

# Surgical site infections in obstetrics

## Abstract

Reaching up to 3% of maternal mortality, alongside postpartum hemorrhage, the infection in obstetrics is the second-mentioned contributor to maternal mortality. In order to review the literature on the surgical site infections in obstetrics, including risk factors, diagnosis and management, published electronic databases such as PubMed and MEDLINE were reviewed and searched, from the 1<sup>st</sup> of January 2015 to the 30<sup>th</sup> of April 2020, using keywords such as surgical site infection, infection prevention in obstetrics, risk factors, caesarean section, along with medical texts pertaining to surgical site infections in obstetrics. From a total of 666 eligible studies, 22 papers were selected as relevant to the subject and included in our final review, 7 trial studies, totaling 48,262 patients, and 15 clinical guidelines and systematic reviews incorporating risk factors, methods of diagnosis, prevention and treatment. As caesarean section delivery rates are unceasingly increasing around the world, complications such as surgical site infections continue to concern the obstetricians and healthcare professionals.

**Keywords:** surgical site infection, infection prevention in obstetrics, risk factors, caesarean section

## Rezumat

Alături de hemoragia postpartum, infecțiile în obstetrică sunt amintite ca fiind a doua cauză a mortalității materne, atingând un procentaj de 3% din totalul cazurilor menționate. Pentru o bună analiză a literaturii de specialitate privind infecțiile postoperatorii în obstetrică, incluzând factorii de risc, diagnosticul și tratamentul, au fost utilizate baze de date electronice precum PubMed și MEDLINE, din perioada 1 ianuarie 2015 – 30 aprilie 2020, fiind folosite cuvinte-cheie precum infecții postoperatorii, prevenirea infecțiilor în obstetrică, factori de risc, operație cezariană, alături de texte medicale care fac referire la infecțiile postoperatorii în obstetrică. Dintr-un total de 666 de studii eligibile, 22 de lucrări au fost selectate ca fiind relevante pentru subiectul dezbătut și incluse în studiul nostru final, 7 studii clinice, totalizând 48.262 de pacienți, și 15 ghiduri clinice care au cuprins factori de risc, metode de diagnostic, prevenție și tratament. Din moment ce la nivel global rata nașterilor prin operație cezariană se află într-o continuă creștere, complicațiile precum infecțiile postoperatorii continuă să preocupe atât obstetricienii, cât și profesioniștii din domeniul medical.

**Cuvinte-cheie:** infecții postoperatorii, prevenția infecțiilor în obstetrică, factori de risc, operație cezariană

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Submission date:  
20.06.2020  
Acceptance date:  
11.08.2020

## Infecțiile postoperatorii în obstetrică

Suggested citation for this article: Turcu A, Gică C, Panaitescu AM, Botezatu R, Peltecu G, Ciobanu A, Gică N. Surgical site infections in obstetrics. *Ginecologia.ro*. 2020;29(3):29-33.

## Introduction

In the past decades, caesarean delivery rates have increased dramatically<sup>(1)</sup> in defiance of paucity of data regarding the increasing percentages of obstetric emergencies<sup>(2)</sup>, in some countries reaching up to 50% of the total deliveries<sup>(3)</sup>. Caesarean section is the most important surgical obstetrical procedure with complications that consist of postpartum hemorrhage, endometritis, thromboembolic events or incision infections<sup>(3)</sup>. In 2013, the European Health for All database recorded in Romania a caesarean section delivery rate of 40.1%, one of the highest in the world<sup>(4)</sup>.

## Definition

A surgical site infection (abbreviated as SSI) is described as a condition that alters the skin incision or the tissues underneath it, which can evolve up to thirty days after the surgical procedure<sup>(5)</sup>. According to the Procedure Assisted Module, published in January 2020 by the Centers for Disease Control and Prevention (CDC) and the National Healthcare Safety Network

(NHSN), SSIs represent a considerable determinant of morbidity, extended treatment and hospitalization, with criteria exemplified in Table 1<sup>(5)</sup>.

## Microbiology

Up to 20% of cases of SSIs had a positive microbiologic determination of *Staphylococcus aureus*, followed by *Enterococcus* species and *Escherichia coli*, both the skin and the vagina being appointed as the dual source of the bacterium, with high rates of polymicrobial infections consisting of both aerobic and anaerobic organisms (Table 2)<sup>(6)</sup>.

## Risk factors

Through a retrospective population-based cohort study, in an article published in January 2017, Krieger et al.<sup>(7)</sup> described the main risk factors that lead to SSI post-caesarean delivery, as indicated in Table 3. Patients who acquired SSIs had a history of habitual mis-carriage or previous caesarean section delivery, they were of a slightly older age and with a higher parity rate.

**Table 1** SSI criteria modified after CDC and NHSN Procedure Assisted Module

<p><b>Superficial incisional SSI</b></p> <ul style="list-style-type: none"> <li>■ <b>SIP – Primary</b> (described in the main incision in a patient with one/ more incisions – e.g., C-section)</li> <li>■ <b>SIS – Secondary</b> (described in the subsidiary incision in a patient with more than one incision – e.g., donor site in coronary bypass)</li> </ul> <p><b>Excluded</b> (are not superficial incisional SSI):</p> <ul style="list-style-type: none"> <li>■ cellulitis</li> <li>■ solely stitch abscess</li> <li>■ isolated stab laceration</li> </ul>	<ul style="list-style-type: none"> <li>■ date of procedure ≤30 days (day 1 – day of procedure) +</li> <li>■ involvement of the skin and subcutaneous tissue only +</li> <li>■ one of:                     <ul style="list-style-type: none"> <li>✓ superficial incision pus discharge</li> <li>✓ microbiologic determination of an organism from the superficial incision or subcutaneous tissue</li> <li>✓ purposely breach in the superficial incision (without microbiologic determination) and at least one of four classical signs of inflammation</li> <li>✓ physician/physician appointee diagnosis of superficial incision SSI</li> </ul> </li> </ul>
<p><b>Deep incisional SSI</b></p> <ul style="list-style-type: none"> <li>■ <b>DIP – Primary</b> (described in the main incision in a patient with one/ more incisions – e.g., C-section)</li> <li>■ <b>DIS – Secondary</b> (described in the subsidiary incision in a patient with more than one incision – e.g., donor site in coronary bypass)</li> </ul>	<ul style="list-style-type: none"> <li>■ date of procedure: 30-90 days (day 1 – day of procedure) +</li> <li>■ involvement of deep soft tissue (e.g., fascia, muscle) +</li> <li>■ one of:                     <ul style="list-style-type: none"> <li>✓ deep incision pus discharge</li> <li>✓ deep incision impromptu/purposely opening + microbiologic determination of an organism from the deep soft tissue + at least one of: fever, localized pain or tenderness</li> <li>■ abscess/infection in deep incision (gross anatomy/histopathologic or image exam)</li> </ul> </li> </ul>

**Table 2** Main microbiologic basis of SSIs

Gram-negative	Gram-positive	Other
<p><b><i>Escherichia coli</i></b> (<i>Enterobacteriaceae, Gammaproteobacteria</i>)</p> <p><b><i>Klebsiella</i></b> (<i>Enterobacteriaceae, Gammaproteobacteria</i>)</p> <p><b><i>Pseudomonas</i></b> (<i>Pseudomonadaceae, Gammaproteobacteria</i>)</p> <p><b><i>Enterobacter</i></b> (<i>Enterobacteriaceae, Gammaproteobacteria</i>)</p> <p><b><i>Acinetobacter</i></b> (<i>Moraxellaceae, Gammaproteobacteria</i>)</p> <p><b><i>Proteus</i></b> (<i>Morganellaceae, Gammaproteobacteria</i>)</p>	<p><b><i>Staphylococcus</i></b> <b><i>Streptococcus</i></b> (including group B <i>agalactiae</i>)</p>	<p><b><i>Mycobacterium</i></b> (<i>Corynebacterineae, Actinobacteriae</i>)</p> <p><b><i>Mycoplasmataceae</i></b> with genera <b><i>Mycoplasma</i></b> <b><i>Ureaplasma</i></b> <b><i>Candida</i></b> <b><i>Legionella</i></b> (<i>Gammaproteobacteria, Legionellaceae</i>)</p>

It is noted that procedure-related risk factors included emergency caesarean delivery, lack of preincision antibiotic prophylaxis, procedure duration more than one hour or complications such as significant blood loss with subsequent blood transfusion, uterine rupture or caesarean hysterectomy<sup>(7)</sup>.

**Management**

To reduce the incidence of SSIs post-caesarean delivery, preventive care and measures are taken in order to determine the risk factors and to identify the proper pre-/intra- and postoperative procedures that can lead to a higher success rate, as indicated in Table 4.

**Preoperative measures**

One of the most frequently mentioned risk factors is gestational diabetes in pregnant women,

which is associated with a higher rate of surgical site complications post-caesarean delivery<sup>(8)</sup>. As indicated in a study conducted by Hu et al. and published in July 2016, there are physiologic elements involved in the dysfunction of epidermal keratinocytes caused by a rich glucose climate, therefore an improvement in the patient’s glycemic control may lead to a better outcome, with auxiliary benefits of a normal glycemic range that is lessening the risk of hypoglycemia in the neonates and ketoacidosis of the mother<sup>(9)</sup>.

According to the Global guidelines on the prevention of surgical site infections, hair removal before the surgical procedure does not considerably influence the rates of SSIs<sup>(10)</sup>, but using razors, that can cause microscopic skin breach, instead of clippers, may cause more harm than good. Microorganisms found on the skin and their pathogenic aspect are seen as the main

**Table 3** Risk factors for SSI post C-section<sup>(5)</sup>

<b>Patient-related</b>
Body Mass Index over 30
Maternal hypertension disease
Gestational diabetes mellitus
Prelabor rupture of membranes
Habitual miscarriage
Tobacco use
<b>Procedure-related</b>
Emergency caesarean delivery
Lack of preincision antibiotic prophylaxis
>1 hour procedure duration
Significant blood loss
Blood transfusion
Uterine rupture
Anterior caesarean delivery

**Table 4** Measures to prevent SSIs

<p><b>Preoperative measures</b></p> <ul style="list-style-type: none"> <li>■ identification of risk factors</li> <li>■ hair removal before the surgical procedure</li> <li>■ proper choice of skin antiseptic agents</li> <li>■ preprocedure vaginal antiseptic use</li> <li>■ preprocedure prophylactic antibiotics administration</li> </ul>
<p><b>Intraoperative measures</b></p> <ul style="list-style-type: none"> <li>■ continuous training and understanding the basics of sterilization and scrubbing techniques</li> <li>■ choice of skin incision</li> <li>■ normothermia: maintenance of maternal body temperature above 36 degrees Celsius</li> <li>■ normovolaemia: maintenance of normal circulating volume</li> <li>■ traction of umbilical cord as placental removal method</li> <li>■ wound irrigation</li> <li>■ tissue closure techniques</li> </ul>
<p><b>Postoperative measures</b></p> <ul style="list-style-type: none"> <li>■ 24-48 hours wound dressing discharge</li> <li>■ chlorhexidine gluconate soap wound hygiene</li> </ul>

**Table 5** Caesarean delivery antibiotic prophylaxis recommendations modified after ACOG

<p><b>General recommendations</b></p> <ul style="list-style-type: none"> <li>■ all caesarean deliveries*, except complications such as chorioamnionitis (already on wide-spectrum antibiotic medication)</li> </ul>
<p><b>Timing</b></p> <ul style="list-style-type: none"> <li>■ within 60 minutes before the first incision</li> <li>■ emergency: at the earliest opportunity</li> </ul>
<p><b>Type of antibiotic</b></p> <ul style="list-style-type: none"> <li>■ first or second generation of cephalosporins</li> <li>■ beta-lactam</li> <li>■ azithromycin</li> </ul> <p>* beta-lactam allergy: clindamycin with aminoglycosides</p>
<p><b>Body Mass Index</b></p> <ul style="list-style-type: none"> <li>■ &lt;30 (≤80 kg): 1 g cefazolin/900 mg clindamycin +1 mg/kg aminoglycoside</li> <li>■ ≥30 (≥80 kg): 2-3 g cefazolin/900 mg clindamycin + 1 mg/kg aminoglycoside</li> </ul>

determinant involved in SSIs. To address this topic, a randomized controlled trial comparing skin antiseptic agents use such as chlorhexidine-alcohol and iodine-alcohol in caesarean delivery was conducted by Tuuli et al. at the University of South Florida and published in February 2016. From 1147 patients, 4% of the chlorhexidine-alcohol category had SSIs complications versus 7.3% in the iodine-alcohol category (relative risk 0.55; 95% confidence interval; 0.34 to 0.90; p=0.02)<sup>(11)</sup>. In a Cochrane review updated in April 2020, it was noted that the use of vaginal antiseptic such as povidone-iodine or chlorhexidine anterior to caesarean delivery may be considered to reduce the risk of SSIs (RR 0.62; 95% CI; 0.50 to 0.77; 18 trials,

6385 women)<sup>(12)</sup>. To reduce the incidence of SSIs, the American College of Obstetricians and Gynecologists (ACOG), in its committee opinion from September 2018, proposed the prophylactic antibiotic administration as a routine measure for all patients who have to go through a caesarean delivery. Recommendations were made for the use of first-generation cephalosporins or their alternative, clindamycin with aminoglycosides, in patients with beta-lactam allergy, as shown in Table 5<sup>(13)</sup>.

### Intraoperative measures

The continuous training and understanding the basics of sterilization and scrubbing techniques play a pivotal role in diminishing the prevalence of

SSIs<sup>(14)</sup>. Addressing the issue of choice of skin incision, compared to the Pfannenstiel incision, the Joel-Cohen incision reported up to 65% less cases of hyperpyrexia complications post-caesarean delivery (RR 0.35; 95% CI; 0.14-0.87; p=0.023), with no significant differences in SSIs<sup>(14)</sup>. Intraoperative hypothermia enhances the risk of surgical site infections and prolongs the period of hospitalization, therefore the World Health Organization guidelines recommend maintaining the intraoperative maternal body temperature above 36 degrees Celsius<sup>(15)</sup>. Equally as important as maintaining an intraoperative body temperature above 36 degrees Celsius is the maintenance of normovolaemia. In accordance with the new World Health Organization recommendations on intraoperative and postoperative measures for surgical site infection prevention, a diminished incidence of surgical site infections was reported for intraprocedure goal-directed fluid therapy (GDFT) versus an average intraprocedure fluid management (OR 0.56; 95% CI; 0.35-0.88)<sup>(15)</sup>. A higher rate of endometritis as a complication of post-caesarean delivery has been reported in manual removal as placental removal method versus intraoperative controlled traction of umbilical cord (RR 1.64; 95% CI; 1.42-1.90)<sup>(15)</sup>. Wound irrigation does not occupy a statistically important role in the management of post-caesarean delivery surgical site infections. The irrigation of the tissues found above the fascial area with povidone-iodine solution did not reduce the incidence of SSIs post-caesarean delivery, as shown in a substantial randomized controlled trial published in 2016 by K. Mahomed et al. (RR 0.97; 95% CI; 0.78 to 1.21)<sup>(16)</sup>. The same result was obtained evaluating the use of intraprocedure saline irrigation that led to maternal nausea, but did not influence the outcome of surgical site infections or endometritis (RR 1.68; 95% CI; 1.36 to 2)<sup>(17)</sup>. Updated in September 2019, the NICE clinical guidelines on caesarean section encourage different tissue closure techniques in order to prevent SSIs<sup>(18)</sup>. Multiple layer tissue closure is not recommended for all women undergoing caesarean delivery; *ergo*, for patients with an increased Body Mass Index or a subcutaneous tissue thickness over 2 cm, two-layer closure is encouraged<sup>(18)</sup>. Wound breach or skin infections have been reported with a higher incidence in obese women undergoing staples closure versus subcuticular suture as indicated in a retrospective cohort study that included 1147 women (RR 1.78; 95% CI; 1.27 to 2.49)<sup>(19)</sup>.

**Postoperative measures**

The periodic checkup of the caesarean delivery wound is fundamental to assess the postprocedure progression in order to identify any signs of inflammation or infection. Although it is recommended that all wound bandage be removed between 24 and 48 hours postprocedure<sup>(20)</sup>, a randomized controlled trial conducted by Peleg et al. in 2016 revealed that there is no difference regarding the rate of complications

between bandage discharge at 6 hours (n=160) versus 24 hours (n=160) postprocedure, while the rate of satisfaction in women pertaining to the first category has increased (OR 2.35; 95% CI; 1.46-3.79)<sup>(21)</sup>.

**Management**

Although the procedures required to prevent surgical site infections play a crucial role, measures meant to raise the rate of success, such as the right choice of antibiotics or the type of wound dressing (as indicated in Table 6), are important in the management and treatment of complications.

There are different types of wound bandage materials available, from foam, beads, hydrocolloids, plaster with chlorhexidine to povidone iodine and mercury chloride solutions, that can be used in order to isolate and treat the wound site<sup>(22)</sup>. The “wet-to-dry” technique consists of securing the wound with a moist plaster followed by a dry bandage coating. In some circumstances, cellulitis, a complication that affects the dermis and the subcutaneous tissue, can be treated with antibiotics, without demanding incision and drainage. Two types of cellulitis are taken into consideration: with purulent drainage or exudates, and the empiric treatment covers the methicillin-resistant *Staphylococcus aureus* (MRSA) with options that consist of clindamycin, trimethoprim-sulfamethoxazole and tetracycline (doxycycline or monocyline); and cellulite without purulent drainage, with therapy such as dicloxacillin, cefadroxil, cephalixin and clindamycin taken into consideration to cover beta-hemolytic streptococci and methicillin-sensitive *Staphylococcus aureus* (MSSA), as indicated in Table 7. Incision and drainage are required when hematoma, abscess or exudates complicate the wound<sup>(22)</sup>.

**Table 6** Management of surgical site infections

<ul style="list-style-type: none"> <li>■ wound bandage</li> <li>■ antibiotic treatment</li> <li>■ incision and drainage</li> </ul>
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**Table 7** Antibiotic treatment of cellulite

<p>Cellulite with purulent drainage or exudates</p> <p>*the methicillin-resistant <i>Staphylococcus aureus</i> (MRSA)</p> <ul style="list-style-type: none"> <li>■ clindamycin</li> <li>■ trimethoprim-sulfamethoxazole</li> <li>■ tetracycline (doxycycline or monocyline)</li> </ul>	<p>Cellulite without purulent drainage</p> <p>*beta-hemolytic streptococci and methicillin-sensitive <i>Staphylococcus aureus</i> (MSSA)</p> <ul style="list-style-type: none"> <li>■ dicloxacillin</li> <li>■ cefadroxil</li> <li>■ cephalixin</li> <li>■ clindamycin</li> </ul>
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## Conclusions

Pregnancy plays an important role in a woman's life and healthcare providers around the world are constantly searching for new methods for the diagnosis and treatment of pregnancy-related complications in pursuance of a safe parturient journey and childbirth process. Understanding the importance of this issue, the current Procedure Assisted Module, published in January 2020 by the Centers for Disease Control and Prevention and the National Healthcare Safety Network, precisely stipulates the diagnosis criteria for surgical

site infections, and identifying the microbiological basis of the infection contributes greatly to the end result. As prevention is better than cure, conjointly with proper identification of risk factors, pre-/intra- and postoperative procedures are needed to be implemented. With accessible treatment options, all cohesive efforts are made for a better outcome for the new mother and her child. ■

**Conflict of interests:** The authors declare no conflict of interests.

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