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# Post caesarian section surgical site infections. Review of current literature

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email: kokolakisioannis@gmail.com**Abstract**

Caesarean delivery rates have increased globally during the past three decades. Caesarean delivery is the most important obstetrical procedure performed with complications that consist of postpartum hemorrhage, endometritis, thromboembolic events or incision infections. While surgical site infections (SSIs) complicate 1.9% of all surgeries performed, the incidence of SSIs after caesarean delivery is significantly higher, almost 7-10%, constituting an important cause of increased morbidity, mortality, readmission, prolonged hospitalization and increased health care costs worldwide. Incisional infection after caesarean delivery happens in 2-7% of cases, necrotizing fasciitis in 0.18% and endometritis in 2-16%. Many risk factors for SSIs have been described. This review includes the several risk factors that have been identified in women who developed post-caesarean section surgical site infections. We also provide an overview of strategies for prevention of postoperative infections including antibiotic prophylaxis, surgical techniques, management of wound infections. Criteria of diagnosis for SSIs are also given, as well as current treatment regimens. Given the impact of maternal post-caesarean infection, it is important for gynecologists to understand how to prevent these postoperative infections, as well as recognize and treat them.

**Key Words:** Infection, post caesarian, antibiotic prophylaxis**Introduction**

Caesarean section is the most commonly performed major obstetric procedure and rates are increasing globally. According to recent data primary caesarean rates in the absence of obstetric indications are rapidly rising, as a result of maternal preferences and modifying obstetric practices.<sup>1</sup> While SSIs complicate 1.9% of all surgeries performed,

the incidence of SSIs after caesarean delivery is substantially higher, approximately 7-10%.<sup>40</sup> Incisional infection following caesarean delivery occurs in 2-7% of cases, necrotizing fasciitis in 0.18% and endometritis in 2-16%.<sup>3</sup> Caesarean section represents the most important surgical obstetrical procedure with complications that include postpartum

haemorrhage, endomyometritis, thromboembolic events or incision infections.<sup>2</sup> Post-caesarean surgical site infection is a cause of maternal morbidity and mortality, increasing the infectious risk by five-to 20-fold in comparison to vaginal birth.<sup>3</sup> Post-caesarean section surgical site infection includes wound infection and endomyometritis. The frequency of post-caesarean infection varies widely worldwide, ranging from 2.8%-26.6%.<sup>4</sup> In rare cases pelvic abscess, bacteremia, septic shock, septic pelvic vein thrombophlebitis, necrotizing fasciitis, dehiscence of the wound or evisceration may occur. Urinary tract, respiratory and blood stream infections can be related to caesarean section.

Postoperative infection constitutes the most crucial cause of increased morbidity, includes additional cost, more use of therapeutic antibiotics, prolonged hospital stay, additional surgical interventions, and occasionally maternal death.<sup>5</sup> A post-caesarean wound infection detected prior to hospital discharge will lead to prolongation of hospital stay and will increase the hospitalization costs and need of re-admission.<sup>6</sup> Approximately 30% to 40% of women having an unscheduled caesarean delivery develop endomyometritis in the absence of antibiotic prophylaxis. Contrarily after a scheduled caesarean delivery, approximately 10% to 15% of women become infected in the absence of antibiotic prophylaxis.<sup>7</sup> The incidence of postpartum endomyometritis is low and varies between 1%-3% after vaginal birth, while infection rates are similarly low after spontaneous, complete or missed abortions.

### **Risk factors**

Urgent caesarean section is the dominant risk factor for development of puerperal endomyometritis, especially when performed after the onset of labour. The main risk factors for post-caesarean section infection include: young age, obesity, diabetes, prolonged use of systemic steroids, immunosup-

pressive disorders, chorioamnionitis, pre-existing infection of the low genital tract, prolonged rupture of membranes >18 hours, multiple internal vaginal examinations, invasive fetal monitoring, fewer prenatal care visits, excessive blood loss > 1500ml.<sup>8,9,10</sup> Other risk factors include pre-existing operative site infection, repeated caesarean section, length of surgery >60 min, breaks in sterile technique, use of electrocautery, low socioeconomic status, urinary tract infection or the operator's skill.<sup>6,9,10</sup>

Wound breach or skin infections have been described with a higher prevalence in obese women undergoing staples closure versus subcuticular suture as demonstrated in a retrospective cohort study that included 1,147 women (RR 1.78; 95% CI:1.27 to 2.49).<sup>11,12</sup> Bacterial vaginosis (BV) is another risk factor associated with a nearly six fold increase in risk after adjusting for duration of labour, duration of membranes rupture and maternal age.<sup>13</sup> The rate of upper genital tract infection in women with BV may be related to higher vaginal concentrations of certain anaerobic and facultative bacteria. *Ureaplasma* or *Mycoplasma* is the most common pathogen isolated from the amniotic fluid and chorioamnion during caesarean section, and is related to a 3 to 8-fold increased risk of postoperative infection.<sup>14</sup> A higher rate of endomyometritis as a complication of post-caesarean delivery has been described 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>

Other risk factors for post-caesarean surgical site infection are: large amount of meconium in amniotic, colonization with group B *Streptococcus*, heavy vaginal colonization by *E.coli*, nasal carriage of *Staphylococcus aureus*.<sup>16</sup>

Abdominal wounds larger than 2cm in depth should be closed with a running suture. For patients with an increased BMI index or a subcutaneous tissue thickness over 2cm, two-layer closure is recommended.<sup>17</sup>

### Microbiology

Postpartum endomyometritis is a commonly polymicrobial infection usually caused by a mixture of two to three aerobes and anaerobes from the genital tract. The most common pathogens are aerobic Gram- positive cocci (group B *Streptococcus*, *enterococci*, and *staphylococcus species*), aerobic Gram-negative bacilli (*E.coli*, *Klebsiella pneumoniae*, and *Proteus species*) and anaerobic Gram- negative bacilli (*Bacteroides* and *Prevotella species*).<sup>18</sup> In HIV – infected women, the microbiology can be broader and includes other less likely pathogens, such as herpes simplex virus and cytomegalovirus.<sup>19</sup> These microorganisms are part of the endogenous vaginal flora and enter the upper genital tract following the normal mechanics of labour and/or instrumentation during surgery.<sup>18,20</sup> The most frequent pathogens presented in endometrial cultures of women with postpartum endomyometritis are *Ureaplasma/ Mycoplasmas*, aerobic Gram- negative rods, *Enterococci*, *Gardnerella* and anaerobes. The principal

microorganisms isolated from wound infections also include *Ureaplasma* as well as *Staphylococci* and *Enterococci*.<sup>20,21</sup>

### Post-caesarean section surgical site infections

The Centre for Disease Control and Prevention (CDC) defines surgical site infections as infections that occur at or near the surgical incision within 30 days after surgery. Surgical site infections can be classified as superficial incisions (skin or subcutaneous tissue), deep incisional (fascial and muscle layers), and infections involving the organ/space (tissue deeper than the muscle/ fascial layers that was opened/ manipulated during surgery).<sup>22</sup> Criteria for SSIs classification modified after CDC and NHSN Procedure Assisted Module are shown in Table 1.

A high rate of SSIs (25.2%) has been noted in emergency caesarean section when compared to 7.6% in elective cases.<sup>23</sup> In a later study from Oman, 1.5% of SSIs were reported after emergency caesar-

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>• SIP- Primary (described in the main incision in a patient with one/ more incisions -e.g., C-section)</li> <li>• SIP- Secondary (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 (ARE NOT SUPERFICIAL INCISIONAL SSI)</b></p> <ul style="list-style-type: none"> <li>• Cellulitis</li> <li>• Solely stitch access</li> <li>• isolated stab laceration</li> </ul> <p><b>DEEP INCISIONAL SSI</b></p> <ul style="list-style-type: none"> <li>• DIP-Primary (described in the main incision in a patient with one/more incisions -e.g., C-section)</li> <li>• DIP- Secondary (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 &lt;= 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> <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> </ul> </li> <li>• abscess/ infection in deep incision (gross anatomy/ histopathologic or image exam)</li> </ul>
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ean section compared to 1.16% in elective cases<sup>23</sup> whereas in a trial from Kuwait rates of SSIs were 1.56% after emergency caesarean section versus 0.53% post elective caesarean section.<sup>24</sup> Wound infections represent the most prevalent hospital infections, and the dominant microorganisms are aerobic *Staphylococci and streptococci*; aerobic Gram-negative bacilli, such as *E. Coli, Klebsiella pneumoniae, Proteus species* and anaerobes.

### Management of postoperative SSI

Wound infections may take one of two forms: an incisional abscess or wound cellulitis. Wound cellulitis can be treated with antibiotics without demanding incision and drainage<sup>25</sup> (Table 2).

Two types of cellulitis are taken into consideration; with purulent drainage or exudates and cellulitis without purulent drainage. Empirical treatment was used for the first type covering the methicillin resistant *Staphylococcus aureus* (MRSA) with options that consist of tetracycline, trimethoprim- sulfamethoxazole and clindamycin. Treatment options for cellulite without purulent drainage consist of

Table 2. Single-agent antimicrobial for treatment of postoperative infection.

DRUG	Intravenous dose
<b>Carbapenemes</b>	
Ertrapenem	1g every 24h
Imipenem- cilastatin	500mg every 6h
Meropenem	1g every 8h
<b>Cephalosporins</b>	
Cefoxitin	2g every 6h
Cefotetan	2g every 12h
Cefipim	1-2 g every 8-12h
<b>Penicillins</b>	
Ampicillin-sulbactam	3g every 6h
Piperacillin-tazobactam	3,375g every 6h
Ticarcillin-clavulanate	3,1g every 6h

dicloxacillin, cefadroxil, cephalexin and clindamycin administered to cover  $\beta$ - hemolytic *streptococci* and methicillin- sensitive *Staphylococcus aureus* as showed in Table 3. Antibiotics should be continued until all clinical symptoms of infection have been resolved; the usual course of treatment is 5-7 days.<sup>25,26</sup>

If an incisional abscess is present the wound must be opened and drained, while the fascial layer should be examined to be certain that it is intact. All turbulent and necrotic material of the wound should be removed and then the wound should be irrigated with copious amounts of normal saline. In case of the growing incidence of MRSA organisms vancomycin 1g every 12h, is likely the optimal additional agent to the regimen.<sup>25,26</sup>

### Prevention of post-caesarean section surgical site infections

Many interventions have proven efficient in decreasing postoperative infections; attention should be given on modifiable risk factors. Patients who have pre-existing medical illnesses should be stabilized before surgical operation. In order to decrease the risk of colonization with hospital acquired bacteria prolonged preoperative hospitalization should be avoided. These microorganisms tend to be more

Table 3. Antimicrobials for treatment of wound infection.

TYPE OF INFECTION	ANTIBIOTIC CHOICE
<b>Incisional Abscess</b>	Vancomycin 1g IV every 12h or
	Cefazolin 1g IV every 8h or
	Trimethoprim-sulfamethoxazole 1tabPO every 12h or
	Quinolone
<b>Wound Cellulitis</b>	Moxifloxacin 400mg po/IV every 24h
	Trimethoprim-sulfamethoxazole 1tabpo every 12h or
	Quinolone
	Moxifloxacin 400mg po/ IV every 24h

resistant to antibiotics in comparison to endogenous bacterial flora. According to the global guidelines on the prevention of SSIs, hair removal before the caesarean section does not significantly affect the rates of SSIs,<sup>27</sup> but use of razors that may cause microscopic skin breach instead of clippers can cause more harm than good. One of the primary prevention keys is to maintain perioperative glycemic control with target levels of blood glucose less than 200mg/dl for diabetic as well as non diabetic patients.

In case of the obese patients undergoing caesarean section, closure of the lower half of subcutaneous layer lowers the incidence of wound infection, hematoma, seroma and dehiscence.<sup>27</sup> Incision and drainage are required when the wound is complicated by hematoma, abscess or exudates. This layer should be reapproximated with a suture such as a 3-0 Vicryl, Dexon, or Polysorb, placed in a continuous manner. An increased dose of antibiotic prophylaxis should be administered to obese women with a BMI >30kg/m<sup>2</sup>.

Tuuli et al<sup>28</sup> in a randomized controlled trial of 1,147 women undergoing caesarean section compares chlorhexidine-alcohol with iodine-alcohol as skin antiseptic agents. 4% of the group who received chlorhexidine-alcohol developed SSIs versus 7.3% in the group of iodine-alcohol (RR 0.55; 95%CI 0.34 to 0.90; p=0.02). In a Cochrane review updated in April 2020, it was revealed that the use of vaginal antiseptic such as povidone or chlorhexidine prior to caesarean section may be considered to decrease the risk of SSIs, (RR 0.62; 95%CI: 0.50 to 0.77, 18 trials, 6,385 women).<sup>29</sup>

The irrigation of the tissue found above the fascial area with povidone- iodine solution did not reduce the rates of post caesarean section SSIs as shown in a substantial randomized controlled trial published in 2016 by Mahomed et al (RR 0.97; 95%CI: 0.78 to 1.21).<sup>30</sup> The same results were observed evaluating the use of intraoperative saline irrigation that led to maternal nausea, but did not affect the outcome of SSIs (RR 1.68; 95%CI: 1.36 to 2).<sup>31</sup>

Perioperative hypothermia is linked with increased wound infection, length of hospital stay and higher morbidity and mortality for premature infants.<sup>41</sup> Maternal temperature should be monitored intraoperatively and postoperatively with a goal perioperative maternal temperature of >36°C per WHO guidelines. The maintenance of normovolaemia is equally important to ensuring an intraoperative body temperature above 36°C. Consistent with the new WHO recommendation an intraoperative and postoperative measure for SSIs prevention, decreased frequency of SSIs was observed for intraprocedure goal-directed fluid therapy (GDFT) versus an average intraprocedure fluid management (OR 0.56; 95% CI: 0.35-0.88).<sup>41</sup>

To decrease the incidence of SSIs, the ACOG, in its committee opinion from September 2018 proposed the prophylactic antibiotic administration as a routine measure for all women undergoing caesarean delivery.<sup>32</sup> Practice use of prophylactic antibiotics decreases the risk of post caesarean fever and infections by over 50% from baseline rates as high as 20-50%.<sup>33</sup> Antibiotic prophylaxis reduces overall length of hospital stay and decreases treatment costs associated with caesarean, while it is highly cost-effective.<sup>34</sup> Recommendations were made regarding the use of first-generation cephalosporins or their alternative clindamycin with aminoglycosides in women presenting beta-lactam allergy.<sup>32</sup> Several studies show that prophylactic antibiotics are more effective if administered just prior to caesarean section.<sup>35</sup>

Sullivan and al<sup>36</sup> showed that parenteral administration of antibiotic prophylaxis before skin incision resulted in decreased prevalence of endomyometritis and total infections (endomyometritis, wound infections, urinary tract infections and pneumonia), but not in wound infections alone. In a recent cohort study using azithromycin, the incidence of wound infection decreased from 3.2 to 1.3%.<sup>37</sup>

Prophylactic antibiotics action is obtained by 3 mechanisms. First by reducing the size of the bacterial

inoculum at the surgical site; second by shifting the environment at the operative site to make it less hospitable to the growth of bacteria. Finally, by concentrating the antibiotics in white blood cells and enhancing the phagocytosis of pathogenic bacteria.<sup>38</sup> For most of the patients a single dose of antibiotics is sufficient to achieve the desired therapeutic effect.<sup>32</sup> The usual recommendation is to administer the antibiotic immediately after the infant's umbilical cord was clamped. However, Sullivan et al<sup>36</sup> described that women who received prophylaxis 15-60 min prior to the beginning of caesarean section, had a remarkably lower rate of endomyometritis (RR 0.2; 95% CI: 0.15-0.94) than women who received prophylaxis after the umbilical cord was clamped. Women undergoing a prolonged procedure >3h or with a total blood loss >1500ml, are advised to receive a second dose of antibiotic.<sup>39</sup> Generally, antibiotic prophylaxis decreases the rate of post caesarean and postabortal endomyometritis by approximately 50-60%. In indigent patients with a high baseline rate of wound infection, the incidence of SSI is reduced. Prophylaxis does not affect the frequency of urinary tract infection.

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