NCPD **2.0 ANCC Contact Hours**

MATERNAL SEPSIS: PRESENTATION, COURSE, TREATMENT, AND OUTCOMES

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Abstract

Purpose: The current adult definition of sepsis and septic shock, as developed in 1992, does not adequately define sepsis in the pregnant and peripartum women due to the alteration of sepsis presentation in the maternal population. The purpose of this study was to determine potential causative factors for sepsis with the aim of prevention and reducing morbidity and mortality.

Study Design and Methods: A descriptive observational design via a retrospective medical record review was used with a convenience sample of 22 women who were identified after admission as having sepsis. The setting was the labor and delivery unit of a large urban hospital in Fort Worth, Texas, with over 5,000 births per year.

Results: The most common diagnoses related to maternal sepsis included urinary tract infections, endometritis, chorioamnionitis, and wound infections. Main causative agents identified were predominantly *Escherichia coli* (*E. coli*), followed by group B streptococcus (GBS), and group A streptococcus (group A strep). The most prevalent presenting symptom was hypothermia or hyperthermia, followed by tachycardia. Primary laboratory results included above and below normal white blood cell count and elevated lactate levels. Sixty-four percent of patients diagnosed with sepsis were readmitted postpartum and 41% gave birth via cesarean.

Clinical Implications: Findings are applicable for nursing care and maternal sepsis protocol development. Early identification of mothers at risk for maternal sepsis and tool development for early diagnosis would be beneficial to support the ongoing work on decreasing maternal morbidity and mortality that have a devastating effect on women, their families, and their health care team. Early warning signs of sepsis can be shared by nurses with new mothers and their families as part of routine postpartum discharge teaching so they know when to call their primary health care provider and when to seek care in person.

Key words: Chorioamnionitis; Maternal sepsis; Puerperal infection; Pyelonephritis.

Sepsis is identified by organ dysfunction leading to a high rate of mortality and morbidity and can result from a multitude of infections (Novosad et al., 2016). Organ and tissue damage occur with sepsis as a reaction to the initial infection. Managing sepsis starts with understanding that sepsis is a medical emergency requiring prompt assessment, fluid resuscitation, source control, and evaluation of hemodynamic status (Levy et al., 2018). Sepsis is the second leading cause of maternal mortality, accounting for 12.7% of maternal deaths in the United States (Centers for Disease Control and Prevention [CDC], 2020b). Maternal sepsis contributes to 5% of maternal ICU admissions (Parfitt et al., 2017a). During pregnancy, signs and symptoms of sepsis may be increasingly difficult to distinguish due to maternal adaptations to pregnancy, effects of interventions required during labor, maternal pushing efforts, and blood loss after birth (Bonet et al., 2017).

Physiological adaptations during pregnancy include increased circulation, tachycardia, decreased blood pressure, diminished oxygen reserve, and increased susceptibility to infection (Bonet et al., 2017; Escobar et al., 2020). Due to an increase in maternal intervascular volume during pregnancy, there is a subsequent increase in maternal heart rate by 10 to 20 beats per minute (bpm), along with a compensatory decrease in blood pressure due to vasodilation, mimicking signs of sepsis (Escobar et al.; Gibbs et al., 2019). Respiratory changes during pregnancy include an increase in tidal volume and a decrease in the residual volume and functional residual capacity (Olvera & Dutra, 2016). This causes a reduction in oxygen reserve thereby affecting the mother's ability to compensate when a severe infection potentially leads to metabolic acidosis (Olvera & Dutra). Immunologic adaptations during pregnancy include a decrease in inflammatory response and cell-mediated immunity causing a predisposition to infection (Parfitt et al., 2017b). To protect the fetus, this immune response occurs to allow tolerance of fetal antigens (Gibbs et al.). The increased susceptibility to infection and invasion of microorganisms in the genitourinary tract is likely to cause ascending infections such as pyelonephritis and chorioamnionitis (Parfitt et al., 2017b). Cesarean birth increases risk for development of a surgical site and endometrial infection (Olvera & Dutra). These immunologic changes increase risk of development of acute respiratory distress syndrome during pregnancy and postpartum (Olvera & Dutra). The physiologic and immunologic adaptations that occur may mask initial signs and symptoms of infection that can result in a delay in recognition and treatment (Escobar et al.).

The current adult definition of sepsis and septic shock as developed in 1992 (Bone et al.) does not adequately define sepsis in pregnant and peripartum women due to the altered presentation of sepsis in this population (Acosta et al., 2014). Despite improvements in medical care, incidence of maternal sepsis continues to rise globally (Acosta et al., 2016). Current incidence of maternal sepsis in developed countries is estimated to be from 9 to 49 per 100,000 births (Bonet et al., 2017). Evidence has shown that maternal sepsis mortality rate is 8%; cases that progress to septic shock increase the mortality rate to between 20% and 28% (Bonet et al.). There is a link between organ system failure and mortality rate (Bonet et al.; Parfitt et al., 2017c). In the United States, there has been an approximate increase of maternal sepsis by 50% in 2003 (Acosta et al., 2014). According to the California Maternal Quality Care Collaborative, "for each maternal death, there are 50 women who experience life-threatening morbidity from sepsis" (Gibbs et al., 2019). Of the deaths associated with sepsis, group A streptococcal infection was identified as the more prevalent infection related to maternal sepsis mortality, whereas *E. coli* has been shown to be the more prevalent cause of sepsis (Acosta et al.).

Sepsis is the second leading cause of maternal mortality and makes up 5% of maternal ICU admissions in the United States.

The two greatest sources of infection in the maternal population are urinary tract and genital infections including chorioamnionitis and endometritis (Bonet et al., 2017). In the maternal population, infection can rapidly progress in less than 24 hours from the first symptom to the diagnosis of sepsis. In women with group A strep infection, infection was found to progress in as little as 9 hours from onset to diagnosis, highlighting importance of initiating high-dose intravenous antibiotics within 1 hour of onset (Acosta et al., 2014). A high number of women develop sepsis after hospital discharge; therefore, discharge teaching of signs and symptoms of infection is critical (Gibbs et al., 2019).

Another study identified a link between antibiotic treatment during the perinatal period and a greater likelihood of the development of maternal sepsis (Acosta et al., 2014). This implies that there is a progression of the infection even after initiation of antibiotic treatment suggesting improper diagnosis, treatment, and follow-up (Acosta et al.). A significant risk factor was identified as an unscheduled cesarean birth that increases the risk for sepsis 5- to 20-fold when compared with a vaginal birth (Parfitt et al., 2017b). Other risk factors that increase a mother's probability for development of sepsis are also poorly understood and include obesity, chronic hypertension, anemia, poor nutrition, history of GBS infection, lack of prenatal care, and nonwhite ethnicity (Parfitt et al., 2017b).

The Surviving Sepsis Campaign suggests that to decrease sepsis mortality and morbidity there has to be awareness, recognition, appropriate treatment, health care education, guidelines of care, post intensive unit care, and quality improvement programs (De Backer & Dorman, 2017). The World Health Organization encourages use of specific maternal guidelines to best recognize

and treat maternal sepsis (Bonet et al., 2017). There is need to understand progression of maternal sepsis to gain knowledge of treatment and infection control (Acosta et al., 2014). Generally, intensivists, general practitioners, or emergency room providers have the most sepsis management education and knowledge in the adult population. However, they have less understanding of maternal presentation and the rate at which infection rapidly progresses (Acosta et al.). When group A strep infection is confirmed, providers should treat and manage infection as a maternal emergency.

Maternal adaptations to pregnancy conceal and mimic signs and symptoms of maternal sepsis. To better understand the infectious process, retrospective medical record review of cases of mothers with a confirmed sepsis diagnosis was analyzed. Medical records were evaluated for maternal presenting signs and symptoms, laboratory and assessment findings, and progression of maternal sepsis. The main purpose of this study was to determine factors associated with sepsis cases with the aim of generating knowledge to help reduce morbidity and mortality in maternity patients by early recognition. We also sought to identify obstacles in recognition of sepsis in this population.

Study Design and Methods

We used a descriptive observational design through a retrospective medical record review of cases of maternal sepsis with the following research question. Among maternity patients who are subsequently diagnosed with maternal sepsis, what concerning criteria including vital signs, laboratory results, and presenting symptoms are found on a retrospective medical record review?

Sample

The sample consisted of women who were identified after admission as having maternal sepsis. The research team obtained a list from health information management of patients using discharge and readmission coding for sepsis and sepsis-related terms: puerperal sepsis, maternal sepsis. Inclusion criteria were records of patients who gave birth at the study hospital or who were admitted during the postpartum period, up to 6 weeks after birth with suspected or confirmed sepsis. Exclusion criteria were patients who did not give birth at a hospital and postpartum patients who did not have coding for sepsis or sepsis-related diagnoses.

Setting

The setting was the labor and delivery unit of Baylor Scott & White All Saints Medical Center-Fort Worth, a 538-bed hospital with a level III neonatal intensive care unit and a level III trauma center. The labor and delivery unit has 19 labor-delivery-recovery rooms, an obstetric triage unit, and averages over 5,000 births per year.

Study Procedures

After obtaining institutional review board approval, researchers obtained a list of patients who met inclusion criteria. All data were collected on a shared, password-protected electronic file that was accessible only to the members of the research team. Patient medical information included: patient demographics, gravidity and parity, gestational age at birth, type of birth, pertinent medical and prenatal history, reason for admission, membrane status (including time of rupture, meconium staining), vital signs (infant and mother), pertinent laboratory results, capillary refill, urinary output, blood cultures, 12-lead electrocardiogram, treatment information (oxygen administration, antibiotics, fluid resuscitation), and infant disposition.

TABLE 1. MATERNAL SEPSIS OUTCOMES

	Average	Range
Demographics and Pregnancy Outcomes		
Age	27 years	16–40 years
Gravidity	2.27	1–5
Parity	1.8	1–4
Gestation	36.8 weeks	23.1–41.1 weeks
Length of membrane rupture time to birth	31.9 hr	1 min–21 days
Maternal Vital Signs		
Temperature	101.8 °F	95.8–103.7 °F
Heart rate	125 bpm	84–175 bpm
Respiratory rate	21.8 bpm	16–48 bpm
Blood pressure	105/61 mmHg	71/43–140/78 mmHg
Infant Vital Signs		
Temperature	99.5 °F	97.8–102.1 °F
Heart rate	164.1 bpm	140–190 bpm
Respiratory rate	55.5 bpm	38–80 bpm

Results

Demographics

Twenty-four cases of maternal sepsis were identified from 2014 to 2019 using the puerperal sepsis diagnosis code. Of these, two were excluded due to not meeting specified criteria. Average maternal age at time of diagnosis was 27 years with a range of 16 to 40 (Table 1). Fifty-nine percent were Caucasian, 19% were Hispanic, 13% African American, and 9% were Asian.

Pregnancy and Birth Outcomes

Mothers

Average gravidity was 2.27 and average parity was 1.8. Average gestation at time of birth was 36.8 weeks. Fifty-nine percent (14) gave birth vaginally, whereas 41% (9) had a cesarean birth. Of the nine cesareans, two were scheduled repeat cases and seven were unplanned for indications including: failure to progress (4), fetal "distress" (1), severe intrauterine growth restriction and preeclampsia (1), and twin pregnancy with preterm spontaneous rupture of membranes (1). Meconium-stained fluid was

noted in 9% of cases (2). Average length of time from membrane rupture to birth was 31.9 hours (range: 1 minute to 21 days) (Table 1). Sixty-four percent (14) were GBS negative, 23% (5) had unknown status, and 13% (3) were GBS positive. There were no maternal deaths.

Babies

Newborn and fetal findings included a fetal tachycardia in 13% (3) of the cases averaging 173 bpm (120–190 bpm), average infant weight 3,196.9 g (536 to 4,022 g), and admittance of 36% (8) of the infants to the neonatal intensive care unit (NICU). Seventy-five percent (6) of infants who required NICU admissions resulted from a maternal diagnosis of chorioamnionitis and hospital policy for NICU observation, whereas the remaining 25% (2) due to prematurity. Average infant vital signs at birth included temperature of 99.5 °F (min 97.8, max 102.1), heart rate of 164.1 bpm (min 140, max 190), and a respiratory rate of 55.5 breaths per minute (bpm) (min 38, max 80) (Table 1). Due to micro prematurity (23-week twin gestation), two infant deaths had occurred.

Of the babies of the women who were readmitted, we found that infants' initial vital signs at birth were abnormal including infant tachycardia with an average heart rate of 164 bpm, an average temperature of 99.9 °F, and an average respiratory rate of 56 bpm.

Maternal Sepsis Source and Trigger

Sixty-four percent (14) of patients did not develop maternal sepsis symptoms during their initial birth hospitalization but were readmitted with maternal sepsis approximately 7.8 days from postpartum discharge. Sixty-four percent (5) of the patients readmitted had a spontaneous vaginal birth, whereas 36% (9) gave birth via cesarean. Identified sources of sepsis included urinary tract infections (50%, 11), endometritis (27%, 6), chorioamnionitis (18%, 4), and pneumonia (5%, 1). Triggers that were primarily recognized were maternal fever (81%, 18), hypotension (9%, 2) hypothermia (5%, 1), and shortness of breath (5%, 1). Urinary cultures resulted in *Escherichia coli* (*E. coli*) (12), respiratory culture showed macrobacterium (1), two wound cultures resulted in GBS (1) and Vividans strep (1), blood cultures resulted in extended spectrum beta-lactamases (1), *E. coli* (1), and group A strep (1).

Laboratory and Assessment Results

Average diagnostic vital signs included maternal temperature of 101.8 °F (min 95.4, max 103.7), heart rate 125 bpm (min 84, max 175), respiratory rate 21.8 bpm (min 16, max 48), and blood pressure 105/61 mmHg (min 71/43, max 140/78). Of the vital sign changes, the most prevalent change was hyperthermia (86%, 19) and hypothermia (4%, 1) followed by maternal tachycardia (77%, 17), and tachypnea (27%, 6). Hypotension (18%, 4) was not as predominant in these maternal cases as related to the nonpregnant adult signs and symptoms.

Laboratory data included white blood cell (WBC) count of 13.45 mcL (min 1.4, max 23.4) of which 36% (8) had bands present. WBCs were elevated in 50% (11) of women, 23% (5) were in normal range, 9% (2) were below normal, and 18% (4) were within normal limits but had bands present. Other laboratory data included timed lactic acid results of 2.3/2.0/1.6 mmol/L, 28.9 IU/L; aspartate transaminase (AST) 28.9 IU/L and alanine transaminase (ALT) 33 IU/L; random glucose 98.6 mg/d; platelets 269.1 mcL; creatinine clearance 0.79 mL/min; and bilirubin 0.58 µmol/L (Table 2). One woman had a mental status change, 18% (4) required supplemental oxygen, and 13% (3) had reduced urine output (<30 mL/hr).

Treatment

Treatment with antibiotics was given to 100% (22) of the patients, 95% (21) required fluid resuscitation, whereas 13% (3) required vasopressors for blood pressure support. Admission to the intensive care unit was required for 23% (5) of patients diagnosed with maternal sepsis.

TABLE 2. MATERNAL SEPSIS LABORATORY OUTCOMES

	Average	Range	Normal Pregnancy Values
WBC	13.45 mcL	1.4–23.4 mcL	5.9–16.9 mcL
Bands, when present	12.1%	4–34%	0%
Lactic acid, initial	2.3 mmol/L	0.6–8.0 mmol/L	0.9–1.7 mmol/L
Lactic acid, 3 hour	2.0 mmol/L	0.7–6.0 mmol/L	0.9–1.7 mmol/L
Lactic acid, 6 hour	1.6 mmol/L	0.7–7.2 mmol/L	0.9–1.7 mmol/L
AST	28.9 IU/L	7–88 IU/L	4–32 IU/L
ALT	28.9 IU/L	7–137 IU/L	2–25 IU/L
Glucose	98.6 mg/d	70–185 mg/d	70–99 mg/dL
Platelets	269.1 mcL	131–462 mcL	146–429 mcL
Creatinine clearance	0.79 mL/min	0.43–1.13 mL/min	0.4–0.9 mL/min
Bilirubin	0.58 µmol/L	0.2–3.4 µmol/L	0.1–1.1 µmol/L

Note. Adapted from Cunningham (2010)

Discussion

Cesarean Birth

There appeared to be an increased susceptibility to developing maternal sepsis when birth is by cesarean, as evidenced by 41% of our cases. During the study period, average cesarean birth rate was 30% at our facility.

Readmissions

The majority (64%) of patients diagnosed with sepsis were readmitted. These findings were similar to Gibbs et al. (2019) and further solidifies need for patient and family teaching at discharge. When considering babies of the women who were readmitted, infants' initial vital signs at birth were abnormal, potentially signifying early signs of infection. This suggests that the infant's vital signs at birth could possibly point to maternal sepsis well before the mother's first signs and symptoms appear.

Women and their families must be made aware of early warning signs of sepsis as part of discharge teaching so they know when to call their health care provider and when to seek care in person. Several well-developed patient teaching aids are available for this purpose including the *POST-BIRTH warning signs education program* from Association of Women's Health, Obstetric, and Neonatal Nurses (2020), and the *Urgent maternal warning signs* project from the Council on Patient Safety in Women's Health Care (2020). The CDC's (2020a) *Hear Her* program offers information for women, their families, and health care professionals.

Laboratory Results

In our cases of maternal sepsis, the only laboratory values that were identified as abnormal during the entire patient stay included WBC, presence of bands, and an elevated lactic acid level. Initial lactic acid levels were elevated. Platelets, AST/ALT, blood sugar, creatinine clearance, and bilirubin stayed within normal range. This suggests that a nonpregnant screen will not necessarily show early chemistry changes in the maternal population.

Vital Signs

Our data identified risk factors, maternal triggers, most common sources, and began to fill in the gaps of the differences between adult sepsis and maternal sepsis presentation. Additional study of laboratory results, evaluation of infant vital signs, and a focus on maternal readmissions after infant birth need to be examined further.

Limitations

Limitations of this study include the small sample size and single study site. More cases could allow a better understanding of maternal sepsis triggers and progression.

Clinical Implications

The most common diagnoses related to maternal sepsis included urinary tract infections, endometritis, chorioamnionitis, and wound infections. Main causative agents identified were predominantly *Escherichia coli* (*E. coli*), followed by group B streptococcus (GBS), and group A streptococcus (group A strep). The most prevalent presenting symptom was hypothermia or hyperthermia, followed by tachycardia. Primary laboratory results included above and below normal white blood cell count and elevated lactate levels. Sixty-four percent of patients diagnosed with sepsis were readmitted postpartum and 41% gave birth via cesarean. Due to maternal adaptations of pregnancy, signs and symptoms of sepsis may be masked. It is essential that bedside nurses recognize alterations from baseline and use clinical assessment skills and critical judgment for optimal patient outcomes. Understanding that primary maternal triggers such as hypothermia and hyperthermia, tachycardia, and tachypnea warrant prompt response and notification of other members of the perinatal health care team is vital to promote safe care. Nurses sharing information about maternal sepsis as part of postpartum discharge teaching with new mother and their families can potentially save lives. ✣

SUGGESTED CLINICAL IMPLICATIONS

- Due to maternal adaptations of pregnancy, signs and symptoms of sepsis may be masked. The bedside nurse should be able to recognize alterations from baseline, and use clinical assessment skills and critical judgment for optimal patient outcomes for mothers and babies.
- Understanding primary maternal triggers such as hypothermia and hyperthermia, tachycardia, and tachypnea warrant further investigation and prompt response.
- Our findings apply to nursing care and offer information for maternal sepsis protocol development to best recognize and treat maternal sepsis.
- In efforts to decrease maternal morbidity and mortality related to sepsis, nurses and health care providers need to be aware of current guidelines, and emerging research, and continuously revaluate practice to help in prompt recognition and the most effective treatment measures.
- Discharge teaching to patient and family is paramount following birth, once signs and symptoms appear, follow-up care should be prioritized.
- Consider using one or more of the maternal early warning signs patient education materials from AWHONN, CDC, and Council on Patient Safety in Women's Health Care as part of routine hospital discharge teaching.

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