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Post Caesarean Surgical Site Infections

Renu Gur[1],
Shalini Dewan Duggal[1],
Sharon Rainy Rongpharpi[1],
Ruhi Srivastava[2],
Avinash Kumar[1],
Vinita Gupta[2], Dolly Chawla[2],
Seema Pundhir[2]

1 Department of Microbiology, Dr. Baba Saheb Ambedkar Hospital, Delhi, India
2 Department of Obstetrics and Gynaecology, Dr. Baba Saheb Ambedkar Hospital, Delhi, India

Corresponding author: Dr. Renu Gur

Senior Specialist and Head, Department of Microbiology, Dr Baba Saheb Ambedkar Hospital, Sector 6, Rohini, Delhi, India

renugur@hotmail.com

Phone: 009968679770

Abstract

Surgical site infections add to the morbidity, mortality; delay recovery and add to the hospital stay and costs. These are avoidable in most circumstances by altering host, microbial and environmental factors in favour of the host. Caesarean section is a clean contaminated type of surgery where procedure- related chances of infection are less. Careful pre-, inter- and post-surgical prevention and management of associated risk factors, with stringent infection control practices in the operation room can help to achieve minimal infection rates in patients undergoing caesarean section deliveries.

Keywords: Surgical site infection; Superficial; Deep; Organ; Space

Introduction

More than a century earlier, the concepts of antisepsis and infection prevention in surgical practices were realized. This was later boosted by the use of pre-operative antibiotics at correct dose and time. Any breach in the integrity of skin and mucous membranes is a risk factor to acquisition of infection by endogenous or exogenous organisms. Surgery is a risk factor for acquisition of infection and nosocomial infections were found in 4.17% of patients in a surgical ward in India [1]. Of these infections, 40% occur at the operative site, 42% are associated with the urinary tract, 14% with respiratory tract, and nearly 4% present with sepsis or bacteraemia [2]. Determinants of infection may be related to the host, microbe, environment, procedure adopted or perioperative antibiotic prophylaxis. Malnutrition and low socioeconomic status further exacerbate the risk of infection in caesarean sections. Caesarean section carries five to 20-fold increased risk of infection compared to vaginal delivery. Unnecessary caesarean sections should be avoided as they are also associated with an additional potential risk of iatrogenic prematurity. The most common postoperative infections following caesarean section are urinary tract infections, surgical site infections (SSI) or infections of the pelvic organs [3,4].

Surgical Site Infections

A surgical site infection is defined as an infection which occurs at the incision / operative site (including drains) within 30 days after surgical operation if no implant is left in place / within 1 year if an implant is left in place. The infection must appear to be related to the surgical procedure [5]. According to CDC's National Nosocomial Infection Surveillance system 38% of all nosocomial infections in surgical patients are surgical site infections (SSI). They constitute third most common nosocomial infection. Surgical site infections delay recovery, prolong hospitalization or outpatient treatment, may necessitate readmission, increase hospital bills as well as other morbidities and mortality [6], thus are responsible for significant psychological and economic burden to the society. The rate of surgical site infection after caesarean section range from 3% to 15%, depending on the surveillance methods used to identify infections, the patient population, and the use of antibiotic prophylaxis [7-9].

Causes of SSI

The causes of surgical site infection following caesarean section are universal with only slight regional variations [10-13]. Intrinsic factors are patient related and include age, obesity, underlying medical conditions like diabetes mellitus, hypertension, asthma,

immunocompromised states like HIV infection, hypoalbuminemia, hyperlipidemia, anemia. Extrinsic factors relate to the management and care, which include preoperative preparation of the patient (part preparation and skin asepsis), type of procedure (emergency/elective), type of anaesthesia (regional/general), type of skin incision (horizontal/vertical), method of skin closure, type of suture used (mono/ polyfilament) or use of staples, antibiotic prophylaxis, length of time membranes ruptured prior to operation, manual extraction of placenta, chorioamnionitis, number of vaginal examinations carried out before surgery, duration of operation, transfusion of blood products, grade of operator (consultant/registrar/senior resident), previous caesarean section, and environment of the operating room [14, 15]. Knowledge of risk factors associated with surgical site infection is essential to develop targeted prevention strategies and reduce the risk of infection. Surgical site infection frequently affects the superficial tissues, but some serious infections affect the deeper tissues or other parts of the body manipulated during the procedure. Majority of surgical site infections become apparent within 30 days of an operative procedure and most often between the 5th and 10th postoperative days. The CDC definition [16] describes three levels of surgical site infection; 'Superficial incisional' affecting the skin and subcutaneous tissue, 'Deep incisional', which affects the fascial and muscle layers and 'Organ or Space infection' which involves any part in the body other than the incision that is opened or manipulated during the surgical procedure.

Role of Microbes

Diagnosis of surgical site infection requires evidence of clinical signs and symptoms of infection which may be further supported by microbiological evidence. Skin is normally colonised by a range of microorganisms that could cause infection. In clean-contaminated procedures like caesarean section the polymicrobial aerobic–anaerobic flora closely resembling the normal endogenous microflora of the operated organ constitutes the most frequently isolated pathogens [17]. Amongst the aerobic bacterial agents causing surgical site infection in caesarean section patients, enteric gram negative bacilli are the most common followed by enterococci and group B streptococci. Clostridia and *Bacteroides* spp. are commonly isolated anaerobic organisms. These are endogenous vaginal flora usually introduced following repeated vaginal examinations or instrumentation [18]. Organisms frequently associated with SSI are listed in **Table 1** [19]. Considering that the postoperative caesarean section infections could be polymicrobial the samples should be appropriately processed for aerobic, anaerobic, fastidious bacteria, slow growing organisms, fungi. To identify a possible cluster or outbreak of wound infection by a particular organism the wound isolate should be maintained and stocked in the laboratory for at least 2-3 weeks [2].

Prevention of SSI

Employing strict infection control policies by a functional infection control committee is the most important step in preventing SSI. This committee should be able to monitor surveillance studies with a view to issuing guidelines to circumvent established risk factors. This would bring the level of SSI to an acceptable level.

Table 1 Organisms frequently associated with SSI [19]

Gram Negative Bacteria	Gram Positive Bacteria	Other Organisms
Escherichia coli *Klebsiella* *Pseudomonas* Nonfermenting Gram Negative Bacilli *Enterobacter* *Acinetobacter* *Serratia marcescens* *Proteus* spp	*Staphylococcus aureus* *Streptococcus faecalis* Group B *Streptococcus*	*Mycobacterium chelonae* *Mycobacterium fortuitum* *Mycobacterium abscessus* *Ureaplasma urealyticum* *Mycoplasma hominis* *Staphylococcus aureus* Coagulase-Negative Staphylococci *Legionella* Species *Actinomyces* *Nocardia* *Coxiella burnetti* Corynebacteria *Bacteroides fragilis* Clostridia *Candida* spp.

Surveillance of SSI with feedback of appropriate data to surgeons has been shown to be an important component of strategies to reduce SSI risk. A successful surveillance program includes the use of epidemiologically-sound infection definitions and effective surveillance methods, stratification of SSI rates according to risk factors associated with SSI development, and data feedback.

At our institution in North-West District of Delhi, India; we encountered four cases of surgical site infections over a period of six months and analysed the associated risk factors. A brief summary of each case is presented here.

Case 1

A 20 year old primigravida full term pregnant female with low grade fever and anaemia was admitted with cephalopelvic disproportion in labour. Emergency caesarean section was done. Discharge from the surgical site wound was observed on the 7th postoperative day. Initially it was a superficial SSI which progressed to deep SSI on the 11th postoperative day with wound dehiscence and presence of devitalized tissue. Culture of the wound swabs revealed growth of *Enterococcus* spp., followed by *Pseudomonas* spp. and *Escherichia coli.* Accordingly the spectrum of antibiotic therapy kept changing and patient was on different antibiotics for a long time. Risk factors for multiple subsequent infections in this case could be poor personal hygiene, malnutrition and emergency surgery. Along with antibiotics, oral and parenteral nutritional support was given and daily dressing was done followed by re-suturing of the wound. The patient recovered and was discharged on 56th postoperative day.

Case 2

A 25 year old multigravida full term pregnant female with anaemia was admitted with history of obstructed labour and intrauterine death. She was handled by untrained personnel before admission to the hospital. Emergency caesarean section was performed. On 6th postoperative day, serosanguinous discharge was seen which revealed growth of *Acinetobacter* spp. Parenteral antibiotics, nutritional support and daily antiseptic dressing followed by

resuturing was done. The urinary catheter was removed on fifth post-operative day. The patient was discharged on 34th postoperative day. Risk factors in this case could be prolonged duration of labour before caesarean section, emergency surgery, vaginal examinations by untrained birth attendant, anaemia, delayed catheter removal, intrauterine death and psychological stress.

Case 3

A 23 year old primigravida full term pregnant female was admitted with labour pains. The foetus had breech presentation with hydrocephalous and meningocele with intrauterine death. Induction of labour was done but due to non-progress of labour, emergency caesarean section was performed and the patient was discharged on 4th post-operative day. On 8th day the patient presented with serosanguinous discharge, pain and redness around the surgical site. Pus culture report showed growth of Coagulase negative *Staphylococcus*. Patient was managed with parenteral antibiotics, nutritional support and daily antiseptic dressing followed by resuturing. She was discharged on 24th postoperative day. Risk factors in this case were non progress of labour, multiple vaginal examinations, emergency surgery, foetal factors and psychological stress.

Case 4

A 28 year old primigravida full term female was admitted with severe pre-eclampsia. Induction of labour was done but due to foetal distress, emergency caesarean section was done. On 4th post-operative day serosanguinous discharge was seen. Pus culture report revealed growth of Coagulase negative Staphylococci. Antibiotic therapy, nutritional support and daily dressing were done. The patient recovered and was discharged two weeks after surgery. Risk factors include hypertension and emergency surgery.

In all the above cases, emergency caesarean section and psychological stress were the most common risk factors. Infection control practices were initiated so that the infection does not spread to the other post-surgical patients. All these patients recovered and wounds have been found to completely heal following a 3-month follow up of each case.

Various studies have been done worldwide to ascertain the cause and magnitude of caesarean section associated SSI. These are tabulated in **Table 2** [20-29]. The Surgical site infection rates varied from 2.9% to 30% in various studies, most of these were superficial SSI. Antibiotic resistance patterns were variable with some studies reporting 23.8% MRSA [21], 78.6% Ciprofloxacin resistance [24], 85.7% aminoglycoside resistance [24].

Two important factors for development of a surgical site infection are inoculation of microbes into the wound and development of infection with regard to host immunity [30]. Factors related to prevention of these infections have been listed in **Table 3.**

Overall it has been realised that adequate emphasis should be laid on reduction of caesarean sections to reduce its associated morbidity and sequelae [24]. Possibility of an infection depends on a delicate balance between the host immunity and external factors. External factors include the number and virulence of contaminating bacteria, surgical trauma to the tissues and the use of foreign material which increase the risk while systemic and local host immune mechanisms function to contain and prevent infection. Prophylactic antibiotics at adequate tissue levels at the time of surgery provide a pharmacological defence mechanism in favour of the host [2].

IDSA recommends antibiotic prophylaxis for all women undergoing elective or emergency Caesarean section. Single dose of a first-generation cephalosporin should be given 15 to 60 minutes prior to skin incision. The duration cut off for caesarean section is one hour [30] but an additional dose to be given may be given 3 to 4 hours later if the procedure takes more than three hours or if estimated blood loss is greater than 1500 mL. Clindamycin or erythromycin can be used if the patient is allergic to penicillin [31]. Some surgeons prefer a combination of cefuroxime and metronidazole for antibiotic prophylaxis [32]. Compared with no treatment, prophylactic antibiotics have been found to reduce the incidence of wound infection by up to three-quarters following elective and non- elective caesarean section [33].

Diagnosis of SSI

Surgical site wound infections may present as an incisional abscess or wound cellulitis [34]. The diagnosis of incisional abscess or wound cellulitis can be established by clinical examination. In incisional abscess, the margins of the wound are erythematous and warm with presence of discharge at the incision site. In wound cellulitis, the skin is warm and tender with an intense erythematous reaction that spreads outwards from the incision site but no discharge can be seen. In complicated cases the pus should be aspirated or a wound swab taken in the former to confirm diagnosis by Gram stain and culture. If a deep SSI has occurred, the most likely pathogens are anaerobic bacteria and aerobic Gram-negative bacilli [34].

Management of SSI

Management of an incisional abscess is done by opening and draining the wound. The fascial layer should be examined for integrity. All purulent and necrotic material should be removed and wound thoroughly irrigated with normal saline. A thin layer of gauze should be placed at the base of the wound, and covered with sterile dressing. This should be repeated at least twice each day and dressing replaced with a fresh one. Patients should be treated with a broad spectrum antibiotic initially to be narrowed down after culture sensitivity results. Antibiotics should be continued until all clinical evidence of infection has resolved which usually takes 5-7 days. Subsequently, the wound can be allowed to close by secondary intention or if healthy granulation tissue is evident at the base of the wound, the edges of the incision may be re-approximated with sutures. Pelvic abscess may develop in patients having caesarean delivery, in the broad ligament, posterior cul-de-sac, or between the bladder and anterior uterine wall. These patients present with spiking fever, tachycardia, tachypnea, lower abdominal pain and tenderness, elevated white blood cell count. In such cases

Table 2 Review of studies showing SSI rates following Caesarean section in different institutes

S. No	Year	Authors, Place	% and Type of SSI	Risk Factors	Antibiotic susceptibility	Treatment and Outcome
1	2012	Ansar A, Pakistan [20]	5.8% (68% Superficial, 22% Deep and 10% Organ/ body cavities)	Poor nutritional status, anemia, previous scar and handling by the local health workers/dai	NA	Most of the patients managed with broad spectrum antibiotics,3 patient by laporotomy and antibiotics All Recovered
2	2010	De D, New Delhi India [21]	24.2% (All Superficial SSI)	Premature rupture of membrane, Long duration of stay in the hospital	33.3% susceptible to penicillin,76.2% methicillin susceptible *Staphylococcus aureus*	Conservative treatment All Recovered
3	2008	Varkonyi I, Hungary [22]	3.6% (not specified as Superficial/ Deep)	Anemia, subcutaneous haematoma, meconium stained or purulent amniotic fluid.	NA	NA
4	2002	Mitt P, Estonia [23]	6.2% (63% Superficial, 10.5% Deep, 21.2% endometritis, and 5.3% intraabdominal abscess)	Internal foetal monitoring, chorioamnionitis, surgical wound class III and IV	Not done	As per hospital policy All recovered
5	2001	Jido TA, Nigeria [24]	9.1% (Not specified as Superficial/ Deep)	Long duration of labour, long operation time heavy intraoperative loss ,blood transfusion	Ceftriaxone 64.3%, Cefuroxime 21.4%, Ofloxacin 50%, Ciprofloxacin 21.4%, Amoxicillin- clavulanate 50%, azithromycin 42.9% and aminoglycosides in 14.3% of cases	NA
6	1999	Oslen MA, USA [25]	5% (Superficial 92.6%, Deep 4.9%, Organ specific infection 2.5%)	Subcutaneous haematoma, Obesity, Staple closing of suture	NA	NA
7	2002	Johnson A, Glasgow UK [9]	11.2% (Not specified as Superficial/ Deep)	Obesity, increase maternal age	NA	NA
8	1996	Griffiths J, Edmonton Canada [26]	9.9% (Not specified as Superficial/ Deep)	NA	NA	NA
9	1996	Killian CA, New York USA [27]	9.1%	No antibiotic prophylaxis, <7 prenatal visits, premature rupture of membrane	Cephalosporins and quinolones sensitive	NA
10	2001	Sabbak M-Al, Iraq [28]	2.9%	Obesity, anemia, diabetes	NA	NA
11	2010	Heethal J, South India [29]	28% (Not specified as Superficial/ Deep)	Anaemia	Amikacin sensitive	Amikacin IV All Recovered
NA-not available						

radiological diagnosis by an ultrasound examination or CT scan should be done to confirm the presence of an abscess. Surgical drainage of the abscess may be required in some cases. In some situations, laparotomy may be necessary for complete drainage of the abscess. Medical management involves treatment with broad-spectrum parenteral antibiotics involving combination of clindamycin (900 mg every 8 hours) or metronidazole (500 mg every 12 hours) plus penicillin (5 million units every 6 hours) or ampicillin (2 g every 6 hours) plus gentamicin (7 mg/kg of ideal body weight every 24 hours) or Aztreonam (1 g every 8 hours) in patients who have renal impairment. Parenteral antibiotics should be continued till 24 hours after the patient is a febrile and asymptomatic. This is followed by oral antibiotics to complete a 10-day course. A combination of oral antibiotics including metronidazole, 500 mg, twice daily, plus doxycycline, 100 mg, twice daily has been recommended [4,35,36].

Conclusion

However, bacterial resistance mechanisms may exist and contribute to evade the effect of prophylactically administered antibiotics and contribute to the pathogenesis of wound infections [2]. It becomes imperative therefore, to understand the local antibiotic susceptibility patterns existing in a community to design a suitable antibiotic policy. It may be individualised to an institution but at the same time be reasonable enough not to

Table 3 Prevention of surgical site wound infections following Caesarean sections [2,13,14,30]

Prevention of microbial inoculation (first line of defence)		
Preoperative factors	**Intraoperative factors**	**Postoperative factors**
• Avoid antibiotic excess • Minimise hospitalization • Treat remote sites of infection • Avoid shaving. Epilation recommended • Timely administration of prophylactic antibiotics • Duration of labour prior to the Caesarean Section • Prolonged rupture of membranes • Multiple vaginal examinations • Emergency Caesarean Section • Regular antenatal visits • Internal fetal monitoring Maternal age	• Proper skin antisepsis with povidone iodine or chlorhexidine containing solution • Strict aseptic techniques • Laminar flow of filtered air • Minimise staff movement • Minimise length of surgery • Minimise blood loss • Minimise use of drains • Avoid rinsing instruments in contaminated surgical solutions, tap water	• Regular monitoring of wound sites • Minimise use of catheters and intravenous lines
Host factors (Second line of defence)		
• Resolve malnutrition or obesity • Avoid smoking • Proper glycemic Control • Low serum albumin • Psychological factors • Foetal wellbeing	• Skilled surgical team: gentle handling, avoidance of dead space, careful approximation of tissue planes • Maintain normothermia and oxygenation • Tight control of glucose levels	• Maintain adequate hydration • Nutrition maintenance Restrict visitors in postoperative wards • Infection control practices including hand hygiene • Avoid unnecessary handling of the infection site

contribute to further antimicrobial resistance in the community and especially to the newborn to which the antibiotic may be passively transferred.

References

1 Shah, F., Gandhi, M., Mehta, V., Udani, D., Mundra, M., et al. Nosocomial Infections in Surgical Wards. The Internet Journal of Surgery 2009; 24(1).

2 Mandell, GL., Bennett, JE., Dolin, R. Practice of Prevention of Postoperative Infection. In: Mandell, Bennett, and Dolin: Principles and Practice of Infectious Diseases (6thedtn), Churchill Livingstone, Elsevier, Florida, USA 2005; 3540-3545.

3 Smaill, FM., Gyte, GML. (2010) Antibiotic prophylaxis versus no prophylaxis for preventing infection after caesarean section. Cochrane Database of Systematic Reviews. 2010; CD007482.

4 Smaill, F., Hofmeyr, GJ. Antibiotic prophylaxis for caesarean section. Cochrane Database Syst Rev 2002; CD000933.

5 Bruce, J., Russel, EM., Mollison, J. The Measurement and Monitoring of Surgical Adverse Events. Health Technol Assess 2001; 5:13-28.

6 Ezechi, OC., Fasuba, OB., Dare, FO. Socioeconomic barrier to safe motherhood among booked patients in rural Nigerian communities. J Obstet Gynaec 2000; 20: 32-34.

7 Chaim, W., Bashiri, A, Bar-David, J., Shoham-Vardi, I., Mazor, M. Prevalence and clinical significance of postpartum endometritis and wound infection. Infect Dis Obstet Gynecol 2000; 8: 77- 82.

8 Killian, CA., Graffunder, EM., Vinciguerra, TJ., Venezia, RA. Risk factors for surgical-site infections following cesarean section. Infect Control Hosp Epidemiol 2001; 22: 613- 617.

9 Johnson, A., Young, D., Reilly, J. Caesarean section surgical site infection surveillance. J Hosp Infect 2006; 64: 1-6.

10 Webster, J. Post Caesarean wound infection: a review of the risk factors. Aust N Z J Obstet Gynaecol 1988; 28: 201-207.

11 Mitt, P., Lang, K., Peri, A., Marimets, M. Surgical-site infections following Caesarean section in an Estonian University hospital: post discharge surveillance and analysis of risk factors. Infect Control Hosp Epidemiol 2005; 26: 449-454.

12 Litta, P., Vita, P., Konshi, de Toffoli, J., Omnis, GL. Risk factors for complicating infections after Caesarean section. Clin Exp Obstet Gynaecol 1995; 22: 71-75.

13 Beattie, PG., Rings, TR., Hunter, MF., Lake, Y. Risk factors for wound infection following Caesarean section. Aust N Z J Obstet Gynaecol 1994; 34: 398-402.

14 Gorbach, S., Bartlett, J., Blacklow, N. Surgical Site Infections. Infectious Diseases (3rdedtn). Lippincott Williams and Wilkins 2004; 823-829.

15 Lilani, SP., Jangale, N., Chowdhury, A. Surgical Site Infections in clean and clean-contaminated cases. Ind J of Med Microbiol 2005; 23: 249-252.

16 Horan, TC., Gaynes, RP., Martone, WJ., Jarvis, WR., Emori, TG. CDC definitions of nosocomial surgical site infections: A modification of CDC definition of surgical wound infections. Infect Control Hosp Epidemol 1992; 13: 606-608.

17 Nichols, RL. Prevention of infection in high risk gastrointestinal surgery. AMJ Med 1984; 76: 111.

18 Duff, P. The pathophysiology and management of post caesarean endomyometritis. Obstet and Gynaec 1986; 67: 269-274.

19 National nosocomial infection surveillance report, data summary from October 1986-april 1996. A report from the NNIS system. Am J Infect Control 1996; 24: 380-338.

20 Ansar, A. Surgical Site Infection in Obstetrics Practice. Pak J Surg 2013; 18:2.

21 De, D., Saxena, S., Mehta, G., Yadav, R., Dutta, R. Risk Factor Analysis and Microbial Etiology of Surgical Site Infections following Lower Segment Caesarean Section. Int J Antibiot 2013; 1-6.

22 Varkonyi, I., Makai, I., Papdine Nyiri, G., Bacsko, G., Kardos, L. Postoperative surveillance of wound infection after cesarean section at Kenezy Hospital, Debrecen, Hungary. Orv Hetil 2011; 152 (1): 14-22.

23 Mitt, P., Lang, K., Peri, A., Maimets, M. Surgical-site infections following caesarean section in an Estonian university hospital: post discharge surveillance and analysis of risk factors. Infect Control Hosp Epidemiol 2005; 26: 449-454.

24 Jido, TA., Garba, ID. Surgical-site infection following cesarean section in Kano, Nigeria. Ann Med Health Sci Res 2012; 2:33-36.

25 Olsen, MA., Butler, AM., Willers, DM., Devkota, P., Gross, GA., et al. Risk factors for surgical site infection after low transverse caesarean section. Infect Control Hosp Epidemiol 2008; 29: 477 - 84.

26 Griffiths, J., Demianczuk, N., Cordoviz, M., Joffe, AM. Surgical site infection following elective Caesarian section: a case-control study of post discharge surveillance. J Obstet Gynaecol 2005; 27:340-344.

27 Killian, CA., Graffunder, EM., Vinciguerra, TJ., Venezia, RA. Risk factors for surgical-site infections following cesarean section. Infection control Hosp Epidemiol 2001; 22: 613-617.

28 Sabbak, M-Al., Sadiq, R. Wound infection following cesarean section. Bas J Surg 2003; 185-190.

29 Heethal, J., Sarala, N., Kumar, TN., Hemalatha, M. Pattern of antimicrobial use in caesarean section in a tertiary care hospital in rural south India. Int J of Biomed Res 2010; 2: 57-61.

30 National Nosocomial Infections Surveillance System. National Nosocomial Infections Surveillance (NNIS) System report, data summary from January 1992 to June 2002. Am J Infect Control 2002; 30: 458-475.

31 Van Eyk, N , Schalkwyk, JV. (2010) Antibiotic Prophylaxis in Obstetric Procedures. J Obstet Gynaecol 2010; 32: 878-884.

32 Gholitabar, M., Ullman, R., James, D., Griffiths, M. On behalf of the Guideline Development Group. Caesarean section: summary of updated NICE guidance. Br Med J 2011; 343:d7108.

33 Duff, P. Infections in pregnancy. In Ling FW, Duff P (eds): Obstetrics &Gynecology. Principles for Practice. New York, McGraw-Hill 2001.

34 Duff, P. Diagnosis and Management of Postoperative Infection. Global library of women's medicine 2011.

35 Duff, P. Antibiotic selection in obstetric patients. Infect Dis Clin North Am 1997; 11: 1-12.

36 Duff, P. Antibiotic selection in obstetrics: making cost-effective choices. Clin Obstet Gynecol 2002; 45: 59-72.