemia in a specialist maternity hospital from 2001 to 2014. *Infect Dis Obstet Gynecol*. 2015;2015:518562.
2. Mohn SF, Reimer R, Mar N, Katelieva A, Paquette V, Albert AYK, et al. Empiric antibiotics for peripartum bacteremia: a chart review from a quaternary Canadian centre. *Int J Gynaecol Obstet*. 2024;164:786–92.
3. Gad A, Alkhedr M, Terkawi R, Alsharif H, Ibrahim M, Amin R, et al. Associations between maternal bacteremia during the peripartum period and early-onset neonatal sepsis: a retrospective cohort study. *BMC Pediatr*. 2024;24:526.
4. Puopolo KM, Benitz WE, Zaoutis TE, Committee on Fetus and Newborn; Committee on Infectious Diseases. Management of neonates born at  $\geq 35$  0/7 weeks' gestation with suspected or proven early-onset bacterial sepsis. *Pediatrics*. 2018;142(6):e20182894.
5. Wynn JL, Polin RA. Progress in the management of neonatal sepsis: the importance of a consensus definition. *Pediatr Res*. 2018;83(1–1):13–5.

6. Cantey JB, Wozniak PS, Pruszynski JE, Sánchez PJ. Reducing unnecessary antibiotic use in the neonatal intensive care unit (SCOUT): a prospective interrupted time-series study. *Lancet Infect Dis.* 2016;16(10):1178–84.
7. Laxminarayan R, Duse A, Wattal C, Zaidi AKM, Wertheim HFL, Sumpradit N, et al. Antibiotic resistance – the need for global solutions. *Lancet Infect Dis.* 2013;13(12):1057–98.
8. Schulfer A, Blaser MJ. Risks of antibiotic exposures early in life on the developing microbiome. *PLoS Pathog.* 2015;11(7):e1004903.
9. Money N, Newman J, Demissie S, Roth P, Blau J. Anti-microbial stewardship: antibiotic use in well-appearing term neonates born to mothers with chorioamnionitis. *J Perinatol.* 2017;37(12):1304–9.
10. Jan AI, Ramanathan R, Cayabyab RG. Chorioamnionitis and management of asymptomatic infants  $\geq$  35 weeks without empiric antibiotics. *Pediatrics.* 2017;140(1):e20162744.
11. Higgins RD, Saade G, Polin RA, Grobman WA, Buhimschi IA, Watterberg K, et al. Evaluation and management of women and newborns with a maternal diagnosis of chorioamnionitis: summary of a workshop. *Obstet Gynecol.* 2016;127(3):426–36.
12. Bonet M, Nogueira Pileggi V, Rijken MJ, Coomarasamy A, Lissauer D, Souza JP, et al. Towards a consensus definition of maternal sepsis: results of a systematic review and expert consultation. *Reprod Health.* 2017;14(1):67.
13. European Centre for Disease Prevention and Control. Point prevalence survey of healthcare-associated infections and antimicrobial use in European acute care hospitals – protocol version 4.3. Stockholm: ECDC. 2012.  
<https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/0512-TED-PPS-HAI-antimicrobial-use-protocol.pdf>. Accessed 30 Sep 2026.
14. National Maternity Hospital. The National Maternity Hospital Holles Street Annual Report 2025. Dublin: National Maternity Hospital; 2026.
15. Klingenberg C, Kornelisse RF, Buonocore G, Maier RF, Stocker M. Culture-negative early-onset neonatal sepsis – at the crossroad between efficient sepsis care and antimicrobial stewardship. *Front Pediatr.* 2018;6:285.
16. Sarkar SS, Bhagat I, Bhatt-Mehta V, Sarkar S. Does maternal intrapartum antibiotic treatment prolong the incubation time required for blood cultures to become positive for infants with early-onset sepsis? *Am J Perinatol.* 2015;32(4):357–62.
17. McGovern M, Giannoni E, Kuester H, van den Turner MA, Bliss JM, et al. Challenges in developing a consensus definition of neonatal sepsis. *Pediatr Res.* 2020;88(1):14–26.
18. Joshi NS, Gupta A, Allan JM, Cohen RS, Aby JL, Weldon B, et al. Clinical monitoring of well-appearing infants born to mothers with chorioamnionitis. *Pediatrics.* 2018;141(4):e20172056.