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The utility of systemic inflammatory response syndrome (SIRS) for diagnosing sepsis in the immediate postpartum period

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ABSTRACT

Background: The systemic inflammatory response syndrome (SIRS) and sepsis definitions were developed to improve the ability for early detection of infection and sepsis. We studied the incidence of immediate postpartum SIRS and sepsis. We further studied immediate postpartum SIRS as a potential predictor for immediate postpartum sepsis.

Methods: This was a retrospective study of 638 immediate postpartum women who delivered either vaginally or by cesarean section. Multivariate logistic regression was used for statistical analysis. Predictor variables included demographic, labor and delivery, and SIRS variables to determine their association with acute immediate postpartum sepsis.

Results: We found that 72.10% of vital signs of immediate postpartum women met SIRS criteria while only 1.25% had sepsis. Both preterm gestational age of <37 weeks (OR:19.09, 95% CI:4.13, 88.36, $p < 0.001$) and only one of the four SIRS criteria of abnormal temperature (OR:25.90, 95% CI: 3.17, 211.52, $p = 0.002$) were each significantly associated with increased odds for sepsis.

Conclusion: Our findings suggest that immediate postpartum SIRS is not useful for the identification of immediate postpartum sepsis. Furthermore, SIRS does not appear to be a useful screening tool for infection and sepsis in the immediate postpartum period.

Introduction

Sepsis is the primary cause of death from infection [1] and is a clinical emergency that requires prompt diagnosis and treatment [2]. Sepsis is one of the four most costly conditions with aggregate hospital costs of over $20 billion and was 5.2% of total United States hospital costs [3]. The systemic inflammatory response syndrome (SIRS) criteria were developed to screen for infection and sepsis [4]. SIRS is manifested by two or more of the following conditions: (1) temperature >38 °C or <36 °C; (2) heart rate >90 beats per minute; (3) respiratory rate >20 breaths per minute or PaCO2 < 32 mm Hg; and (4) white blood cell count > 12,000/cu mm, <4000/cu mm, or >10% immature (band) forms. Sepsis is when the SIRS criteria are met in the presence of an infection [4].

SIRS criteria have been used broadly to screen for infection and sepsis and are reported to be useful for diagnostic and prognostic utility in settings such as intensive care units [5] cardiac surgery [6] and hospitalized medical patients [7]. However, some studies question the diagnostic and prognostic utility of SIRS criteria in settings such as the emergency department [8,9] and intensive care units [10].

Sepsis is the third leading cause of maternal mortality in the United States and accounts for 12.7% of maternal deaths [11]. Pregnant women and immediate postpartum women are predisposed to several infections such as endometritis, pneumonia, and pyelonephritis [12]. Postpartum endometritis is a risk factor for sepsis and septic shock and is more common after non-elective cesarean section than vaginal birth [13].

To our knowledge, we are not aware of any studies of on the clinical utility of SIRS for the detection of sepsis in the

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immediate postpartum period. This study has three aims. We studied the incidence of immediate postpartum SIRS and immediate postpartum sepsis. We also studied the association of SIRS criteria, demographic, and labor and delivery variables with immediate postpartum sepsis.

Methods

Setting

This was a retrospective chart review of 638 consecutive charts from January through March 2009. Inclusion criteria were immediate postpartum women who delivered vaginally or by cesarean section at a suburban New York City hospital which caters to a largely underserved and immigrant population. The immediate postpartum period was defined as the first 24 h after delivery. Exclusion criteria were patients with incomplete medical records. The study was conducted ethically and received Institutional Review Board approval.

Variables

Demographic variables were maternal age (years), race/ethnicity (Caucasian, Black, Hispanic, Asian, other), and body mass index [BMI] (normal weight, overweight, obese). One underweight patient with BMI of 18.1 was included in the normal weight category.

Labor and delivery variables were mode of delivery (vaginal, cesarean section), estimated blood loss (mL), postpartum hemorrhage defined as >500 mL for vaginal delivery or >1000 mL for cesarean section (no/yes), gestational age (term ≥37 weeks, preterm <37 weeks), pre-gestational diabetes (no/yes), gestational diabetes (no/yes), pre-eclampsia (no/yes), meconium staining (no/yes), and chorioamnionitis (no/yes).

Individual SIRS variables were abnormal white blood cells >12,000mU/dL or <4000 mU/dL (no/yes), band neutrophils >10% (no/yes), abnormal temperature (>38 °C or <36 °C), elevated heart rate >90 beats per minute (no/yes), and elevated respiratory rate >20 respirations/minute (no/yes). SIRS criteria met (no/yes) were based upon the American College of Chest Physicians/Society of Critical Care Medicine Consensus [4].

Statistical analysis

Descriptive statistics of mean and standard deviation were used to describe the continuous variables. Frequency and percentage were used to describe the categorical variables. The outcome variable was absence or presence of sepsis. Univariate inferential statistics of analysis of variance compared the continuous variables to sepsis. The Fisher's exact test compared the categorical variables to sepsis. All variables significantly differing in these univariate analyses were included in a multivariate logistic regression analysis for presence of sepsis. This multivariate logistic regression analysis was repeated in the subset of those with vaginal delivery and cesarean delivery. All p-values were two-tailed. IBM SPSS Statistics Version 24 was used for all analyses [14].

Results

We found that 72.10% of immediate postpartum patients met SIRS criteria. However, sepsis was only diagnosed in 1.25% (8/638) of the sample. The causes for sepsis diagnosis were 4 related to childbirth and 4 related to other factors consisting of pyelonephritis (n = 2), pneumonia (n = 1), and active herpes infection (n = 1). Among those with vaginal delivery, this percentage was 1.35% (6/446). Among those with cesarean delivery, this percentage was 1.04% (2/192).

Table 1 compares the sample characteristics between those with and without sepsis. Gestational age significantly differed where those preterm had a greater percentage with sepsis. The SIRS criteria of abnormal temperature significantly differed where there was a greater percentage for those with sepsis. Mode of delivery, demographic, the other labor and delivery variables, and the other SIRS criteria did not significantly differ between those with and without sepsis.

Table 2 shows logistic regression analyses for presence of sepsis among those variables that significantly differed between those with and without sepsis. In the whole sample, both preterm gestational age (<37 weeks) and abnormal temperature were each significantly associated with increased odds for sepsis. In the subset of only those with vaginal delivery, this same significance pattern occurred with higher increased odds for sepsis for both preterm gestational age and abnormal temperature. However, in the subset of those with cesarean delivery, only abnormal temperature was associated with increased odds for sepsis.

Discussion

Using SIRS criteria, our study found that 72% of the vital signs of immediate postpartum patients met SIRS criteria. However, immediate postpartum sepsis was only diagnosed in 1.25% of the sample. Both preterm gestational age and abnormal temperature were each significantly associated with increased odds for sepsis among the whole sample and for those with vaginal delivery. However, among those with cesarean delivery, only abnormal temperature was associated with increased odds for sepsis.

We found that 72% of immediate postpartum patients met SIRS criteria. As the majority of our sample met SIRS criteria, this likely reflects immediate postpartum physiologic changes. It is likely that the normal physiologic changes of pregnancy, as well as labor and delivery such as elevated heart rate [15,16], elevated respiratory rate [16,17], and elevated white blood cells [18,19] overlap with SIRS criteria.

We found that 1.25% of immediate postpartum women were diagnosed with sepsis. A review article about the rates of maternal sepsis and severe sepsis during and after pregnancy reports an incidence of 9–49 per 100,000 deliveries-year (0.009% to 0.049%), depending on the definition and population used [20]. Our findings suggest that sepsis incidence for immediate postpartum women is higher than sepsis incidence rates reported for overall rates for during and after pregnancy. We speculate that recording such data in the immediate 24 h after delivery may show physiologic elevations which over time may normalize.

We found that abnormal temperature (>38.0 C) was associated with increased odds for immediate postpartum sepsis in the whole sample, among those with vaginal delivery, and those with cesarean delivery. In the general population, abnormal high temperature or fever is associated with sepsis [21]. As fever is a known metabolic and immunologic response to infection [22], this is most likely the reason for our finding of the association of abnormal temperature (>38.0 C) with immediate postpartum sepsis. Interestingly, abnormal temperature is the only SIRS criterion which is not within the normal parameters of pregnancy [23].

We found that preterm gestational age of <37 weeks was significantly associated with increased odds for acute postpartum sepsis after a vaginal delivery. We are not aware of any previous research on the association of preterm gestational age with maternal immediate postpartum sepsis. Systemic and genital tract infections are risk factors for preterm delivery due to proposed mechanisms of decidua activation and the fetal immune response [24,25]. We sug-

Table 1
Sample Characteristics of 638 Postpartum Patients.

Variable	No sepsis mean (SD) or frequency (%) (n = 630)	Yes sepsis mean (SD) or frequency (%) (n = 8)	p-Value
Demographic variables			
Maternal age (years) [mean]	27.3 (6.48)	24.8 (6.32)	0.28
Race/ethnicity			0.86
Caucasian	60 (9.5)	0 (0.0)	
Black	122 (19.4)	1 (12.5)	
Hispanic	401 (63.7)	7 (87.5)	
Asian	22 (3.5)	0 (0.0)	
Other	25 (4.0)	0 (0.0)	
Body mass index			0.29
18.1–24.9	114 (18.1)	3 (37.5)	
25.0–29.9	251 (39.8)	3 (37.5)	
30.0 and greater	265 (42.1)	2 (25.0)	
Labor and delivery variables			
Mode of delivery			1.00
Vaginal	440 (69.8)	6 (75.0)	
Cesarean	190 (30.2)	2 (25.0)	
Estimated blood loss (mL) [mean]	424.1 (227.00)	437.5 (273.54)	0.87
Postpartum hemorrhage (yes)	17 (2.7)	0 (0.0)	1.00
Gestational age			<0.001
Term (≥ 37 weeks)	582 (92.4)	3 (37.5)	
Preterm (<37 weeks)	48 (7.6)	5 (62.5)	
Pre-gestational diabetes (yes)	7 (1.1)	0 (0.0)	1.00
Gestational diabetes (yes)	35 (5.6)	0 (0.0)	1.00
Pre-eclampsia (yes)	10 (1.6)	0 (0.0)	1.00
Meconium staining (yes)	72 (11.4)	0 (0.0)	0.61
Chorioamnionitis (yes)	12 (1.9)	1 (12.5)	0.15
SIRS criteria			
Abnormal white blood cells (yes)	369 (58.6)	7 (87.5)	0.15
Band neutrophils (yes)	2 (0.3)	0 (0.0)	1.00
Abnormal temperature (yes)	7 (1.1)	2 (25.0)	0.005
Elevated heart rate (yes)	300 (47.6)	4 (50.0)	1.00
Elevated respiratory rate (yes)	539 (85.6)	7 (87.5)	1.00
SIRS (yes)	452 (71.7)	8 (100.0)	0.11

Note: SD = standard deviation, SIRS = systemic inflammatory response syndrome. Only 1 person had underweight body mass index of 18.1 and this person was placed into the normal category of 18.5–24.9 for analyses.

Table 2
Logistic regression analysis for sepsis.

Variable	Whole sampleOR (95% CI)	p-Value	Vaginal deliveryOR (95% CI)	p-Value	Cesarean deliveryOR (95% CI)	p-Value
Gestational age		<0.001		0.001		0.17
Term (≥ 37 weeks)	1.00		1.00		1.00	
Preterm (<37 weeks)	19.09 (4.13, 88.36)		23.03 (3.86, 137.54)		9.42 (0.39, 227.51)	
Abnormal temperature (yes)	25.90 (3.17, 211.52)	0.002	21.40 (1.19, 384.89)	0.04	21.40 (1.82, 1149.49)	0.02

Note: OR = odds ratio, CI = confidence interval.

gest that those of preterm gestational age of <37 weeks may be at increased risk for infection which then can result in immediate postpartum sepsis after a vaginal delivery.

SIRS is not the only approach for detecting sepsis. Other methods of detecting sepsis include the Sepsis in Obstetrics Score (S.O.S.) [26], the Quick Sepsis Related Organ Failure Assessment (QSOFA) [1] and the Modified Obstetric Early Warning Scoring Systems (MOEWS) [27]. The S.O.S. was validated with pregnant emergency department patients and incorporates systolic blood pressure, oxygen saturation and lactic acid in addition to the SIRS criteria. This score, unlike SIRS, adjusts for the normal physiologic changes of pregnancy [26]. The QSOFA has been validated in non-ICU settings in patients with suspected infection to determine if they are at high risk for mortality. It incorporates altered mental status (Glasgow Coma Score of <15), a respiratory rate ≥22 rpm, and a systolic blood pressure ≤100 mmHg (Sepsis 3 conference). The utility of these approaches would be useful to study in pregnant and acute postpartum patients, although the diagnostic burden of using the Glasgow Coma Score in a maternity setting may render it unfeasible. The MOEWS tracks physiological parameters and evolving morbidity and once a predetermined threshold has been reached, it triggers evaluation by a healthcare professional. The healthcare professional determines further evaluation, treatment or intervention as necessary. The MOEWS has been advocated with the aim to reduce maternal morbidity and mortality, and improve clinical outcomes [28].

This study has several limitations. First, this study was conducted in one setting and may not generalize to other settings. Second, for cesarean section, there are factors associated with surgery that also produce abnormal vital signs post operatively such as elevated heart rate, respiratory rate, and white blood cell count [29]. Surgery may be a confounding factor with pregnancy for those with cesarean section. Third, due to only two cases of sepsis among the cesarean-section patients in our sample, this may be a reason why preterm gestational age was not associated with sepsis. Fourth, as this was a retrospective study, we are not aware of the time frame used by the clinicians to observe the patients and make their clinical diagnosis of meeting SIRS criteria and/or a diagnosis of sepsis.

In conclusion, our findings suggest that the SIRS criteria might not be a useful tool for the identification of postpartum infection/sepsis in the immediate postpartum period. As early and aggressive sepsis treatment improves patient survival, further study to determine a better screening tool for obstetric infection and sepsis in the immediate postpartum period is warranted.

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Competing interests

None declared.

Ethical approval

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