

Evaluation of Puerperal and Postpartum Infections after Cesarean Section and Their Clinical Outcomes

Nematulloeva Feruza, Zhimei Wang

Department of Obstetrics and Gynecology, First Affiliated Hospital of Xinjiang Medical University, Urumqi, China
Email: nematulloevafiruza6@gmail.com

How to cite this paper: Feruza, N. and Wang, Z.M. (2023) Evaluation of Puerperal and Postpartum Infections after Cesarean Section and Their Clinical Outcomes. *Open Journal of Internal Medicine*, 13, 330-350. <https://doi.org/10.4236/ojim.2023.134030>

Received: September 4, 2023

Accepted: November 12, 2023

Published: November 15, 2023

Copyright © 2023 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Puerperal and postpartum infections after cesarean section are a leading cause of maternal and neonatal morbidity and mortality worldwide. Postpartum infections account for a significant, and often preventable, portion of the global healthcare burden. Puerperal sepsis is one of the top five causes of maternal deaths worldwide and accounts for 10% - 15% of deaths in the postpartum period. Postpartum infections also present a significant social burden: they increase maternal anxiety and the risk of postpartum depression, interfere with bonding, and negatively impact breastfeeding. To prevent complications and improve outcomes, the evaluation of these infections must be accurate and prompt. This review provided a summary of causes, clinical presentation, laboratory tests, imaging modalities, treatment options, complications, and prognosis of puerperal and postpartum infections following cesarean section. Future directions in the evaluation of these infections were also discussed, including the development of novel diagnostic assays, the use of point-of-care testing and risk factors responsible for the onset of infections. This review emphasized the significance of early diagnosis and prompted treatment of these infections in order to prevent complications and enhance maternal and neonatal outcomes. This article also provided an exhaustive overview of the evaluation and management of puerperal and postpartum infections and the clinical outcome of infections for both mother and neonate.

Keywords

Cesarean Section, Endometritis, Puerperal Infections, Sepsis

1. Introduction

Puerperal and postpartum infections following cesarean section are major con-

cerns in maternal and newborn care. They can contribute to maternal and neonatal morbidity and mortality and can render significant complications. The incidence of these infections varies based on the clinical setting, patient population, and surgical techniques used during cesarean delivery [1] [2].

To prevent complications and improve maternal and fetal outcomes, prompt evaluation and treatment of these infections are essential. As these infections can manifest as endometritis, urinary tract infections, wound infections, and sepsis, clinicians must be aware of their diverse clinical manifestations. It can be difficult to recognize these infections early, and a high index of suspicion is required for prompt diagnosis and treatment.

Evaluation of these infections must be precise and prompt in order to prevent complications and enhance outcomes. Laboratory and imaging tests are used to corroborate the diagnosis because the clinical presentation of these infections is often nonspecific. In severe cases, imaging modalities such as ultrasound, computed tomography, and magnetic resonance imaging may be necessary. Frequent laboratory procedures include complete blood count, C-reactive protein, and blood cultures. Utilizing appropriate diagnostic tests can aid in identifying the causative pathogens and choosing the most effective treatment protocols [3] [4].

Effective management of puerperal and postpartum infections following cesarean section requires a multidisciplinary approach, including the use of antimicrobial therapy, wound care, and abscess drainage [5]. To ensure the appropriate selection of antimicrobials and prevent the emergence of antibiotic-resistant organisms, antibiotic prophylaxis and therapy must adhere to established guidelines. Non-pharmacologic interventions such as hair removal with clippers rather than razors, vaginal cleansing with povidone-iodine, and suture closure of subcutaneous tissue, if incision thickness is >2 cm, can also aid in the prevention of infections [6].

1.1. Definition of Puerperal and Postpartum Infections after Cesarean Section

Puerperal and postpartum infections after cesarean section are infections that develop after a cesarean section delivery. Multiple bacterial pathogens can cause these infections, which can affect the mother and the newborn. The incidence and severity of these infections can vary depending on the clinical setting, patient population, and surgical techniques used during cesarean delivery [1] [7]. These infections can result in severe complications and contribute to maternal and neonatal morbidity and mortality, making prompt and accurate diagnosis and treatment crucial for improving outcomes [8].

1.2. Epidemiology and Global Disease Burden

Puerperal and postpartum infections following cesarean section are a major concern in global maternal and newborn healthcare. Depending on the clinical setting, patient population, and surgical techniques used during cesarean delivery, the incidence of these infections varies [9] [10].

The World Health Organization estimates that in 2015, approximately 21.1% of births occurred via cesarean section worldwide. This increase in cesarean section rates has been linked to a rise in the incidence of puerperal and postpartum infections following cesarean section. In developing nations, where access to healthcare resources and competent providers may be limited, these infections are more prevalent. Endometritis was the most prevalent infection following cesarean delivery, according to a study conducted in an Ethiopian hospital. In another Nigerian hospital study, the incidence of post-cesarean wound infection was found to be 8.5% [11] [12].

The incidence of puerperal and postpartum infections following cesarean section is lower in developed countries where healthcare resources and skilled providers are more broadly available. The incidence of surgical site infections following cesarean delivery was 2.1%, according to a study executed in a hospital in the United States [7] [13].

Puerperal and postpartum infections following cesarean section contribute substantially to global maternal and infant mortality. Sepsis in mothers is one of the preliminary etiology of maternal mortality, accounting for 11 percent of maternal deaths worldwide. Up to forty percent of neonatal fatalities in developing nations are attributed to sepsis, making neonatal sepsis a significant concern [14].

1.3. Types of Puerperal and Postpartum Infections

After cesarean delivery, puerperal and postpartum infections can manifest as a variety of infections, including:

- 1) Endometritis is an infection that causes inflammation of the endometrium, the interior layer of the uterus. When the inflammation reaches the muscular layer, it is referred to as endomyometritis, and when it reaches the parametrium, it is referred to as endoparametritis. This condition can occur during or outside of pregnancy, and it can be either acute or chronic. Postpartum endometritis is the most prevalent puerperal infection, and it is typically caused by the transfer of normal vaginal bacteria into the uterus during delivery. In comparison to vaginal delivery, caesarean section increases the risk of Endometritis.

- 2) Urinary tract infections (UTIs) are common in pregnant women, and pyelonephritis is the most significant pregnancy-related medical condition. Therefore, obstetric care specialists must have a thorough comprehension of normal urinary tract findings, how to diagnose abnormalities, and how to treat them. The majority of UTIs in expectant women can be successfully treated with relative ease. In uncommon instances, however, pyelonephritis during pregnancy can cause significant complications for both mother and fetus [15]. Changes to the urinary tract and immune system augment the probability of developing a UTI during pregnancy. Physiological alterations in the urinary tract, including ureter and renal calyx dilation, can occur as a result of progesterone-induced relaxation of smooth muscles and compression of ureters by expanding the uterus. Signifi-

cant ureteral dilation and a diminished bladder capacity frequently result in frequent urination. Vesicoureteral reflux may also be present, increasing the risk of UTIs even further.

3) Surgical site infection is defined by the Centers for Disease Control and Prevention (CDC) as an infection that happens within 30 days of a surgical modus operandi. The CDC further categorized SSIs as primary and secondary superficial incisional SSIs, primary and secondary deep incisional SSIs, and organ or space SSIs if they involve structures located deeper than the muscle and fascia space [16].

4) Sepsis is a life-threatening infectivity caused by the spread of bacteria from a localized infection into the circulation. Sepsis is a complication of any of the infections listed above and can result in distress and organ failure [17].

1.4. Objective of the Article

This review aimed to give an overview of clinical manifestations of puerperal and postpartum infections following cesarean section and to emphasize the significance of early recognition and expeditious management along with laboratory test, imaging modalities and risk factors and clinical outcomes of these infections. This review aimed to provide healthcare professionals with a comprehensive comprehension of evaluation and management of puerperal and postpartum infections after cesarean section, with a particular emphasis on enhancing maternal and neonatal outcomes. This review's objectives will be met by synthesizing the current literature on the topic and identifying significant knowledge deficits for future research.

2. Puerperal and Postpartum Infections Following Cesarean Delivery

Globally, maternal morbidity and mortality represent significant healthcare and socioeconomic burdens, with a significant portion of this burden attributable to preventable postpartum infections. During postpartum period, which is typically defined as period six weeks following childbirth, infections are relatively common, afflicting between 5 and 7 percent of women. Puerperal sepsis is one of the top five causes of maternal mortality worldwide and accounts for 10% to 15% of postpartum fatalities. Infections are also the primary cause of death after induced or spontaneous abortions. These infections are exacerbated by the rising prevalence of bacterial resistance to the most common antibiotics [1].

Postpartum infections are also a significant social burden, as they can increase maternal anxiety, contribute to postpartum depression, impede bonding, and have adverse impacts on lactation. Infections that occur after live deliveries, stillbirths, and induced or spontaneous abortions are covered in this discipline [18].

2.1. Epidemiology of Puerperal and Postpartum Infections

Postpartum infections are a major cause of maternal mortality globally, with ap-

proximately five million cases of pregnancy-related infections occurring annually and 75,000 deaths. In low-resource settings, the incidence of infections is higher, and many infection-related maternal fatalities are preventable. Postpartum infections are infections that occur between delivery and the 42nd day postpartum. Endometritis (puerperal sepsis), urinary tract infections, surgical site infections, bloodstream infections, and wound infections are the most prevalent types of postpartum infections (**Tables 1-4**). According to a retrospective study conducted in Mbarara, Uganda, 31% of maternal fatalities were caused by puerperal sepsis, making it the leading cause of maternal mortality at that facility [2].

Screening of automated ambulatory medical records, hospital and emergency room claims, and pharmacy records of 2826 health maintenance organization members who had given birth during a 30-month period was done. The incidence of postpartum infections was 6.0% overall, with 7.4% after caesarean delivery and 5.5% after vaginal delivery. Significant predictors of infection included

Table 1. Incidence of puerperal and postpartum infections, the endometritis.

S. No	Type of infection	Incidence (%)	Reference
1		16.4	Salmanov <i>et al.</i> , 2020
2	Endometritis	18	Ngonzi <i>et al.</i> , 2018
3		1.2	Woodd <i>et al.</i> , 2019

Table 2. Incidence of puerperal and postpartum infections, the UTIs.

S. No	Type of infection	Incidence (%)	Reference
1		4.2	Bishaw <i>et al.</i> , 2023
2	Urinary tract	4.6	Gundersen <i>et al.</i> , 2018
3	Infections (UTIs)	3.0	Ngonzi <i>et al.</i> , 2018
4		2.7	Woodd <i>et al.</i> , 2019

Table 3. Incidence of puerperal and postpartum infections, the infections of surgical incision.

S. No	Type of infection	Incidence (%)	Reference
1		29.2	Bishaw <i>et al.</i> , 2023
2	Infections of surgical incision	3.0	Ngonzi <i>et al.</i> , 2018

Table 4. Incidence of puerperal and postpartum infections, the sepsis.

S. No	Type of infection	Incidence (%)	Reference
1		1.42	Bishaw <i>et al.</i> , 2023
2		0.83	Anger <i>et al.</i> , 2021
3	Sepsis	10	Boushra <i>et al.</i> , 2022
4		16.6	Melkie <i>et al.</i> , 2021

re-hospitalization, caesarean delivery, the use of anti-staphylococcal antibiotics, diagnosis codes for mastitis, endometritis, and wound infection, and ambulatory blood or wound cultures.

2.2. Factors Associated with Puerperal and Postpartum Infections

Multiple factors contribute to commencement of the postpartum infections, which are significant causes of maternal morbidity and mortality. Mode of delivery, prolonged labor, premature membrane rupture, instrument-assisted delivery, maternal age, comorbidities, antibiotic use, poor sanitation, insufficient prenatal care, and low socioeconomic status are all risk factors for postpartum infections. To reduce the incidence of postpartum infections and enhance maternal outcomes, these risk factors need to be managed effectively [2].

According to WHO, puerperal sepsis is an infection of the genital tract that occurs between the onset of membrane rupture or labor and 42 days (6 weeks) after delivery, accompanied by two or more of the following symptoms: pelvic pain, fever, abnormal vaginal discharge, abnormal smell, foul odor discharge, or delay in uterine involution. Puerperal sepsis is one of the top five causes of maternal mortality worldwide, accounting for 10.7% of maternal fatalities (Figure 1). Despite significant advances in postnatal care, puerperal sepsis continues to be a prevalent and preventable cause of maternal mortality [19].

2.3. Puerperal and Postpartum Infection Microbiology

Common complications following childbirth, puerperal and postpartum infections are caused by a variety of pathogenic microbes. *Escherichia coli*, *Streptococcus*, *Enterococcus faecalis*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Streptococcus pyogenes* are most frequently isolated bacteria associated with

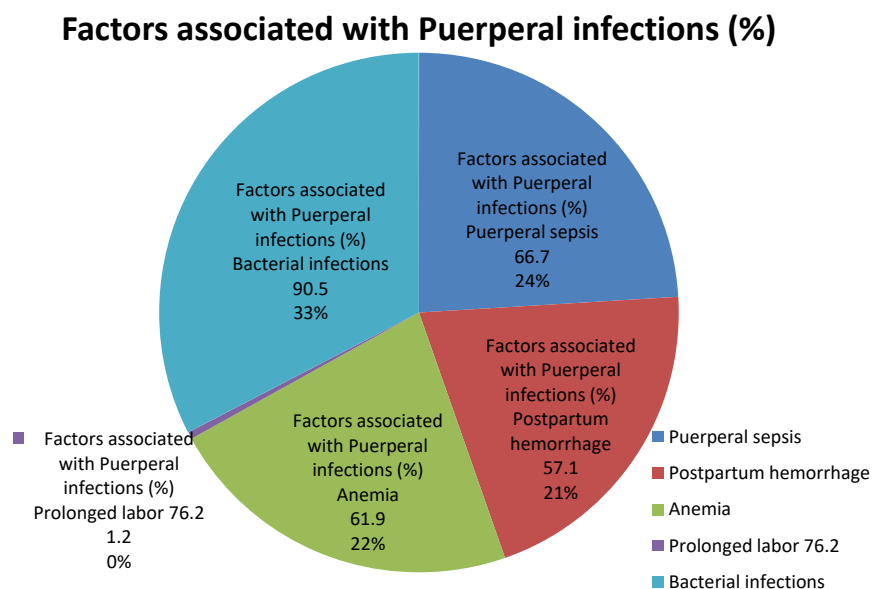


Figure 1. Factors associated with the postpartum infections.

postpartum infections. Understanding the microbiology of postpartum infections is essential for their effective management and prevention [20].

The genital tract of a healthy expectant woman is colonized by a wide variety of commensal bacteria, which bear an essential role in protecting woman from pathogenic microorganisms. During pregnancy, the vaginal microbiota endures numerous changes, including an increase in the number of lactobacilli, which maintain the acidic environment required to prevent the growth of pathogenic bacteria [21]. After childbirth, a woman's immune system is compromised, resulting in a transition in the vaginal microbiota from lactobacilli dominance to a mixed microbial community consisting of both aerobic and anaerobic bacteria, rendering pathogenic bacterial invasion and are associated with postpartum infections [22].

For instance; *Escherichia coli*, *Streptococcus*, *Enterococcus faecalis*, and anaerobic bacteria, bacteroides and streptococcus species commonly cause Endometritis [23]. *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Enterococcus faecalis* are microbes most frequently isolated from wound infections [24]. Same pathogens *Escherichia coli*, *Klebsiella pneumoniae*, and *Enterococcus faecalis* are prevailing in postpartum UTIs [25]. *Escherichia coli*, *Klebsiella pneumoniae*, and *Streptococcus* are the most frequently isolated pathogens in postpartum sepsis [26].

3. Review of Literature

3.1. Incidence of Puerperal and Postpartum Infections

A study was conducted to ascertain incidence and predictors of puerperal sepsis among postpartum women at Debre Markos Comprehensive Specialized Hospital, in 2020-21. 330 women who had recently given birth participated in a prospective cohort study. Incidence rate of puerperal sepsis was computed, and a Kaplan-Meier survival curve was utilized to estimate the probability of survival for developing puerperal sepsis. Utilizing the cox-proportional hazards regression model, predictors of puerperal sepsis were identified. During a total of 1685.3 person-weeks of observation, the incidence rate of puerperal sepsis was 14.24 per 1000 person-weeks among the study participants. Statistically significant predictors of puerperal sepsis were a lack of formal education, caesarean delivery, pre-mature rupture of membranes, complicated pregnancy, referral status, and absence of birth preparation and complication readiness plan. Thus the incidence of puerperal sepsis was determined to be 7.27%, with several risk factors including caesarean delivery, complicated pregnancy, and lack of birth preparation and complication contingency plan. In order to prevent and treat puerperal sepsis, it is essential to improve maternal health education and access to quality maternal health services [27].

3.2. Risk factors for Puerperal and Postpartum Infections

During 2011, Obstetrics and Gynecology Department of Liaquat University of

Medical & Health Sciences in Jamshoro, Sindh, conducted an observational prospective cohort study. All women who delivered in the hospital or were referred within 42 days after delivery with puerperal pyrexia, sepsis diagnosed on clinical examination and pertinent investigations were included in the study. During the study period, 3.89 percent of the 3,316 women admitted for obstetrical reasons had puerperal sepsis, or 129 women. The preponderance of these women were over the age of 31 (65.11%), multiparous (78.29%), and unreserved (75.96%). There were 108 women with absent membranes (83.72%), mismanaged and referred cases (73.64%), and hospital births (26.35%) identified as common risk factors. Observed morbidities included septicemia in 35 patients (27.13%) and disseminated intravascular coagulation in 23 cases (17.82%). Sadly, eleven (8.52%) women perished. The conclusion of the study was that common risk factors for puerperal sepsis were anemia, suboptimal personal hygiene, and improper sterilization practices, which led to severe health risks including septicemia, disseminated intravascular coagulation, and mortality.

3.3. Outcome of Puerperal and Postpartum Infections

In a regional referral hospital in Uganda, 4231 women presenting for delivery or postpartum care were enrolled in a prospective cohort study. The results indicated that 5% of the women were febrile or hypothermic. Among febrile participants, 174/205 (85%) undertook a complete clinical and microbiological evaluation for infection, while 24 (12%) underwent a partial evaluation. Endometritis was identified in 76/193 (39%) of the clinically evaluated women. Overall, the maternal mortality rate during hospitalization was minimal and there was no significant difference between the febrile/hypothermic and normo-thermic groups (Table 5).

Table 5. Clinical outcomes of puerperal and postpartum infections after cesarean section are evaluated.

Type of infection	Clinical manifestations	Diagnosis	Treatment	Clinical outcome (recovery in days)	Reference
Endometritis	Fever, pelvic pain, anomalous vaginal discharge	Blood and urine cultures, clinical examination, and imaging	cephalosporin and, intravenous azithromycin, chlorhexidine	16 - 18	Kawakita <i>et al.</i> , 2017
UTI	Urination discomfort, frequent urge to urinate, fever	Biochemical tests, culture, microscopy	sulfamethizole, mecillinam, nitrofurantoin, trimethoprim, amoxicillin, ampicillin	30	Gundersen <i>et al.</i> , 2018
Infection of surgical incision	Signs of pelvic infections, pain and fever	Physical examination, Imaging techniques	Wound exploration, debridement and antibiotics	20 - 30	Zuarez-Easton <i>et al.</i> , 2017
Sepsis	High temperature, accelerated respiration and, low blood pressure, and confusion	diagnosed with chorio-amnionitis by imaging	Antibiotics and supportive care	15 - 30	Bishaw <i>et al.</i> , 2023

Hence, Incidence of postpartum infection among rural Ugandan women was low, and caesarean delivery was independently associated with postpartum infection, whereas antenatal clinic attendance was protective [2].

4. Clinical Presentation of Puerperal and Postpartum Infections

Common complications following childbirth include puerperal and postpartum infections. These infections can be severe and necessitate prompt medical care. These include; puerperal sepsis, Endometritis, UTIs, infected incision site and neonatal sepsis. After delivery, it is crucial for women to seek medical attention if they experience any of these symptoms. Early detection and treatment can assist in preventing complications and enhancing outcomes because untreated infections can have severe consequences [28].

4.1. Symptoms and Signs of Endometritis

Endometritis is an inflammation of the interior lining of the uterus that typically occurs after childbirth (Figure 2). It is a common puerperal and postpartum infection that, if left untreated, can result in severe complications. Typically, endometritis manifests with a combination of symptoms and indicators with fever, chills, abdominal pain or discomfort, offensive-smelling vaginal discharge, and excessive bleeding or discharge. Rigidity or perspiration may accompany the fever. Typically, these symptoms occur within the first 3 to 5 days after delivery or within the first 2 weeks following a caesarean section. Nevertheless, they can also manifest weeks or even months after delivery.

Endometritis is characterized by palpable uterine tenderness, a robust or enlarged uterus, and purulent or foul-smelling vaginal discharge. Leukocytosis, an elevated C-reactive protein level, and an elevated erythrocyte sedimentation rate may also be present. In some cases, systemic infection symptoms may include tachycardia, hypotension, and altered mental status [29].



Figure 2. Ultrasound image of postpartum infections of endometritis.

Endometritis can lead to sepsis, a potentially fatal condition characterized by organ dysfunction and distress, in severe cases. Endometritis must be promptly diagnosed and treated to prevent complications.

4.2. Symptoms and Manifestations of Urinary Tract Infections

Postpartum UTIs are prevalent type of infection. Depending on the severity of the infection and the area of the urinary tract that is affected, UTI symptoms and signs can vary (Figure 3).

Urge to urinate, even when the bladder is empty, is the most prevalent symptom of urinary tract infections. A burning sensation while urinating, passing frequent, small volumes of urine, cloudy or pungent-smelling urine, and pelvic pain or pressure are also common symptoms.

In extreme instances, UTIs can cause fever, chills, nausea, vomiting, and back pain. If the infection extends to the kidneys, it can cause more severe symptoms, including high fever, severe back pain, and even sepsis, a potentially fatal condition that can lead to organ failure [30].

Women who received a catheter during labor or delivery are more likely to develop UTIs after giving birth. A history of UTI, diabetes, inadequate personal hygiene, and a weakened immune system are also risk factors [31].

UTIs can lead to more severe complications, such as kidney damage and sepsis, if left untreated. Therefore, it is essential for postpartum women to seek medical attention if they experience any UTI symptoms. Antibiotics are commonly used to eliminate the infection and alleviate symptoms.

4.3. Symptoms and Signs of Wound Infections

A wound infection is an infection that develops in a cut or laceration. It is a common complication following surgery or any form of injury in which the skin is broken. Infections of wounds can range from mild to severe and manifest a variety of symptoms (Figure 4). Redness, swelling, pain, and warmth are the most



Figure 3. Ultrasound image of postpartum infections of UTI.



Figure 4. Image of postpartum infections of surgical incision infections.

typical symptoms of a wound infection. In severe cases, these symptoms may be accompanied by fever and chills, and there may be pus or discharge emerging from the wound. Additionally, the area surrounding the incision may become tender and touch-sensitive [32].

Other indicators of a wound infection include an offensive odor emanating from the wound, an increase in redness or tenderness around the wound, and a delay in the wound's mending. If you observe any of these symptoms or indications, you must seek immediate medical attention. In certain instances, a wound infection can extend to the surrounding tissues, resulting in cellulitis. Cellulitis is a severe bacterial skin infection that can result in inflammation, redness, and discomfort. In severe cases, it may result in sepsis, a life-threatening condition, as well as fever and shivers [4].

4.4. Symptoms and Signs of Sepsis

Sepsis is a potentially fatal condition that develops when the body's immune system over-reacts to an infection, resulting in inflammation and tissue injury. It is a severe complication that can arise from a variety of infections, including those that occur during the postpartum period [1].

Depending on the severity of the infection and the afflicted organs, the symptoms and signs of sepsis can vary. In general, sepsis can produce a number of symptoms and signs, including: High fever and a low body temperature, which is indicative of a severe infection. A rapid pulse rate may indicate that the body is attempting to combat an infection. Sepsis can inflame the lungs and make breathing problematic, resulting in rapid respiration. It can affect the brain and result in confusion, disorientation, and even seizures. It can cause blood pressure to decline to dangerously low levels, which can result in organ failure and even death. Rash or skin discoloration may indicate sepsis. Inflammation of the abdomen can result in abdominal pain, nausea, and vomiting when sepsis is present. Sepsis can result in urinary tract infections, which can cause urinary pain or discomfort, frequent urination, and turbid or pungent urine. Extreme fatigue

and frailty can be caused by sepsis, making it difficult for patients to perform even the most fundamental tasks [33].

5. Laboratory Examinations of Puerperal and Postpartum Infections

Laboratory tests are essential for the diagnosis and treatment of puerperal and postpartum infections. Clinical examination, laboratory tests, and imaging studies are utilized to confirm the diagnosis, monitor the patient's response to treatment, and identify complications. These include:

5.1. C-Reactive Protein Total Blood Count

C-reactive protein (CRP) and complete blood count (CBC) are common laboratory tests used to diagnose and treat puerperal and postpartum infections. CRP is a protein produced by the liver during the acute phase in response to inflammation, infection, or tissue injury. In cases of puerperal and postpartum infections, elevated levels of CRP in the blood are indicative of an inflammatory response. In healthy adults, the normal CRP level is typically less than 10 mg/L. CRP levels can be substantially elevated in the context of puerperal and postpartum infections, indicating an inflammatory response. CRP levels are frequently elevated in endometritis, with some studies reporting mean CRP levels of 100 mg/L or higher. In instances of wound infections and sepsis, CRP levels may also be elevated [34].

CBC measures the quantity of white blood cells (WBCs) present in the blood. WBCs are vital immune cells that aid in the fight against infections. As the body fights an infection, the number of WBCs in the blood increases. CBC can aid in the surveillance and diagnosis of infections, including puerperal and postpartum infections. WBC counts are frequently elevated in puerperal infections, indicating a heightened immune response to the infection. In severe infections, the white blood cell count may exceed 15,000 cells/mm³. The differential count, which indicates the proportion of various types of WBCs, can also be used to determine the infection's cause.

5.2. Blood Cultures

Blood cultures are a laboratory test used to detect the presence of bacteria or other microorganisms in the circulation. This test is essential for detecting sepsis and other systemic infections that can occur after childbirth [35].

Blood sample is collected and sent to a laboratory in order to conduct a blood culture. Blood is deposited in a culture medium in laboratory that promotes the growth of any microorganisms that may be present in the sample. If bacteria or other microorganisms develop in the culture, their susceptibility to various antibiotics can be determined by identifying and testing them. Blood cultures are typically only advised if the patient is exhibiting signs of a systemic infection, such as fever or chills, or if they have other risk factors for sepsis, such as pro-

tracted membrane rupture, prolonged labor, or a history of recent infection. Blood cultures are frequently performed alongside other laboratory tests, such as a complete blood count (CBC) and C-reactive protein (CRP) level, to aid in the diagnosis and monitoring of an infection's progression [36].

5.3. Pro-Calcitonin Levels

Pro-calcitonin is a biomarker commonly used to aid in the diagnosis of bacterial infections. It is a peptide precursor of the hormone calcitonin, which is produced by the thyroid gland as well as other tissues, such as the lungs and liver. In response to bacterial infections, pro-calcitonin levels can rise significantly, especially in cases of severe sepsis [37].

Pro-calcitonin levels can be used to distinguish between bacterial and viral infections in the context of puerperal and postpartum infections. Low levels of pro-calcitonin are indicative of a viral infection, whereas elevated levels suggest a bacterial infection. This can be especially helpful in cases of endometritis where the diagnosis is unclear but symptoms such as fever and abdominal pain are present [38].

Multiple studies have demonstrated the utility of pro-calcitonin levels in postpartum infection diagnosis. It was discovered that women with postpartum infections had significantly higher pro-calcitonin levels than those without. In addition, the study found that pro-calcitonin levels could predict the severity of an infection, with higher levels correlating to more severe cases [39].

In healthy individuals, normal pro-calcitonin levels are typically below 0.05 ng/mL, and levels above 0.5 ng/mL are considered clinically significant. Those infected with endometritis had substantially higher pro-calcitonin levels than those without infection, with a median value of 1.9 ng/mL compared to 0.04 ng/mL in the non-infected group [37].

6. Therapeutic Approach towards Puerperal and Postpartum Infections

Knowledge of microbiological profiles, local resistance patterns, and severity of the patient's illness guide the choice of antibiotics for postpartum infections. Seriously unwell patients initially receive broad-spectrum antibiotics, and then the regimen can be refined as clinical evidence from cultures or pathology specimens becomes available. As required, pharmacists can assist in modifying the initial antibiotic selection and narrowing the spectrum. Consideration should be given to the patient's lactation status when selecting antibiotics to ensure safe breastfeeding.

Although antibiotic regimens for specific postpartum infections may vary, the treatment principles for the majority of infectious conditions are comparable. Patients with hemodynamic compromise receive up to 30 ml/kg of ideal body weight of balanced crystalloid fluids. If the mean arterial pressure remains below 65 mmHg despite adequate resuscitation with fluids, a vasopressor are adminis-

tered. As soon as practicable, broad-spectrum antibiotics are administered, and blood cultures are obtained before antibiotics if there would not be a significant delay.

6.1. Antimicrobial Treatment

Antimicrobial therapy is essential for the management of puerperal infections. The choice of antimicrobial agents should be guided by the microbiological profiles of the infections, local resistance patterns, and severity of the patient's illness. As a general rule, broad-spectrum antimicrobial coverage is recommended at the onset of therapy, especially in patients who are gravely ill. As culture or pathology results become available, antibiotic regimens should be modified accordingly.

In puerperal infections, gram-positive cocci such as *Staphylococcus aureus*, *Streptococcus species*, and *Enterococcus faecalis* are the most prevalent causative organisms. In some instances, Gram-negative organisms like *Escherichia coli*, *Klebsiella pneumonia*, and *Proteus mirabilis* may also be involved (Figure 5). Therefore, empirical treatment regimens should encompass a broad spectrum of gram-positive and gram-negative organisms [40].

For outpatient treatment of endometritis, doxycycline and metronidazole are recommended as first-line agents. Intravenous clindamycin and gentamicin are the preferable initial regimens for hospitalized patients. Other options include intravenous ampicillin-sulbactam or piperacillin-tazobactam, with or without aminoglycoside addition. First-line agents for UTIs include oral nitrofurantoin or trimethoprim-sulfamethoxazole. In cases of pyelonephritis or infections that are complicated, intravenous antibiotics such as ceftriaxone, cefepime, or ampicillin-sulbactam are advised.

The choice of antibiotics for wound infections depends on the severity of the infection and the prevalence of comorbidities. In empirical regimens, intravenous vancomycin, piperacillin-tazobactam, or other broad-spectrum antibiotics

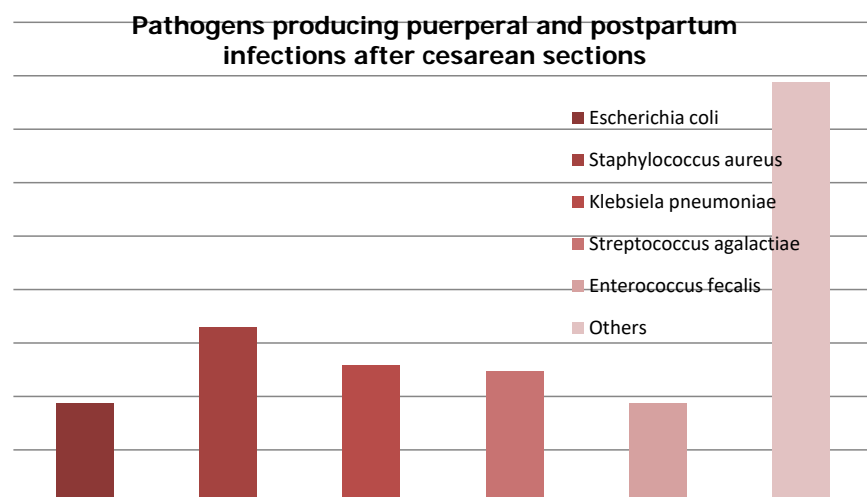


Figure 5. Pathogens causing puerperal and postpartum infections after cesarean sections.

may be administered. The lesion should be cultured to guide the selection of antibiotics for targeted treatment [41].

6.2. Surgical Intervention

In certain instances, surgical intervention may be required to treat puerperal infections. This is particularly true if the infection is severe and antibiotics are ineffective. In addition, if there is a localized abscess or symptoms of tissue necrosis, surgery may be required. The specific type and location of the infection will determine the type of surgical intervention to be performed. For instance, if tissues contain abscess, incision and drainage (I&D) may be required. If the infection is located in the uterus, dilation and curettage (D&C) may be used to eliminate the infected tissue [1].

Typically performed by an obstetrician or gynecologist, surgical intervention for puerperal infections may necessitate hospitalization. The length of time required to recover depends on the severity of the infection and the type of surgery performed. Noting that surgical intervention is typically reserved for severe cases and is not always required for the treatment of puerperal infections is essential. Antibiotics and supportive care are often sufficient for a complete recovery.

7. Complications of Puerperal and Postpartum Infections for Mother and Neonate

Puerperal and postpartum infections are linked to complications for both the mother and newborn. These infections can progress to sepsis, a life-threatening condition in which the immune system attacks the body's tissues and organs in response to an infection. For instance, sepsis, if left untreated, can result in organ failure, shock, and mortality. Postpartum infections can also result in complications such as endometritis, an infection of the uterine lining. It can cause infertility, chronic pelvic pain, and even mortality if left untreated.

7.1. Morbidity and Mortality of Mothers

Postpartum infections can result in substantial maternal morbidity and mortality. Chronic pelvic pain, infertility, and sepsis, which can progress to septic shock and organ failure, are common complications. In extreme cases, mortality is possible [1].

The life-threatening complication of postpartum infections is sepsis. It occurs when the immune system's response to an infection causes extensive inflammation, resulting in organ dysfunction and failure. Prolonged labor, cesarean section, and retained products of conception are risk factors for sepsis [42].

Postpartum infections are a significant cause of maternal mortality, particularly in low-resource contexts. According to WHO, 10.7% of global maternal fatalities are caused by puerperal sepsis. Nevertheless, many postpartum infections are preventable with proper prenatal and postnatal care, including the expeditious administration of antibiotics and, if necessary, surgical intervention [2].

7.2. Neonatal Peritonitis

Neonatal peritonitis is a significant complication of puerperal and postpartum infections. Perforation or rupture of a viscus, such as the bowel or appendix, owing to infections like sepsis or meningitis is the most common cause of neonatal peritonitis. The perforation permits the intestinal contents to leak into the peritoneal cavity, resulting in an inflammatory response. Meconium peritonitis and congenital abnormalities, such as intestinal atresia or mal-rotation, are additional causes of neonatal peritonitis.

Neonatal peritonitis is characterized by abdominal distension, vomiting, diarrhea, and fever. In addition to lethargy, poor nutrition, and respiratory distress, the infant may also exhibit signs of sepsis. Imaging studies, such as ultrasound or scan, are used to make a diagnosis because they can reveal indicators of inflammation and free fluid in the peritoneal cavity [43].

Urgent surgical intervention is required to repair the perforation and remove any infected tissue or foreign material from the peritoneal cavity when treating neonatal peritonitis. Additionally, antibiotics are administered to treat the infection. In certain instances, temporary enterostomies may be required to enable the bowel to heal.

The complications of neonatal peritonitis include sepsis, intestinal obstruction, and short bowel syndrome, which can result in malnutrition and growth issues. In cases of sepsis or perforation due to necrotizing enterocolitis, a critical condition that affects premature infants, mortality rates for neonatal peritonitis are highest.

8. Outcome of Puerperal and Postpartum Infections

Depending on the severity of the infection and the promptness of treatment, the clinical outcome of puerperal and postpartum infections varies. Severe complications, including sepsis, septic shock, and even mortality, can result from delayed diagnosis and treatment. In benign cases, with prompt and appropriate treatment, the vast majority of women recover from puerperal and postpartum infections without long-term consequences. In severe cases, however, where the infection has progressed to sepsis or septic shock, the mortality risk is substantial. The mortality rate for women with puerperal sepsis is as high as 10.7%, making it one of the primary causes of maternal mortality worldwide.

8.1. Probability of Recurrence

Puerperal and postpartum infections may recur if the underlying risk factors are not addressed. For example, if a woman develops UTI during the postpartum period and does not receive the appropriate treatment or if she has underlying urinary tract abnormalities, she may be at an increased risk for recurrent UTIs. Similarly, if a woman develops an incisional wound infection after a cesarean delivery and does not receive the appropriate treatment, she may be at an increased risk for recurrent infections in subsequent pregnancies [15].

To reduce the risk of recurrence of puerperal and postpartum infections, it is necessary to identify and address underlying risk factors. This may entail addressing medical conditions such as diabetes or hypertension, enhancing sanitation and infection prevention practices, and ensuring proper surgical technique during childbirth. In addition, antimicrobial treatment and follow-up care are essential for preventing recurrence.

The probability of recurrence of puerperal and postpartum infections depends on a number of variables, including the nature and severity of the infection, the underlying risk factors, and the efficacy of treatment and prevention strategies. With proper management and follow-up care, the risk of recurrence can be reduced and women can recover healthily after childbirth.

8.2. Long-Term Influence on Maternal and Newborn Health

Puerperal and postpartum infections can have long-term effects on both the mother and the infant's health. Future occurrences of chronic pelvic pain, infertility, and ectopic pregnancy may be more likely in women who have experienced these infections. Infections following childbirth can also result in the formation of adhesions or abscesses in the pelvic, which can be painful and uncomfortable [2].

The health of newborns born to mothers with puerperal and postpartum infections may also be compromised. Neonatal sepsis is a common complication of maternal infections, and it can result in severe health complications, such as respiratory distress, hypotension, and meningitis. In certain instances, neonatal sepsis is fatal [17].

In addition, maternal infections during pregnancy or after delivery can increase the likelihood of preterm birth, low birth weight, and other neonatal complications. These outcomes may have long-lasting effects on the child's health and growth [44].

To prevent long-term complications, it is essential for healthcare providers to carefully monitor both the mother and the newborn for indications of infection and administer the appropriate treatment [44].

8.3. Influencing Variables of Prognosis

Among the variables that can affect the prognosis of puerperal infections are:

The pathogen causing the infection can also affect the prognosis. Some microorganisms are more virulent than others, and it may be more difficult to treat infections caused by antibiotic-resistant bacteria [45].

Immune status of the patient can also affect the prognosis of puerperal infections. Women with compromised immune systems due to preexisting medical conditions or the use of certain medications may experience a more severe infection.

The presence of coexisting medical conditions, such as diabetes or hypertension, can also have an effect on the prognosis of puerperal infections. Adherence

to the prescribed treatment regimen is crucial for achieving a favorable outcome. Noncompliance with treatment can result in treatment failure and reinfection. Preterm birth is a risk factor for puerperal infections, and the prognosis may be worse in these cases. Women who undergo cesarean section have a higher risk of postpartum infections and a worse prognosis. Advanced maternal age may be associated with an increased risk of puerperal infections, and elder women may have a worse prognosis.

With prompt diagnosis, appropriate treatment, and adequate follow-up care, the outlook for puerperal infections can be favorable. However, a delay in diagnosis, non-adherence to treatment, and the presence of underlying medical conditions can result in negative outcomes.

9. Conclusions

In conclusion, puerperal and postpartum infections following cesarean section are major global causes of maternal and neonatal morbidity and mortality. Depending on the clinical setting, patient population, and surgical techniques used during cesarean delivery, the incidence and severity of these infections can vary. Effective evaluation and management of these infections require a multidisciplinary approach, including the use of antimicrobial therapy, wound care, and abscess drainage. This article provided an exhaustive overview of the evaluation and management of puerperal and postpartum infections. The clinical presentation, laboratory tests, imaging modalities, treatment options, complications, and prognosis for these infections have been discussed.

Moreover, prevention of these infections is crucial, and gynecologists must adhere to appropriate guidelines for antibiotic prophylaxis and treatment to ensure the selection of appropriate antimicrobials and prevent the emergence of antibiotic-resistant organisms. Non-pharmacologic interventions such as hair removal with clippers rather than razors, vaginal cleansing with povidone-iodine, and suture closure of subcutaneous tissue, if the incision thickness is >2 cm, can also aid in the prevention of infections.

Availability of Data and Materials

All data generated or analyzed during this study are included in this published article (and its supplementary information files).

Authors' Contributions

NF analyzed and interpreted the patient data regarding old acetabular fracture with THA and also a major contributor in writing the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Boushra, M. and Rahman, O. (2020) Postpartum Infection. StatPearls Publishing, Treasure Island (FL). <https://www.ncbi.nlm.nih.gov/32809639/>
- [2] Ngonzi, J., *et al.* (2018) Incidence of Postpartum Infection, Outcomes and Associated Risk Factors at Mbarara Regional Referral Hospital in Uganda. *BMC Pregnancy and Childbirth*, **18**, Article No. 270. <https://doi.org/10.1186/s12884-018-1891-1>
- [3] Hussain, S., *et al.* (2022) Modern Diagnostic Imaging Technique Applications and Risk Factors in the Medical Field: A Review. *BioMed Research International*, **2022**, Article ID: 5164970. <https://doi.org/10.1155/2022/5164970>
- [4] Li, S., *et al.* (2021) Diagnostics for Wound Infections. *Advances in Wound Care*, **10**, 317-327. <https://doi.org/10.1089/wound.2019.1103>
- [5] Alnajjar, M.S. and Alashker, D.A. (2020) Surgical Site Infections Following Caesarean Sections at Emirati Teaching Hospital: Incidence and Implicated Factors. *Scientific Reports*, **10**, Article No. 18702. <https://doi.org/10.1038/s41598-020-75582-9>
- [6] Calderwood, M.S., *et al.* (2023) Strategies to Prevent Surgical Site Infections in Acute-Care Hospitals: 2022 Update. *Infection Control & Hospital Epidemiology*, **44**, 695-720. <https://doi.org/10.1017/ice.2023.67>
- [7] Kawakita, T. and Landy, H.J. (2017) Surgical Site Infections after Cesarean Delivery: Epidemiology, Prevention and Treatment. *Maternal Health, Neonatology and Perinatology*, **3**, Article No. 12. <https://doi.org/10.1186/s40748-017-0051-3>
- [8] Goldenberg, R.L., McClure, E.M. and Saleem, S. (2018) Improving Pregnancy Outcomes in Low- and Middle-Income Countries. *Reproductive Health*, **15**, Article No. 88. <https://doi.org/10.1186/s12978-018-0524-5>
- [9] Gomaa, K., *et al.* (2021) Incidence, Risk Factors and Management of Post Cesarean Section Surgical Site Infection (SSI) in a Tertiary Hospital in Egypt: A Five Year Retrospective Study. *BMC Pregnancy and Childbirth*, **21**, Article No. 634. <https://doi.org/10.1186/s12884-021-04054-3>
- [10] Bizuayew, H., *et al.* (2021) Post-Cesarean Section Surgical Site Infection and Associated Factors in East Gojjam Zone Primary Hospitals, Amhara Region, North West Ethiopia, 2020. *PLOS ONE*, **16**, e0261951. <https://doi.org/10.1371/journal.pone.0261951>
- [11] Adane, F., *et al.* (2019) Prevalence and Root Causes of Surgical Site Infection among Women Undergoing Caesarean Section in Ethiopia: A Systematic Review and Meta-Analysis. *Patient Safety in Surgery*, **13**, Article No. 34. <https://doi.org/10.1186/s13037-019-0212-6>
- [12] Lijaemiro, H., Lemlem, S.B. and Deressa, J.T. (2020) Incidence of Surgical Site Infection and Factors Associated among Cesarean Deliveries in Selected Government Hospitals in Addis Ababa, Ethiopia, 2019. *Obstetrics and Gynecology International*, **2020**, Article ID: 9714640. <https://doi.org/10.1155/2020/9714640>
- [13] Sway, A., *et al.* (2019) Burden of Surgical Site Infection Following Cesarean Section in Sub-Saharan Africa: A Narrative Review. *International Journal of Women's Health*, **2019**, 309-318. <https://doi.org/10.2147/IJWH.S182362>
- [14] Nchimbi, D.B. and Joho, A.A. (2022) Puerperal Sepsis-Related Knowledge and Reported Self-Care Practices among Postpartum Women in Dar es salaam, Tanzania. *Women's Health*, **18**. <https://doi.org/10.1177/17455057221082954>
- [15] Habak, P. and Griggs Jr, R. (2022) Urinary Tract Infection in Pregnancy. StatPearls Publishing, Treasure Island (FL).

- [16] Zejnullahu, V.A., Isjanovska, R., Sejfića, Z. and Zejnullahu, V.A. (2019) Surgical Site Infections after Cesarean Sections at the University Clinical Center of Kosovo: Rates, Microbiological Profile and Risk Factors. *BMC Infectious Diseases*, **19**, 1-9. <https://doi.org/10.1186/s12879-019-4383-7>
- [17] Odabasi, I.O. and Bulbul, A. (2020) Neonatal Sepsis. *Şişli Etfal Hastanesi Tıp Bülteni*, **54**, 142-158.
- [18] Rouse, C., et al. (2019) Postpartum Endometritis and Infection Following Incomplete or Complete Abortion: Case Definition & Guidelines for Data Collection, Analysis, and Presentation of Maternal Immunization Safety Data. *Vaccine*, **37**, 7585-7595. <https://doi.org/10.1016/j.vaccine.2019.09.101>
- [19] Kajeguka, D.C., et al. (2020) Factors and Causes of Puerperal Sepsis in Kilimanjaro, Tanzania: A Descriptive Study among Postnatal Women Who Attended Kilimanjaro Christian Medical Centre. *The East African Health Research Journal*, **4**, 158-163. <https://doi.org/10.24248/eahrj.v4i2.639>
- [20] Koo, Y.-J. (2018) Puerperal Septic Shock and Necrotizing Fasciitis Caused by *Staphylococcus caprae* and *Escherichia coli*. *Yeungnam University Journal of Medicine*, **35**, 248-252. <https://doi.org/10.12701/yujm.2018.35.2.248>
- [21] Bagga, R. and Arora, P. (2020) Genital Micro-Organisms in Pregnancy. *Frontiers in Public Health*, **8**, Article 225. <https://doi.org/10.3389/fpubh.2020.00225>
- [22] Chee, W.J.Y., Chew, S.Y. and Than, L.T.L. (2020) Vaginal Microbiota and the Potential of Lactobacillus Derivatives in Maintaining Vaginal Health. *Microbial Cell Factories*, **19**, Article No. 203. <https://doi.org/10.1186/s12934-020-01464-4>
- [23] Said, M.S., Tirthani, E. and Lesho, E. (2021) Enterococcus Infections. StatPearls Publishing, Treasure Island (FL). <https://www.ncbi.nlm.nih.gov/33620836/>
- [24] Puca, V., et al. (2021) Microbial Species Isolated from Infected Wounds and Antimicrobial Resistance Analysis: Data Emerging from a Three-Years Retrospective Study. *Antibiotics*, **10**, Article 1162. <https://doi.org/10.3390/antibiotics10101162>
- [25] Yi-Te, C., et al. (2020) Urinary Tract Infection Pathogens and Antimicrobial Susceptibilities in Kobe, Japan and Taipei, Taiwan: An International Analysis. *Journal of International Medical Research*, **48**. <https://doi.org/10.1177/0300060519867826>
- [26] Majangara, R., Gidiri, M.F. and Chirenje, Z.M. (2018) Microbiology and Clinical Outcomes of Puerperal Sepsis: A Prospective Cohort Study. *Journal of Obstetrics and Gynaecology*, **38**, 635-641. <https://doi.org/10.1080/01443615.2017.1399112>
- [27] Bishaw, K.A., et al. (2023) Incidence and Predictors of Puerperal Sepsis among Postpartum Women at Debre Markos Comprehensive Specialized Hospital, Northwest Ethiopia: A Prospective Cohort Study. *Frontiers in Global Women's Health*, **4**, Article ID: 966942. <https://doi.org/10.3389/fgwh.2023.966942>
- [28] Sharma, S. and Mahajan, N. (2023) Complications of Puerperium. In: Garg R., Ed., *Labour and Delivery: An Updated Guide*. Springer, Berlin, 687-701. https://doi.org/10.1007/978-981-19-6145-8_48
- [29] Kitaya, K., et al. (2018) Endometritis: New Time, New Concepts. *Fertility and Sterility*, **110**, 344-350. <https://doi.org/10.1016/j.fertnstert.2018.04.012>
- [30] Belyayeva, M. and Jeong, J.M. (2018) Acute Pyelonephritis. StatPearls Publishing, Treasure Island (FL). <https://www.ncbi.nlm.nih.gov/books/NBK519537/>
- [31] Gundersen, T.D., et al. (2018) Postpartum Urinary Tract Infection by Mode of Delivery: A Danish Nationwide Cohort Study. *BMJ Open*, **8**, e018479. <https://doi.org/10.1136/bmjopen-2017-018479>
- [32] Zabaglo, M. and Sharman, T. (2020) Postoperative Wound Infection. StatPearls Pub-

- lishing, Treasure Island (FL). <https://www.ncbi.nlm.nih.gov/books/NBK560533/>
- [33] Rockenschaub, P. (2021) The Feasibility of Using of Electronic Health Records to Inform Clinical Decision Making for Community-Onset Urinary Tract Infection in England. Ph.D. Thesis, London's Global University, London.
- [34] Mertens, K., Muys, J. and Jacquemyn, Y. (2019) Postpartum C-Reactive Protein: A Limited Value to Detect Infection or Inflammation. *Facts, Views & Vision in Ob-Gyn*, **11**, 243-250.
- [35] Żródłowski, T., *et al.* (2020) Classical Microbiological Diagnostics of Bacteremia: Are the Negative Results Really Negative? What Is the Laboratory Result Telling Us about the "Gold Standard"? *Microorganisms*, **8**, Article 346. <https://doi.org/10.3390/microorganisms8030346>
- [36] Bonnet, M., Lagier, J.C., Raoult, D. and Khelaifia, S. (2020) Bacterial Culture through Selective and Non-Selective Conditions: The Evolution of Culture Media in Clinical Microbiology. *New Microbes and New Infections*, **34**, Article ID: 100622. <https://doi.org/10.1016/j.nmni.2019.100622>
- [37] Samsudin, I. and Vasikaran, S.D. (2017) Clinical Utility and Measurement of Procalcitonin. *The Clinical Biochemist Reviews*, **38**, 59-68.
- [38] Daubin, C., *et al.* (2021) Ability of Procalcitonin to Distinguish between Bacterial and Nonbacterial Infection in Severe Acute Exacerbation of Chronic Obstructive Pulmonary Syndrome in the ICU. *Annals of Intensive Care*, **11**, Article No. 39. <https://doi.org/10.1186/s13613-021-00816-6>
- [39] Walker, S., *et al.* (2022) An Evaluation into the Use of Procalcitonin Levels as a Biomarker of Bacterial Sepsis to Aid the Management of Intrapartum Pyrexia and Chorioamnionitis. *AJOG Global Reports*, **2**, Article ID: 100064. <https://doi.org/10.1016/j.xagr.2022.100064>
- [40] Kucova, P., *et al.* (2021) Bacterial Pathogens and Evaluation of a Cut-Off for Defining Early and Late Neonatal Infection. *Antibiotics*, **10**, Article 278. <https://doi.org/10.3390/antibiotics10030278>
- [41] Baertl, S., *et al.* (2022) What Is the Most Effective Empirical Antibiotic Treatment for Early, Delayed, and Late Fracture-Related Infections? *Antibiotics*, **11**, Article 287. <https://doi.org/10.3390/antibiotics11030287>
- [42] Jain, V., Arora, A. and Jain, K. (2021) Sepsis in the Parturient. *Indian Journal of Critical Care Medicine: Peer-Reviewed, Official Publication of Indian Society of Critical Care Medicine*, **25**, S267. <https://doi.org/10.5005/jp-journals-10071-24033>
- [43] Okeke, R., *et al.* (2022) Infantile Appendicitis: Importance of Diagnostic Accuracy and a Lowered Threshold for Computed Tomography. *Journal of Pediatric Surgery Case Reports*, **84**, Article ID: 102364. <https://doi.org/10.1016/j.epsc.2022.102364>
- [44] Kumar, M., Saadaoui, M. and Khodor, S.A. (2022) Infections and Pregnancy: Effects on Maternal and Child Health. *Frontiers in Cellular and Infection Microbiology*, Article 873253. <https://doi.org/10.3389/fcimb.2022.873253>
- [45] Mancuso, G., Midiri, A., Gerace, E. and Biondo, C. (2021) Bacterial Antibiotic Resistance: The Most Critical Pathogens. *Pathogens*, **10**, Article 1310. <https://doi.org/10.3390/pathogens10101310>