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Subcutaneous rifampicin versus povidone-iodine for the prevention of incisional surgical site infections following gynecologic oncology surgery — a prospective, randomized, controlled trial

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ABSTRACT

Objectives: Surgical site infection (SSI) following gynecologic oncology surgery is a severe problem for both patient and surgeon in terms of increasing morbidity, length of hospital stay, anxiety, and costs. In this prospective, randomized, controlled study we investigated the effect of subcutaneous rifampicin and povidone-iodine on incisional SSI following gynecologic oncology surgery.

Material and methods: Three hundred patients scheduled for abdominal surgery due to any malign gynecological pathology were randomly assigned into one of three groups of 100 members each, as follows: the subcutaneous tissue was irrigated with saline in Group 1; saline + 10% povidone iodine in Group 2; saline + rifampicin in Group 3. Patients were invited to follow-up once every 10 days in a 30-day period for evaluation. Patients who developed a superficial incisional SSI were recorded.

Results: No significant relationship was observed between the SSI and the subcutaneous agents used (p = 0.332). It was observed that there was a statistically significant increase in the rate of incisional surgical site infections as the period of hospitalization (p = 0.044), patient's age (p = 0.003), existence of comorbidities (p = 0.001), and perioperative blood transfusion (p = 0.021) increased.

Conclusions: Subcutaneous agents are not effective in preventing surgical site infections after gynecologic oncology surgeries. Further large-scale prospective randomized controlled studies may provide other options to prevent SSIs.

Key words: gynecologic surgical oncology; povidone-iodine; rifampicin; surgical site infection

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INTRODUCTION

The incidence of surgical site infections (SSIs) is 5–16%, and they are observed in 6–15% of gynecologic oncology cases [1, 2]. The infections in this patient group are much more important and riskier than the others because it may increase the patient's morbidity, cause delay in adjuvant therapy and additional treatment due to infection, thereby increasing the cost of care [3].

Chronic diseases, advanced age, smoking, hypoalbuminemia, malnutrition, hypothermia, hyperglycemia, prolonged hospital stay, perioperative blood transfusion, and corticosteroids and other immunosuppressive agents can increase superficial incisional SSI rates by adversely affecting the host defense. At the same time, the architectural characteristics and ventilation of the operating room, surgical clothing, surgical hand washing, preparation of the incision site under appropriate conditions, prophylactic antibiotic use, surgical technique, the materials used during surgery, and length of surgery also affect superficial incisional SSI rates [4, 5].

Despite the developments in the sterilization methods, operation room conditions, and intensive care unit facilities, SSI continues to constitute a serious problem for surgery. In order to establish a diagnosis according to certain criteria and access more accurate statistical data in infections that occur after surgery, Centers for Disease Control and Prevention of the United States of America provided standard definitions, and it was accepted to use the definition "Surgical Site Infection" [6]. According to the standard definitions provided by this center, the SSIs were grouped into two: incisional and organ/site infection. The incisional SSI is observed within 30 days after the operation and constitutes 2/3 of the surgical site infections [7].

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An increase has recently been observed in the incidence of SSI particularly in gynecologic oncology cases due to reasons such as that elderly individuals with chronic diseases are more commonly operated compared to the past and long and complicated operations are performed [8].

The factors that play a role in the occurrence of surgical site infections can be listed as bacteria load and virulence, tissue factor, and other factors associated with the patient. The source of the pathogens are usually the endogenous flora caused by the patient's skin, mucous membranes, or intestinal system. The microorganisms contained in the patient's skin and mucosa are the most significant reservoir of the incisional surgical site infections in particular; therefore, antibiotics prophylaxis, providing preoperative local cleaning, eliminating the debris when the skin incision is closed and washing the wound abundantly, and providing appropriate local antisepsis decreases the risk of incisional wound infection [9]. The World Health Organization recommended 16-item measures for SSI prevention in 2016 [10]. In this package of measures, incisional wound irrigation with antibiotics and povidone-iodine has been recommended along with important preventions like perioperative oxygenation, maintaining normal body temperature, intensive blood glucose control, adequate circulating volume control. The data on the topical antibiotic use to prevent surgical site infections is limited. Rifampicin is a cheap and easily accessible semi-synthetic, high topical effect antibiotic which is very strong bactericidal on many Gram (+) and (–) bacteria including *S. aureus* [11–13]. For these reasons, we have been using rifampicin as a topical antibiotic for many years in our practice.

Objectives

We have previously evaluated the effects of subcutaneous agents used in benign gynecologic cases on SSI formation [14]. Also, there is a limited number of studies in the literature about the SSIs observed after gynecologic oncology cases in particular. Therefore, we compared the efficacy of the subcutaneous rifampicin and 10% povidone-iodine used for preventing the incisional SSI in gynecologic oncology cases in this preliminary prospective randomized controlled study which is the second leg of SSI research in obstetrics& gynecology. Furthermore, the other factors that could cause SSI were evaluated.

MATERIAL AND METHODS

The Ethical Committee of Gaziantep University approved the study protocol (2018/156), and written informed consent was obtained from all patients before enrollment.

Three hundred patients who had no pregnancy and active infection and who were decided to have abdominal surgery due to gynecologic malignancy between February 2018 and July 2019 in the Gynecology and Obstetrics Clinic of Gaziantep University Faculty of Medicine were grouped into 3 groups of 100 people in a randomized manner. Each patient that was operated on between the dates mentioned above was included in the groups in turn. It was randomly specified which subcutaneous agent would be used for which patient. After the abdominal operation was completed and the abdominal fascia was closed, the subcutaneous tissue was irrigated only with saline in Group 1 (control group), saline + 10% povidone-iodine in Group 2, and saline + rifampicin in Group 3. All subcutaneous tissues were irrigated with 250 mL of saline. Then 10 mL of 10 % povidone-iodine in Group 2 and 500 mg/6 mL of rifampicin in Group 3 was applied directly on the subcutaneous tissue without being diluted. The excess liquid was cleaned off and the subcutaneous tissue scrubbed with a gauze. A five-point gynecological perioperative infection prevention bundle was used in all groups [15]. This bundle includes 5 preoperative measures as; chlorhexidine wash using 4% chlorhexidine gluconate wipes, mechanical bowel preparation with oral antibiotics preoperatively, antibiotic and skin preparation administration, adoption of enhanced sterile techniques during intestinal resection and wound closure perioperatively, and strict wound management postoperatively. All groups were operated in the same operating room under the same technical conditions with the same team. The subcutaneous thickness was grouped into 3 according to the measurements; thin ≤ 4 cm, moderate: 5–9 cm, thick ≥ 10 cm. The 10-Fr hemovac drains (400 cc) were inserted subcutaneously and 2/0 polyglactin 910 (Vicryl®) was used as a subcutaneous suture in moderate and thick groups. Subcuticular 3–0 modified glycolic acid (Monosyn®) was used for the skin in pfannenstiel incisions, and subcuticular 3–0 polypropylene (PP, Premilene®) or staple was used for the skin in midline incisions. The patients were discharged with Cefazolin 1 gram/day and Naproxen sodium 550 mg/day and recommendations for the wound site care. The patients' ages, period of hospitalization, comorbidities, laboratory parameters, perioperative bleeding amount, blood transfusion, if any, and smoking habits were recorded. All patients were invited for SSI check with the intervals of 10 days until postoperative day 30. SSI was diagnosed according to the following criteria: purulent discharge (regardless of whether there is positive culture), positive culture of wound or wound discharge, presence of at least one of the following signs: pain, swelling, redness, warmth and wound-opening and surgeon's opinion towards the infection [16]. Wound swabs were taken when clinically indicated. The patients who met one of the diagnosis criteria for surgical site infection within this period were recorded.

The conformity of numerical data with the normal distribution was tested with Shapiro-Wilk test. ANOVA and LSD tests were used for comparing the variables with normal distribution in 3 groups. The relationship between the categorical variables was tested with the chi-squared test. SPSS 22.0 software pack was used in the analyses. P < 0.05 was considered significant.

Sample size estimation

Sample size estimation was performed based on previous study results [14]. To find significant difference between rifampicin and povidone-iodine with effect size of 27% (%5 vs %32) minimum required sample size for each group was calculated as 90 ($\alpha = 0.05$, $1\text{-}\beta = 0.90$). G power package version 3.1.9.2 was used to perform sample size estimation.

RESULTS

The gynecologic cases and their rates were as follows, respectively: 135 patients had endometrial cancer (45%), 94 patients had ovarian cancer (31.3 %), and 71 patients had cervical cancer (23.7%). The main characteristics of the patients are shown in Table 1.

The total number of incisional SSIs in the patients was 28 (9.3%) (Group 1: 12, Group 2: 6, Group 3: 10). It was observed that there was a statistically significant increase in the rate of incisional SSI as the period of hospitalization ($p = 0.044$), patient's age ($p = 0.003$), existence of comorbidities ($p = 0.001$), and perioperative blood transfusion ($p = 0.021$) increased. The risk factors that can play a role in the occurrence of SSI are shown in Table 2.

No significant relationship was observed between the SSI and the subcutaneous agents used ($p = 0.332$) (Fig. 1).

DISCUSSION

The surgical site infection is one of the most important problems of gynecological surgery. Most of the studies previously conducted in the field of gynecology and obstetrics are on SSI after cesarean section [17 ,18] and less benign gynecological cases [19, 20]. There is a limited number of studies on the surgical site infections that occur after gynecologic oncology cases [21].

The factors they play role in the SSI formation can be classified into 3 groups: microbe-related risk factors, with Staphylococcus aureus and Streptococcus pyogenes; host-related risk factors, with morbid obesity, an index of disease severity, old age, protein-calorie malnutrition, steroid use, diabetes, immunodeficiency, cancer, and systemic infection; and operation-related risk factors, including prolonged hospital stay before surgery, duration of the operation, tissue trauma, poor hemostasis, and foreign material in the wound. The performance of an intraabdominal procedure, operation time > 4 hours, a contaminated or dirty-infected operation, and concomitant illness of significance were other important factors [22]. Although it is not possible to fix the factors related to the patient, most of the risk factors related to surgical practice and microbe can be fixed. Therefore, taking measures for all risk factors that result in SSI will decrease the incidence of these infections.

One of the most important methods in reducing the SSIs is the monitoring and evaluation performed by the hospital infection control committees as also applied in our hospital [23]. For this purpose, the rates of SSIs in the hospitals and the active pathogens must be specified, and the appropriate antibiogram charts must be formed for these. The results obtained from these evaluations must be shared with the surgery team, and studies must be conducted for continuous quality improvement for decreasing the infections. Besides appropriate surgical antibiotic prophylaxis is crucial.

Table 1. The baseline characteristics of the patients

Variables	Saline (n = 100)	Saline + Rifampicin (n = 100)	Saline + 10% povidone-iodine (n = 100)	p value
Age† [yr]	59.31 ± 8.81^{A}	55.38 ± 11.18^{B}	59.47 ± 10.48^{A}	0.021*
Hospitalization† [day]	4.09 ± 0.96	4.4 ± 1.26	4.25 ± 1.04	0.353
SC thickness† [cm]	4.9 ± 1.4	4.98 ± 1.87	4.72 ± 1.25	0.789
PO blood loss† [mL]	208.1 ± 147.75^{B}	372.3 ± 275.97^{A}	218.1 ± 197.31^{B}	0.001*
BMI†	22.2 ± 2.72	23.16 ± 3.47^{A}	21.74 ± 2.39^{B}	0.013*
Hemoglobin† [g/dL]	10.78 ± 1.08	10.86 ± 1.21	10.81 ± 1.29	0.961
Comorbid disease‡	14 (14)	14 (14.1)	16 (16)	0.906
SC drain‡	$12 (12)^{B}$	$33 (33)^{A}$	$18 (18)^{B}$	0.001*
SC suture‡	67 (67)	64 (64)	57 (57)	0.324
İncision‡ Pfannenstiel	2 (2)	2 (2)	1 (1)	0.816
Midline	98 (98)	98 (98)	99 (99)	
Smoking‡	26 (26)	30 (30)	22 (22)	0.445
Blood transfusion‡	10 (10)	15 (15)	10 (10)	0.435

†mean ± st.deviation; ‡Count(percent); *Significant at 0.05 level (A is significantly higher than B); SC — Subcutaneous; PO — Peroperative; BMI — Body Mass Index; CRP — C reactive protein

Table 2. The risk factors that may play a role in SSI formation

Variables	SSI (n = 28)	No SSI (n = 272)	p value
Age† [yr]	58.86 ± 9.27	57.97 ± 10.46	0.003*
Hospitalization† [day]	4.57 ± 0.96	4.21 ± 1.11	0.044*
Sc thickness† [cm]	4.96 ± 1.97	4.86 ± 1.48	0.977
PO blood loss† [mL]	383.93 ± 312.12	254.04 ± 212.1	0.235
BMI†	23.14 ± 3.57	22.29 ± 2.87	0.876
Hemoglobin† [g/dL]	10.89 ± 1.2	10.81 ± 1.19	0.668
Comorbid disease‡	15 (55.6)	29 (10.7)	0.001*
SC drain‡	9 (32.1)	54 (19.9)	0.128
SC suture‡	18 (64.3)	170 (62.5)	0.852
İncision‡ Pfannenstiel Midline	0 (0.0) 28 (100.0)	5 (1.8) 267 (98.2)	0.469
Smoking‡	9 (32.13)	69 (25.4)	0.436
Blood transfusion	7 (25.0)	28 (10.3)	0.021*
Groups‡ Saline Saline + Rifampicin Saline + Povidone-iodine	 12 (42.9) 10 (35.7) 6 (21.4)	 88 (32.4) 90 (33.1) 94 (34.6)	0.332

†mean ± st.deviation; ‡Count (percent); *Significant at 0.05 level; SSI — Surgical Site Infection; SC — Subcutaneous; PO — Peroperative; BMI — Body Mass Index; CRP — C reactive protein

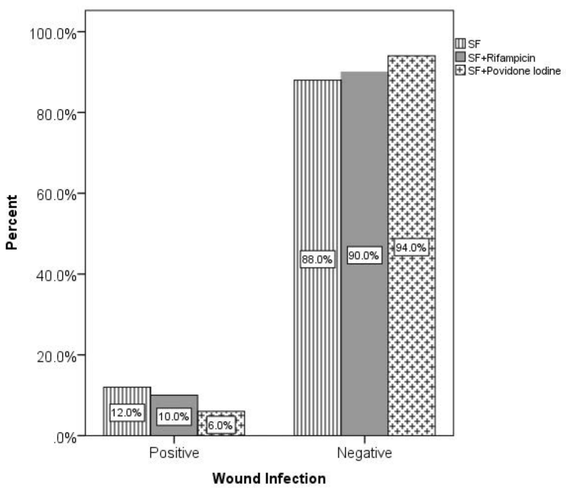

Figure 1. Relationship between subcutaneous agents and SSI

Wound site irrigation with serum saline solution, povidone-iodine, or antibiotics was mentioned among the intraoperative and postoperative recommendations provided by the World Health Organization (WHO) for prevention of the surgical site infection, and it was stated that there was not sufficient evidence demonstrating that irrigation with serum saline solution reduced the risk of infection and that irrigation with povidone-iodine could be helpful in clean and clean contaminated wounds [10].

Subcutaneous antibiotics are more advantageous in terms of side effects, toxicity and efficacy than systemic antibiotics. The agents that could not be used systemically may also be used subcutaneously. There are also disadvantages such as tenderness and contact dermatitis [24].

Subcutaneous antibiotics can be used in different forms like solutions, gels, powders, creams, beads or implants. The frequently used antibiotics are cephalosporins, aminoglycosides, glycopeptides, chloramphenicol, rifampicin and bacitracin [25]. It is not easy to determine using which agent, how much, how long and in what form, for prophylaxis in different types of surgical wounds. For this reason, the efficacy and limits of topical antibiotic use at the surgical site have not been clear enough yet [26]. Besides the topical antibiotics, the efficacy of local anesthetics and local antiseptics have been observed in different studies [27].

It was observed that the use of prophylactic subcutaneous drain did not decrease the rates of subcutaneous hematoma, seroma, and infection even in obese patients [28, 29]. We also did not reveal a positive effect of subcutaneous hemovac drains on the incidence of SSI. At the same time the subcutaneous drains can cause discomfort and excess cost. These results are comparable to studies focusing on other indications like cesarean section [30]. Otherwise, studies demonstrating the benefit of subcutaneous drainage are also available [31]. Therefore, a definite conclusion cannot be obtained about the general use of prophylactic subcutaneous drainage in the surgery.

According to the result of a Cochrane review performed in 2014 about subcutaneous suture, it was stated that subcutaneous tissue closure did not have any effect on the site infection in gynecologic abdominal surgery [32]. We also did not find any effect of the subcutaneous thickness and the presence of subcutaneous suture on the SSIs. Also, considering the potential negative effects like bacterial contamination or tissue reaction, the subcutaneous sutures should be questioned.

In our study, we observed that the rate of SSI increased as the patient's age increased, and that this outcome was similar to the outcomes of many studies that were previously conducted [33]. This can be related to the decrease in the normal defense mechanisms and increase in the incidence of chronic diseases such as diabetes mellitus in particular with the age. We observed more surgical site infections in the patients with chronic diseases as well. It was an expected outcome to observe an increase in the rate of surgical wound infection as the post-operative period of hospitalization prolonged, because an increase is observed in the microorganisms in the skin flora of the patients who are hospitalized for a long period of time, and this flora can contain the resistant microorganisms observed in the hospitals. Therefore, discharging the patients as early as possible during the post-operative period will decrease the probability of surgical site infection [34]. The increase in the rate of wound infection as the rate of perioperative blood transfusion increases are parallel with the outcome of many studies that were previously conducted on this subject, and perioperative blood transfusion must be avoided unless mandatory [35].

In this study we conducted for comparing the efficacy of surgical wound irrigation performed with saline, 10% povidone-iodine, or rifampicin, SSI was most commonly observed in the saline group and least commonly observed in the povidone-iodine group. Despite the numerical difference between the groups, no statistically significant difference was observed between the agents in terms of preventing the SSI. Perhaps the most striking aspect of this study is the emergence of different result from our previous study on benign gynecological cases [14]. Our previous study revealed that SSI decreased significantly with subcutaneous rifampicin and 10% povidone-iodine irrigation compared to saline alone in benign gynecologic cases This different result between these two studies may suggest that defense mechanisms and risk factors in oncology patients have changed and weakened, also the average age, chronic disease and blood transfusion rates are higher than the previous study. In benign gynecological cases, patients receive 3 doses of one type parenteral antibiotics during their hospital stay, while in oncology cases we give uninterrupted two type parenteral antibiotics until they are discharged. However, oncological cases stay in the hospital longer than other cases, and wound care is performed twice a day during their stay. Such differences between benign cases and oncological cases can lead to different results between the two studies. In addition, although there was no statistical difference, the least infection was in the povidone-iodine group and the most infection was in the saline group. This may indicate the possibility of statistically significant difference when more patients are evaluated in larger studies.

The facts that could not be partially foreseen such as limited number of patients, the possibility of existence of people with active infection in the team, and not having information on the hygienic condition of the patients during the perioperative period are included in the limitations of our study.

This clinic trial is a preliminary study to present the results of the wound irrigation technique with rifampicin or povidone-iodine that we have used in our practice for many years and it may contribute to reaching the sufficient level of evidence on surgical wound infections in gynecologic oncology cases, which are still missing in the literature, and that it may be a guide for the studies that will be conducted on this subject in future.

CONCLUSIONS

Superficial incisional SSI rate in gynecologic oncology patients significantly increases as the period of hospitalization ($p = 0.044$), patient's age ($p = 0.003$), existing comorbidities ($p = 0.001$) and perioperative blood transfusion ($p = 0.021$) increased. However, it does not change when using subcutaneous rifampicin or povidone-iodine. Although there was no statistical difference, the least infection was in the povidone-iodine group and the most infection was in the saline group. This may indicate the possibility of statistically significant difference when more patients are evaluated in larger studies. We believe that broader prospective randomized controlled trials are required to make a definitive comment on this issue.

REFERENCES

1. Mahdi H, Gojayev A, Buechel M, et al. Surgical site infection in women undergoing surgery for gynecologic cancer. Int J Gynecol Cancer. 2014; 24(4): 779–786, doi: 10.1097/IGC.0000000000000126, indexed in Pubmed: 24681712.
2. Quiroga-Garza A, Valdivia-Balderas JM, Trejo-Sánchez MÁ, et al. A Prospective, Randomized, Controlled Clinical Trial to Assess Use of 2% Lidocaine Irrigation to Prevent Abdominal Surgical Site Infection. Ostomy Wound Manage. 2017; 63(8): 12–21, indexed in Pubmed: 28873062.
3. Bakkum-Gamez JN, Dowdy SC, Borah BJ, et al. Predictors and costs of surgical site infections in patients with endometrial cancer. Gynecol Oncol. 2013; 130(1): 100–106, doi: 10.1016/j.ygyno.2013.03.022, indexed in Pubmed: 23558053.
4. Lake AG, McPencow AM, Dick-Biascoechea MA, et al. Surgical site infection after hysterectomy. Am J Obstet Gynecol. 2013; 209(5): 490.e1–490.e9, doi: 10.1016/j.ajog.2013.06.018, indexed in Pubmed: 23770467.
5. Leaper D, Ousey K. Evidence update on prevention of surgical site infection. Curr Opin Infect Dis. 2015; 28(2): 158–163, doi: 10.1097/QCO.0000000000000144, indexed in Pubmed: 25692267.
6. Berríos-Torres SI, Umscheid CA, Bratzler DW, et al. Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017.

JAMA Surg. 2017; 152(8): 784–791, doi: 10.1001/jamasurg.2017.0904, indexed in Pubmed: 28467526.
7. Lachiewicz MP, Moulton LJ, Jaiyeoba O. Pelvic surgical site infections in gynecologic surgery. Infect Dis Obstet Gynecol. 2015; 2015: 614950, doi: 10.1155/2015/614950, indexed in Pubmed: 25788822.
8. Badia JM, Casey AL, Petrosillo N, et al. Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. J Hosp Infect. 2017; 96(1): 1–15, doi: 10.1016/j.jhin.2017.03.004, indexed in Pubmed: 28410761.
9. Webster J, Osborne S, Webster J, et al. Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Cochrane Database Syst Rev. 2006; 93(2): CD004985–1341, doi: 10.1002/14651858.CD004985.pub2, indexed in Pubmed: 16625619.
10. Allegranzi B, Zayed B, Bischoff P, et al. WHO Guidelines Development Group, WHO Guidelines Development Group. New WHO recommendations on preoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016; 16(12): e276–e287, doi: 10.1016/S1473-3099(16)30398-X, indexed in Pubmed: 27816413.
11. Demir N, Peker E, Gülşen İ, et al. Powder Topical Rifampin for Reducing Infections After Neural Tube Defect Surgery in Infants. World Neurosurg. 2016; 95: 165–170, doi: 10.1016/j.wneu.2016.07.092, indexed in Pubmed: 27506408.
12. Weber JM, Sheridan RL, Fagan S, et al. Incidence of catheter-associated bloodstream infection after introduction of minocycline and rifampin antimicrobial-coated catheters in a pediatric burn population. J Burn Care Res. 2012; 33(4): 539–543, doi: 10.1097/BCR.0b013e31823c4cd5, indexed in Pubmed: 22210071.
13. Shiels SM, Tennent DJ, Wenke JC. Topical rifampin powder for orthopedic trauma part I: Rifampin powder reduces recalcitrant infection in a delayed treatment musculoskeletal trauma model. J Orthop Res. 2018; 36(12): 3136–3141, doi: 10.1002/jor.24055, indexed in Pubmed: 29781552.
14. Komurcu Ka, Sucu S, Özcan Ç, et al. Topical Rifampicin versus Povidone-Iodine for the Prevention of Incisional Surgical Site Infections Following Benign Gynecologic Surgery: A Prospective, Randomized, Controlled Trial. New Microbiol. 2019; 42(4): 205–209.
15. Lippitt MH, Fairbairn MG, Matsuno R, et al. Outcomes Associated With a Five-Point Surgical Site Infection Prevention Bundle in Women Undergoing Surgery for Ovarian Cancer. Obstet Gynecol. 2017; 130(4): 756–764, doi: 10.1097/AOG.0000000000002213, indexed in Pubmed: 28885412.
16. Horan TC, Gaynes RP, Martone WJ, et al. CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. Am J Infect Control. 1992; 20(5): 271–274, doi: 10.1016/s0196-6553(05)80201-9, indexed in Pubmed: 1332552.
17. Solomkin JS, Mazuski J, Blanchard JC, et al. Introduction to the Centers for Disease Control and Prevention and the Healthcare Infection Control Practices Advisory Committee Guideline for the Prevention of Surgical Site Infections. Surg Infect (Larchmt). 2017; 18(4): 385–393, doi: 10.1089/sur.2017.075, indexed in Pubmed: 28541804.
18. De Nardo P, Gentilotti E, Nguhuni B, et al. Post-caesarean section surgical site infections at a Tanzanian tertiary hospital: a prospective observational study. J Hosp Infect. 2016; 93(4): 355–359, doi: 10.1016/j.jhin.2016.02.021, indexed in Pubmed: 27125664.
19. Tuuli M, Liu J, Stout M, et al. 4: Chlorhexidine-alcohol compared with iodine-alcohol for preventing surgical-site infection at cesarean: a randomized controlled trial. American Journal of Obstetrics and Gynecology. 2016; 214(1): S3–S4, doi: 10.1016/j.ajog.2015.10.025.
20. Steiner HL, Strand EA. Surgical-site infection in gynecologic surgery: pathophysiology and prevention. Am J Obstet Gynecol. 2017; 217(2): 121–128, doi: 10.1016/j.ajog.2017.02.014, indexed in Pubmed: 28209490.
21. Uppal S, Bazzi A, Reynolds RK, et al. Chlorhexidine-Alcohol Compared With Povidone-Iodine for Preoperative Topical Antisepsis for Abdominal Hysterectomy. Obstet Gynecol. 2017; 130(2): 319–327, doi: 10.1097/AOG.0000000000002130, indexed in Pubmed: 28697103.
22. Rubin RH. Surgical wound infection: epidemiology, pathogenesis, diagnosis and management. BMC Infect Dis. 2006; 6: 171, doi: 10.1186/1471-2334-6-171, indexed in Pubmed: 17129369.
23. Nugent EK, Hoff JT, Gao F, et al. Wound complications after gynecologic cancer surgery. Gynecol Oncol. 2011; 121(2): 347–352, doi: 10.1016/j.ygyno.2011.01.026, indexed in Pubmed: 21324517.
24. Heal CF, Banks JL, Lepper P, et al. Meta-analysis of randomized and quasi-randomized clinical trials of topical antibiotics after primary closure for the prevention of surgical-site infection. Br J Surg. 2017; 104(9): 1123–1130, doi: 10.1002/bjs.10588, indexed in Pubmed: 28656693.
25. Karaarslan N, Yilmaz I, Ozbek H, et al. Is Implant Washing and Wound Irrigation with Rifampicin Effective for Preventing Surgical Site Infections in Lumbar Instrumentation? Turk Neurosurg. 2018; 28(6): 904–909, doi: 10.5137/1019-5149.JTN.21341-17.2, indexed in Pubmed: 29368319.
26. McHugh SM, Collins CJ, Corrigan MA, et al. The role of topical antibiotics used as prophylaxis in surgical site infection prevention. J Antimicrob Chemother. 2011; 66(4): 693–701, doi: 10.1093/jac/dkr009, indexed in Pubmed: 21393223.
27. Mueller TC, Loos M, Haller B, et al. Intra-operative wound irrigation to reduce surgical site infections after abdominal surgery: a systematic review and meta-analysis. Langenbecks Arch Surg. 2015; 400(2): 167–181, doi: 10.1007/s00423-015-1279-x, indexed in Pubmed: 25681239.
28. Edmiston CE, Leaper DJ. Intra-Operative Surgical Irrigation of the Surgical Incision: What Does the Future Hold-Saline, Antibiotic Agents, or Antiseptic Agents? Surg Infect (Larchmt). 2016; 17(6): 656–664, doi: 10.1089/sur.2016.158, indexed in Pubmed: 27676639.
29. Ploegmakers IBM, Olde Damink SWM, Breukink SO. Alternatives to antibiotics for prevention of surgical infection. Br J Surg. 2017; 104(2): e24–e33, doi: 10.1002/bjs.10426, indexed in Pubmed: 28121034.
30. Magann EF, Chauhan SP, Rodts-Palenik S, et al. Subcutaneous stitch closure versus subcutaneous drain to prevent wound disruption after cesarean delivery: a randomized clinical trial. Am J Obstet Gynecol. 2002; 186(6): 1119–1123, doi: 10.1067/mob.2002.123823, indexed in Pubmed: 12066083.
31. Panici PB, Zullo MA, Casalino B, et al. Subcutaneous drainage versus no drainage after minilaparotomy in gynecologic benign conditions: a randomized study. Am J Obstet Gynecol. 2003; 188(1): 71–75, doi: 10.1067/mob.2003.103, indexed in Pubmed: 12548198.
32. Gurusamy KS, Toon CD, Davidson BR. Subcutaneous closure versus no subcutaneous closure after non-caesarean surgical procedures. Cochrane Database Syst Rev. 2014(1): CD010425, doi: 10.1002/14651858.CD010425.pub2, indexed in Pubmed: 24446384.
33. Awad SS. Adherence to surgical care improvement project measures and post-operative surgical site infections. Surg Infect (Larchmt). 2012; 13(4): 234–237, doi: 10.1089/sur.2012.131, indexed in Pubmed: 22913334.
34. Bogani G, Rossetti D, Ditto A, et al. Minimally invasive surgery improves short-term outcomes of nerve-sparing radical hysterectomy in patients with cervical cancer: a propensity-matched analysis with open abdominal surgery. J Gynecol Oncol. 2019; 30(2): e27, doi: 10.3802/jgo.2019.30.e27, indexed in Pubmed: 30740958.
35. Xiao H, Quan Hu, Pan S, et al. Impact of peri-operative blood transfusion on post-operative infections after radical gastrectomy for gastric cancer: a propensity score matching analysis focusing on the timing, amount of transfusion and role of leukocyte depletion. J Cancer Res Clin Oncol. 2018; 144(6): 1143–1154, doi: 10.1007/s00432-018-2630-8, indexed in Pubmed: 29572591.