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CLINICAL ARTICLE

Evaluation of the systemic inflammatory response syndrome criteria for the diagnosis of sepsis due to maternal bacteremia

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ABSTRACT

Objective: To examine, in the setting of maternal bacteremia, the implications for the diagnosis of maternal sepsis of customizing the systemic inflammatory response syndrome (SIRS) criteria for physiologic changes of pregnancy. *Methods:* Women with maternal bacteremia in a tertiary maternity hospital during 2009–2014 were identified. Records were retrospectively reviewed to determine whether they fulfilled the criteria for diagnosis of sepsis based on either the standard SIRS parameters derived from the Surviving Sepsis Campaign or SIRS parameters customized for pregnancy. Diagnosis of sepsis was based on the presence of two or more SIRS criteria, in conjunction with infection, during the hour before and the 6 hours after phlebotomy for blood culture. *Results:* Of 93 women with bacteremia, 61 (66%) would have been diagnosed with sepsis based on standard criteria compared with 52 (56%) based on customized criteria ($P = 0.18$). Seventeen women had a diagnosis of sepsis based on the standard but not the customized criteria, while eight women had sepsis based on the customized but not the standard criteria. *Conclusion:* In maternal bacteremia, customized SIRS criteria do not increase the rate of diagnosis of sepsis. Prospective studies should investigate whether the introduction of customized SIRS criteria can improve clinical outcomes.

1. Introduction

A standardized definition of sepsis was proposed in the 1990s by a group of physicians in the USA [1]. They aimed to improve early diagnosis and treatment of sepsis and standardize sepsis research protocols. They identified a systemic inflammatory response syndrome (SIRS), and sepsis was defined as SIRS with a confirmed or suspected infectious etiology [1]. This work was updated with additional guidance in 2003, 2008, and 2012 as part of the Surviving Sepsis Campaign [2–4]. It is notable that none of these guidelines has considered the application of the SIRS criteria in obstetrics.

Despite concern about obstetric sepsis, there is no agreement as to what constitutes abnormal SIRS parameters in obstetrics [5,6]. The physiologic changes that begin in early pregnancy include increased heart rate and increased leukocyte count [7]. The overlap between standard SIRS criteria and the normal physiology of pregnancy was confirmed by a recent systematic review [6].

Sepsis screening tools have been introduced to structure bedside clinical assessment in nonpregnant adult inpatients with suspected infection [8,9]. These tools aim to prompt early diagnosis of sepsis and thus reduce sepsis-associated mortality and morbidity [8,9]. The need for a sepsis screening tool suitable for use in the assessment of pregnant women led in 2014 to the development of a novel customized obstetric sepsis screening tool and its inclusion on the Irish Maternity Early Warning System chart [10], which is used for all pregnant and postpartum women in Irish hospitals (Table 1).

Bacteremia is a well-defined infection, diagnosed and treated in hospital, and if it is associated with sepsis, severe sepsis, septic shock, or multiple organ dysfunction syndrome it may lead to significant morbidity and mortality [11]. However, bacteremia is not synonymous with sepsis [11]. The aim of this retrospective review was to examine, in the setting of maternal bacteremia, the implications of the introduction of customized SIRS criteria for the diagnosis of maternal sepsis.

2. Materials and methods

In a retrospective observational study, all cases of maternal bacteremia detected in a tertiary maternity hospital, including both women who delivered an infant weighing more than 500 g and women who experienced pregnancy loss before fetal viability, during the study period January 1, 2009, to December 31, 2014, were identified from the laboratory database. Maternal bacteremia was defined as the finding of bacterial growth in blood culture specimens from pregnant or postpartum women. Bacterial growth due to contamination at the time of sampling was determined by the laboratory contemporaneously in conjunction with clinical staff. Women whose blood samples had contaminant growth were excluded.

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Table 1
Parameters of the standard sepsis and customized obstetric sepsis screening criteria.

Parameter	Standard sepsis screening criteria[a]	Obstetric sepsis screening criteria[b]
Respiratory rate, breaths per minute	>20	≥20
Heart rate, beats per minute	>90	≥100
Temperature, °C	<36.0 or ≥38.3	<36.0 or ≥38.0
Leukocyte count, $\times 10^9$/L	<4.0 or >12.0	<4.0 or >16.9
Blood glucose, mmol/L	>7.7	>7.7
Acutely altered mental status	Present	Present

[a] National Clinical Effectiveness Committee [8].
[b] National Clinical Effectiveness Committee [10].

The Coombe Women and Infants University Hospital is a tertiary referral university teaching hospital in Dublin, Ireland. It accepts women from all socioeconomic groups and from both urban and rural regions. It is one of the largest maternity hospitals in Europe, delivering over 8000 infants weighing 500 g or more per annum [12]. The hospital is staffed on a 24-hour basis by in-house residents in obstetrics, anesthesiology, and neonatology. Senior staff conduct regular ward rounds and are available for emergencies on a daily basis. The hospital has a high dependency unit (HDU) for women requiring higher level care. As a standalone maternity hospital, there is not an intensive care unit (ICU) on site; when deemed clinically necessary, women are transferred to the ICU of a nearby acute general hospital. The hospital does not have predefined criteria for HDU admission; instead, women are admitted to the HDU when deemed appropriate by senior obstetricians or anesthesiologists. Women are transferred to the ICU when multiorgan support or interventions such as dialysis, which are not available in the HDU, are indicated.

Hospital practice during the study period was to perform a septic screen, including phlebotomy for blood culture and leukocyte count, for women with a temperature greater than or equal to 38.0 °C or with any other clinical suspicion of bacteremia.

Following identification, charts were retrieved from the hospital's records department. A single researcher (PJM) reviewed all the case notes in detail and, in particular, the notes for the in-patient admission during which bacteremia occurred were scrutinized. The time of phlebotomy to obtain the specimen for blood culture was identified. Leukocyte counts during the same episode were retrieved from the computerized laboratory database. All recorded vital signs, whether on a dedicated observation or early warning system (EWS) chart or in the narrative clinical notes, from 1 hour before the time of phlebotomy until 6 hours thereafter, were computerized for analysis. This time period was chosen because, firstly, it coincided with the period of documented bacteremia and, secondly, the Surviving Sepsis Campaign emphasizes the importance of initiating early resuscitation of patients with sepsis during the first 6 hours after recognition [4]. Mental status during the episode of bacteremia was also noted. The laboratory database and case notes were searched for blood glucose concentration results.

A computerized bank of the six clinical findings included in both sets of criteria (heart rate, respiratory rate, temperature, leukocyte count, mental status, and blood glucose concentration) was then used to apply both the standard sepsis screening criteria and the customized obstetric sepsis screening criteria (Table 1). The criteria were compared by determining whether any of the six clinical findings for each woman were defined as abnormal by each set of criteria. The number of women identified as having sepsis by each set of criteria was then compared. The diagnosis of sepsis was based on the presence of two or more SIRS criteria, as defined by the respective screening tools, in conjunction with infection.

The Hospital Research Ethics Committee approved the study and written informed consent was not required because it was a retrospective study utilizing routinely gathered clinical data. Statistical analysis was performed using Excel (Microsoft Corporation, WA, USA). Two sample *t* tests and the Pearson χ^2 test were performed for comparison of groups. $P < 0.05$ was considered significant.

3. Results

Over the study period, 52 031 women delivered an infant weighing 500 g or more. The microbiology laboratory examined 3836 blood culture specimens during the study period. Of these, 93 (2%) women had positive blood cultures (excluding 27 samples that were positive with contaminant growth). The characteristics of the study population are shown in Table 2. Of the 13 women who experienced spontaneous abortion, six had bacteremia diagnosed before abortion and one had bacteremia in the hours following a spontaneous abortion at 22 weeks of gestation. There were three intrauterine fetal deaths before the diagnosis of bacteremia, two among the women who had intrapartum bacteremia and one among the women who had postpartum bacteremia. Twins delivered at 26 weeks of gestation with histologically confirmed acute choriodeciduitis on a background of preterm rupture of the membranes accounted for the only early neonatal deaths. There were no late neonatal deaths. The characteristics of the first 58 cases in the cohort have been described previously [13].

There were no maternal deaths among the 93 women with bacteremia, and all were discharged home well. Of the 93, 15 (16%) women required transfer to higher level care. One case of septic shock was transferred to the nearby ICU. There were 14 transfers to the hospital's HDU. Severe sepsis was the indication for HDU admission for 12 women while primary postpartum hemorrhage was the main indication for admission for two women. Of these 15 women requiring higher level care, 13 fulfilled the criteria for sepsis on both screening tools and two did not fulfil criteria for sepsis on either tool. The two women who did not fulfil the criteria for sepsis were transferred prenatally to the HDU due to maternal and fetal tachycardia but no other SIRS criteria were met.

Of the 93 cases, 80 (86%) had findings related to four or more of the six criteria recorded (Table 3). Blood glucose concentration was not tested in any of the cohort. Of the 93 cases, 61 (66%) cases would have been diagnosed with sepsis based on the standard criteria compared with 52 (56%) based on the obstetric customized criteria ($P = 0.18$) (Table 3). Although there was no difference in the proportion of cases diagnosed with sepsis by either set of screening criteria, the standard criteria relied more on the finding of leukocytosis compared with the customized criteria, while the customized criteria relied more on the finding of hyperthermia (Table 3).

Twenty-four women did not fulfil two or more SIRS criteria on either screening tool. Of these, seven women had all SIRS parameters recorded in the case notes (with the exception of blood glucose concentration) and 12 had findings related to four SIRS parameters recorded with respiratory rate and blood glucose concentration recordings missing.

Table 2
Characteristics of the study population (January 1, 2009, to December 31, 2014).[a]

Characteristic	Obstetric population[b] (n = 52 031)	Cases of bacteremia[c] (n = 93)	*P* value
Age, y	30.9 ± 5.7	29.9 ± 6.0	0.121
Primigravidas	20 694 (40)	39 (42)	0.671
Smokers	7232 (14)	4 (4)	0.007
Unemployed	12 673 (24)	23 (25)	0.920
BMI	25.8 ± 5.1	26.3 ± 5.4	0.167
BMI >29.9	8637 (17)	14 (15)	0.689
Preterm (<37 weeks)	3529 (7)	14 (15)	0.002
Cesarean delivery	14 048 (27)	26 (28)	0.841

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).
[a] Values are given as mean ± SD or number (percentage) unless otherwise indicated.
[b] Women who delivered infants weighing 500 g or more only.
[c] Including women who delivered infants weighing 500 g or more and women who experienced pregnancy loss before fetal viability.