



ISSN: 1813-1638

**The Medical Journal of Tikrit University**

Available online at: [www.mjotu.com](http://www.mjotu.com)

العراقية  
المجلات الأكاديمية العلمية  
**IRAQI**  
Academic Scientific Journals

Basma Mohammad <sup>(1)</sup>  
Dhuha A. Mijthab <sup>(2)</sup>  
Sarmad A. Al-azzawi <sup>(3)</sup>  
Safwan I. Al-jawadi <sup>(4)</sup>

## Comparative study to assess the effect of different antibiotics administration and other factors on post cesarean wound infection

### ABSTRACT

Wound infection is infection at any level from 1-30days of the operation or up to one year after operation if included the embedding of foreign body, reasonable use of antibiotic is one of the key factor to stop wound infection .The administration of prophylactic antibiotic with recommended regimens, such as in developed countries has not been applied in AL-Batool hospital .This hospital still used other types of antibiotics, in addition for several reasons, antibiotics were continued postoperatively to reduce the risk of delayed infections. Therefore, this study was done to analyze the effectiveness of prophylactic antibiotics as recommended in cesarean sections , This is a prospective cohort study carried out at Al- Batool hospital in Mosul city, 150 cases of elective cesarean sections recruited in this study during the period from 1st December 2019 to the 1st June 2020 ,they divided to three groups according to route of antibiotic administration .The ratio of wound infections in group 1&2 was (5%) and 20% in group (3) patients who don't received pre –operative prophylactic antibiotics . No significant differences in wound infection founded between group1&group2,whereas high rate of wound infection occurred in group3 p-value (0.014 ),in this study single prophylactic doses of antibiotics give as much protection as multiple doses in preventing post elective cesarean section wound infections . Obesity prior to pregnancy showed a statistically significant value as a cause of wound infection P-value (0.001). Analysis of the results demonstrated two types of pathogens were identified Staphylococcus species (85%) and proteus (15%).

(1) M.B. Ch.B. D.G.O,  
Department of Obstetrics  
and Gynecology AL-  
Batool Teaching Hospital.  
Iraq  
(2) M.B. Ch.B. D.G.O,  
Department of Obstetrics  
and Gynecology AL-  
Batool Teaching Hospital  
Iraq  
(3) MB.CH.B, F.I.B.M.S,  
Specialist of medical  
microbiology and clinical  
immunology Ibn. Sena  
Teaching Hospital. Iraq  
(4) MB.CH.B.M.S.c (path)AL-  
Batool Teaching Hospital.  
Mosul.  
Iraq

#### Keywords:

*Prophylactic antibiotics,  
Al-Batool hospital,  
surgical site infection,  
Mosul city.*

#### ARTICLE INFO

##### Article history:

Received 20 Apr 2021  
Accepted 10 May 2021  
Available online 01 Dec 2021

The Medical Journal of Tikrit University The Medical Journal of Tikrit University The Medical Journal of Tikrit University

DOI: <http://dx.doi.org/10.25130/mjotu.27.2021.05>

\*Corresponding author E mail : [Basmaiqi86@gmail.com](mailto:Basmaiqi86@gmail.com)

## **Introduction:**

Wound infections are defined as infections that occur at surgical incisions within 30 days of operations or post one year if the implants are placed .Wound infection after cesarean section categorized as superficial, deep and organ spaced according to the involved tissues or organs <sup>[1, 2]</sup> World Health Organization (WHO) defined cesarean section as "the delivery of a fetus, placenta and membranes from the abdominal wall and the uterus after 20 weeks of gestation" <sup>[1]</sup>. C/S is a good index procedure for wound infection ,Since several reasons which may confuse the real cause of wound infections are not present because the operation usually done on young women who do not have medical diseases and age correlated possibilities of infections and the operating technique is standardized <sup>[3]</sup> .Infection during labor and perperium are the main reasons of maternal mortality, representing around one tenth of the maternal death<sup>[4,5]</sup> .Separately from death and severe illness related with

infection throughout or next labor, longstanding for example fallopian tube obstruction, secondary infertility and chronic pelvic pain can also happen. Maternal infection during labor also have a considerable influence on newborn death, and nearly about one million neonatal deaths are related by such infections yearly, furthermore infection-related morbidities and long admission to hospital can affect the mother–newborn relationship in the first days post labor <sup>[6,7]</sup> .After cesarean section the risk of postpartum infection appear to be nearly five folds increased compared to those delivered normally <sup>[8,9]</sup> .Surgical site infection is a most hospital-acquired infection in surgical patient<sup>[10]</sup>.It cause long hospitalization, increase antibiotic usage, and increase cost<sup>[11]</sup> .Proper prophylactic antibiotic can decrease the hazard of wound infections postoperatively, on the other hand extra antibiotic usage favors the appearance of resistance to antibiotics .Cautious usage of antibiotics in the hospitals are then important <sup>[12]</sup>. Prophylactic antibiotics refer to

antibiotic usage before to the start operation or during surgery without clinical signs of infection. The GDG (Guideline Development Group) noted that "it is importance for surgeons to be clear about this definition to avoid using antibiotic regimes that are most recommends for treating confirmed infection – i.e. therapeutic antibiotic use". The GDG confirmed "the significance of using the shortest and simplest antibiotic regime for prophylaxis". As the suggestion proposes that one-dosage regimes are as active as multiple-dosage regimes, Clinical judgment is essential to assess other factors that might increase the risk of developing infections after cesarean sections and are therefore more probably to benefit from multiple antibiotic regimes (e.g. difficult surgical handling, long duration of surgery ,long "skin-to-skin" interval or sever loss of blood)<sup>[13]</sup> . Steps for the prevention of SSIs are based on improving the patient's defenses against infection and on decreasing the risk of bacterial contamination <sup>[14]</sup>. External risk factors consist of the surgeon's skill, the

duration and type of operation, the quality of preparation of skin before surgery, sufficiency and scheduling of antibiotic prophylaxis, insufficient sterilization of surgical tools ,insertion of foreign material <sup>[15,16]</sup> .The incidence of surgical site infection is forcefully effected by quality of operating theatres <sup>[17]</sup> . Postoperative Surgical site infections grow shortly after contamination, usually within 2 hours. Washing of hands is mandatory and the use of sterile gloves is obligatory while handling incision dressings and changing bandages during the early postoperative period. It is almost universally advised that the surgical dressings be kept dry immediately following surgery to reduce contamination of the incision. This is based upon the concept that the wet bandages may 'wick' adjacent skin microorganisms into the surgical field. This can be especially harmful when water from outside the dressing, such as during bathing, contaminates the dressing <sup>[18]</sup>. A new study confirmed that perforated gloves duple the hazard of wound infections. Double gloves

lowers the hazard of perforation throughout operation, however perforations are still seen in 4% of cases post operatively. Many epidemics have been occurred due to contaminated hands from the operating team in spite of wearing sterilized gloves [19]. Caps, face masks, gloves, gowns and sterile drapes must be used to decrease spreading of possible bacteria to the wounds, operating tools must be sufficiently sterilized according to issued rules. It must be noted that despite protection, some contamination of the wound place is unavoidable since certain endogenous microbes persist even with good preparation of the site of operation [20, 21]. Several international scientific organizations made guidelines about the feature of operational theater "exchange of filtered air per hour, positive pressure, air-conditioning system with HEPA filters, etc...". The instructions include "the air in operating theatres should be kept at a higher pressure than in adjacent areas and corridors, because this positive pressure stops the flow of air from lowest sterile areas into more sterile areas

[22]. Considering to ventilations many international scientific organizations advice " a minimum of 15 air exchanges per hour ". Specially the "Guidelines for environmental infection control in health-care facilities issued by the CDC [23] advice "a minimum of about 15 exchanges of filtered air per hour, three of which must be fresh air". "The ANSI/ASHRAE/ASHE Standard 170 (Ventilation of Health-care Facilities)" advices "a minimum of 20 air exchanges per hour and at least of 4 exchanges of outdoor air per hour in operating theater [24]" . Regarding the intrinsic (patient- related) risk factors (BMI body mass index >30, smoking, nutritional status, life style) [25], they are related to the resistance of body toward pathogens post operatively [26, 27]. It is commonly agreed that good control on patients' blood sugar is important in preventing wound infection [28]. Special transient organisms such as *S. aureus*, and coliforms are existing on the human skin ,they could infect the wound site due to bad hygiene[29]. In order to decrease the hazard of wound infection,

persistent and effective skin sterilization, proper antimicrobial prophylaxis, careful operative technique should be used. The hair in the surgical incision area mustn't be removed except if removal is essential for the operation, if removed it must be done by clipper just before operation. Skin sterilization during operation is very important, "not only that the antibacterial solution used has broad spectrum properties, but also that it should be correctly applied" [30]. "Other strategies used to decrease bacterial passage into the surgical incision include the use of antiseptic impregnated adhesive drapes and/or novel cyanoacrylate-based skin sealants that are applied over the skin to prevent mobilization of residual skin flora including those set in hair follicles" [31].

Proteus species are a Gram -negative, facultative anaerobic pathogens. It has a urease activity and swarming motility. Proteus mirabilis is a reason of 90% of total Proteus infection in human being. It's usually distributed in water and soil [32]. It may also cause surgical site

infection, pneumonia, and sepsis particularly in hospitalized patient [32]. It can travel outward the surface of solid media by a kind of group motility named swarming. Proteus bacteria's are mostly associated with infections of the urinary tract, mostly in complicated or catheter-associated urinary tract infections [33].

## **AIM AND OBJECTIVE OF THE STUDY**

To assess the effect of different antibiotics administration and other factors on post cesarean wound infection among patients attended Al - Batool hospital in Mosul city.

## **PATIENTS AND METHODS**

### **Study design**

A prospective cohort study

### **Study population**

This is a prospective cohort study carried out in AL-Batool hospital in Mosul city, we select a low risk elective cesarean section operations to exclude labor related risk factors of infection, to find a real predisposing factors of wound infection and microbiological profile, Our research involved 150 women who admitted to the surgical

ward for elective cesarean section in Al-Batool hospital Mosul, Iraq, during the 6 months period from (1\12\2019\_1\6\2020) ,100 patients received preoperative cefotaxime 1gm IV.( half hour before surgery) ,we divided into 2groups group 1 received single dose, group2 received multiple dose (1st dose half hour before operation 2nd dose 12 hour after 1st dose then oral cefexim 400mg daily 5days post operation). last 50 patients Group3 received post-operative cefotaxime (without pre-operative dose)1gm every 12hours IV. 2days then start oral cefexim(3rd generation cephalosporin) 400mg daily for five days .Each patient in the study was observed for sign of wound infection for 30days post operation, we compare between three groups to find the effect and role of antibiotics administration in prevention of SSI. The demographic documents of the patients, diagnostic criteria and other criteria including associated risks factors (i.e. Obesity, anemia ,smoking, PET.), the duration of surgery, use of prophylactic antibiotics, clinical assessment of

wound (it consider infected if there is redness or purulent discharge , swelling and fever), and laboratory findings documented on a data sheet. According to WHO recommendation good ANC defined as patients has more than 5 visits, medium ANC between (3-5) visits, un-booked (Bad) ANC those who seeking medical advice during last month of pregnancy. Socioeconomic status was broken into 3 levels (high, middle and low), it is commonly theorized as a combination of economic, social and work status measured by income, education &occupation respectively. "Obesity prior to pregnancy as categorized by the WHO BMI classification system", "BMI(25-30)kg/m<sup>2</sup> over weight ,BMI(30-35)Obese class 1,BMI(35-40)Obese class2, BMI(>40)obese class3)".The inclusion criteria were full term pregnant women with elective cesarean section operated upon at AL-Batool hospital. Exclusion criteria: emergency cesarean section, preterm pregnant women, patients allergic to cefotaxime, those operated outside AL-Batool hospital ,surgeries lasting more

than 2.5 hours, patients suffering from diabetes mellitus ,patients who died during or after operation within 30days of surgery.

### **Sample collection**

Swabs are taken in lab. by bacteriologist with sterilized cotton swab dipped with sterilized buffered transport medium then a quarter sized area is wiped in a circular motion, the swab is putted in a vial enclosing (2 ml) of the transport media, then transferred to the microbiologist then plated 2 hours, and then plated into 5% blood agar and selective media for separation of Gm. positive cocci, Gram-negative rods.

### **Examination of specimens**

The swabs are used to make direct smears they stained by Gram stain for bacterial analysis. Plates are incubated at 37°C for 48 hours. Microorganisms are recognized by standard laboratory ways .the antibiotic's sensitivity is complete by diffusion disk test made for all the isolates with the technique suggested in CLSI "clinical and laboratory standard institute".Antibiotic disks are realistic to every plate

.Afterwards incubated at 37C° for 24 hours, the inhibition zone size is determined .The patients receive the appropriate antibiotics after that.

### **RESULTS**

The total (150) cases elective caesarean sections were followed-up for 30 postoperative days. First 50 patients were randomized to (group1), 2<sup>nd</sup> fifty (group2), last fifty (group 3) according to route of antibiotic administration as mentioned above. The demographic data for group1 were compared with group2 the result of the present study suggest no significant differences in wound infection between two groups (5% in both groups), whereas high rate of surgical site infection happened in group 3 who received multiple doses of post-operative antibiotic only without preoperative dose (20% of wound infection),with statistically significant p-value (0.014) as show in Fig.(1).So administering multiple doses of antibiotics post cesarean section did not reduce the risk of post cesarean infection, the characteristics of the study sampled women is shown in

Table (1) Obesity before pregnancy (as categorized by WHO .BMI classification system) show a statistically significant factor for wound infection P-value( 0.001),whereas age, operative time, residence (urban or rural) ,ANC have not statistically significant factors(according to WHO recommendation, minimal antenatal care less than 3visits in whole pregnancy, moderate antenatal care (3-5) visits, and good ANC more than 5visits to health centers during pregnancy) . The operative staff information in the study sampled groups are shown in table (2) including the grade of surgeon, no .of staff in

operating theater and duration of surgery have not statistically significant factors in wound infection. Maternal risk factors of SSI showed in table (3); anemia, PET, UTI, number of previous cesarean section were not statistically associated with wound infection, Analysis of the results demonstrated two types of pathogens were identified in culture results of the infected wounds, Staphylococcus 17/20 (85%) and proteus3/20 (15%).The incidence rate of surgical site infections after surgery was 20\150 (13.3%) and no. of the superficial infections were 17/20 (85%), whereas no. of deep infections 3/20 (15%).

**Table (1): Characteristics of the study sampled women.**

<b>Parameters</b>	<b>Group I Mean ± SD</b>	<b>Group II Mean ± SD</b>	<b>Group III Mean ± SD</b>	<b>P-value*</b>
<b>No. of women</b>	<b>50</b>	<b>50</b>	<b>50</b>	---
<b>Age (years)</b>	28.0 ± 4.4 <sup>A</sup>	26.9 ± 4.8 <sup>A</sup>	26.6 ± 4.4 <sup>A</sup>	0.269
<b>BMI (kg/m<sup>2</sup>)</b>	29.5 ± 2.1 <sup>A</sup>	28.6 ± 4.8 <sup>AB</sup>	27.9 ± 1.9 <sup>B</sup>	<b>0.001</b>
<b>Operative time (min)</b>	34.0 ± 5.9 <sup>A</sup>	32.3 ± 9.9 <sup>A</sup>	31.5 ± 3.1 <sup>A</sup>	0.181
<b>Time of antibiotics prior to surgery</b>	17.4 ± 5.2	17.0 ± 6.3	---	0.178

(min)				
	No. (%)	No. (%)	No. (%)	---
<b>Residence</b>				
<b>Urban</b>	25 (50.0)	30 (60.0)	29 (58.0)	0.567
<b>Rural</b>	25 (50.0)	20 (40.0)	21 (42.0)	
<b>Antenatal care</b>				
<b>Un booked</b>	7 (14.0)	1 (2.0)	4 (8.0)	0.088
<b>Minimal</b>	13 (26.0)	6 (12.0)	14 (28.0)	
<b>Moderate</b>	22 (44.0)	33 (66.0)	23 (46.0)	
<b>Good</b>	8 (16.0)	10 (20.0)	9 (18.0)	

\* One-way ANOVA-test was used for comparison in quantities variables whereas for cat goral data Chi-square test was used.

**Table (2): The operative staff information**

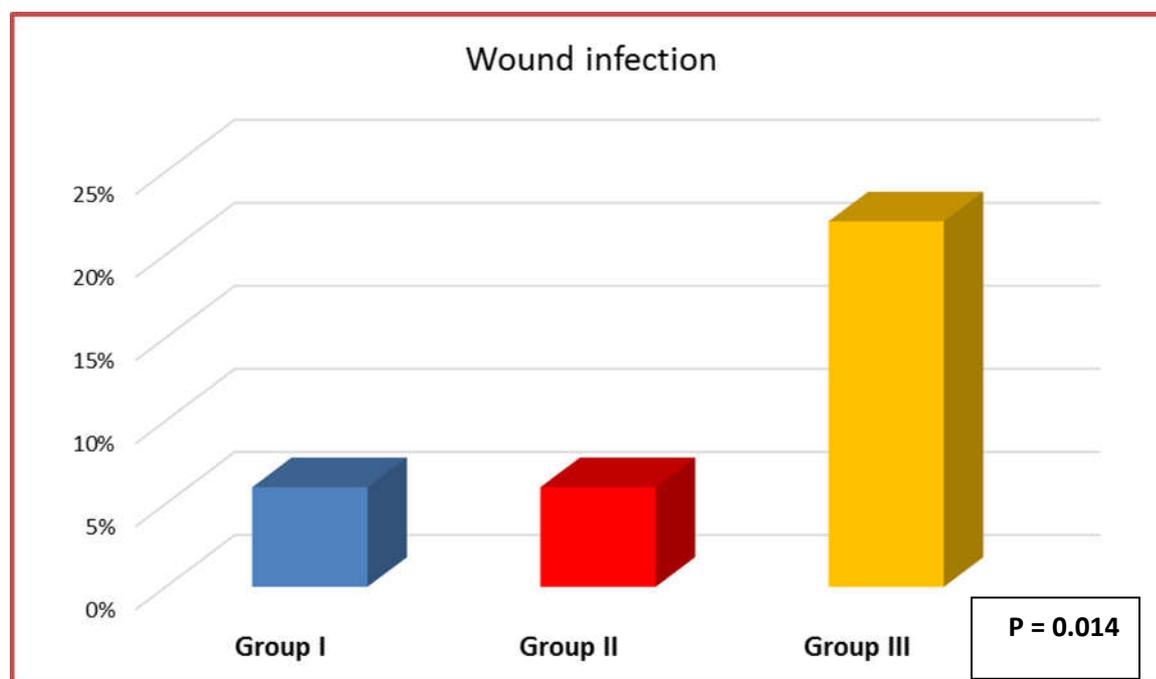
Items	Group I		Group II		Group III		P-value*
	No.	%	No.	%	No.	%	
<b>Grade of surgeon</b>							
<b>Licensed</b>	30	60.0	29	58.0	32	64.0	0.822
<b>Resident</b>	20	40.0	21	42.0	18	36.0	
<b>No. of staff</b>							
<b>≤ 6</b>	12	24.0	24	48.0	18	36.0	0.057
<b>&gt; 6</b>	38	76.0	26	52.0	32	64.0	

\* Chi-square test was applied.

**Table (3): Maternal risk factors of SSI among cesarean section cases and control**

Parameters	Group I No. (%)	Group II No. (%)	Group III No. (%)	P-value*
Anemia	4 (8.0)	3 (6.0)	8 (16.0)	0.211
Obesity	22 (44.0)	7 (14.0)	9 (18.0)	<b>0.001</b>
UTI	2 (4.0)	4 (8.0)	4 (8.0)	0.624
PET	8 (16.0)	2 (4.0)	4 (8.0)	0.111
Previous scar	35 (70.0)	25 (50.0)	26 (52.0)	0.084

\* Chi-square test was applied



**Figure (1): Percentages of wound infection in cesarean section sampled women.**

## DESCUSSION

SSI is the commonest nosocomial infection after surgery, in this research the rate of SSI after cesarean operations was 5% in group 1&2( patients received

pre- operative prophylactic antibiotic) and 20% in group3 patients who don't received pre- operative antibiotics with P-value 0.014 as show in figure (1),it is within the range of reported ratio of

caesarean SSIs globally; the global ratio differ between low ratios of infection of 2.1% in the United States<sup>[34]</sup> , high-level rates of 16% and 23.5% in Irish and Brazilian studies, in that order <sup>[35,36]</sup> , and to higher rate 48% in a resource-restricted Tanzanian hospital<sup>[37]</sup>.It is comforting result especially that we are working in hospital with lowly system of hospitals (shortage of tools and materials essential to keep exact guidelines for asepsis),although we select a low risk elective cesarean section operations and exclude labor related risk factors of infection .

This research is in contract with a recent research conducted at Jordanian university hospital <sup>[38]</sup> showed that a main problem is in the method of antibiotic prophylaxis. In the current results, a significant modification to the surgical antibiotic prophylaxis management should limit the usage of non-indicated postoperative antibiotic treatment, because we have not noticed a difference in the ratio of SSIs between women who used a single dose of preoperative antibiotics and those who continued to receive antibiotics after

operation (incidence of wound infection 5% in both groups as show in figure1). This recommendation is strengthened by the ASHP (American Society of Health System Pharmacists)guidelines and by several authors who have proven that “using a single prophylactic dose (regardless of the type of antibiotic) was at least as effective, if not superior, to administering multiple doses in falling infectious caesarean complications”. Use and misuse of antibiotic not only affect individual patient but also affect hospitals and community environment. Balanced use of antibiotics limit the appearance and spread of bacterial resistance and limit long term effects on new born as a result of changes in gut micro biome.

At Jordanian university hospital study <sup>[38]</sup> obese women, organize a special subpopulation that needs wide study. Jordanian teaching hospital outcomes indicated a 4-fold surge in the hazard of SSIs in obese patients (BMI  $\geq 36$ );this finding was in agreement with the results recounted in our study, the BMI significantly associated with post cesarean wound infection P-value 0.001

as show in table (1&3), the association between obesity and an high risk of wound infection could be clarified by a low tissue concentration of the drugs in obese women, because of high volume of distribution and the clearance , requiring an increase in the antibiotic dosage. Anemia was used as a replacement indicator for malnutrition. A cut-off of hemoglobin less than 10 mg/dl was taken to describe anemia, low hemoglobin may cause hypoxia and damage in surgical and tissue oxygenation then reduced healing to increase wound infection although anemia not significantly associated with SSI in this study. Table (3)

Like other studies, staphylococcal bacteria were the dominate kind of infecting pathogens, in this study it produce 85%, in the result reported from India <sup>[39]</sup> the most largest isolate was Staphylococcus (37%). also in the Taif, Saudi Arabia study <sup>[40]</sup> the greatest commonly isolated bacteria were Staphylococcus species, which can be clarified by its presence in the skin as normal flora and can thus go into deep site during surgery. Proteus species

causes 15% of SSI in current study, this may be due to sharing single WC by the patients pre and post operatively in Al-Batool caravan hospital, or due to use catheter pre-operatively, This difference in the spreading of surgical site infection bacteria may be due to difference in common nosocomial pathogens occupant, difference in rule of infection control and prevention between hospitals and countries.

## CONCLUSION

Surgical site infection after cesarean section is an important cause of maternal morbidity and cause huge impact on health care system .This study confirm that preoperative antibiotic prophylaxis reduce wound infection in addition to its cost effective value .In this study the key risk factor was high body mass index so those patients need special pre, intra and postoperative care .The major pathogen was staph. aureus which need recognition of patient related factors and follow proper intraoperative aseptic measures.

## References

- [1] Solomkin J, Gastmeier P, Bischoff P, Latif A, No index entries found. Berenholtz S, Egger M, Allegranzi B. WHO global guidelines for the prevention of surgical site infection Geneva. Switzerland. *Lancet Infect Dis.* 2017; 17(3):262–4. [https://doi.org/10.1016/S1473-3099\(17\)30081-6](https://doi.org/10.1016/S1473-3099(17)30081-6).
- [2] WHO Library Cataloguing-in-Publication Data. 2016. WHO. SUSP project in African surgical departments; 2014.
- [3] Angie Sway1Peter Nthumba2 Joseph Solomkin3 Giorgio Tarchini4 Ronald Gibbs5 Yanhan Ren6Anthony Wanyoro7,Burden of surgical site infection following cesarean section in sub-Saharan Africa: a narrative review, *Dove Medical Press journal: International Journal of Women's Health* downloaded from <https://www.dovepress.com/> by 178.171.89.103 on 09-May-2019 For personal use only.,
- [4] Say L, Chou D, Gemmill A, Tuncalp O, Moller AB, Daniels J, et al. Global causes of maternal death: a WHO systematic analysis. *The Lancet Global health.* 2014; 2 (6):e323-33
- [5] Khan KS, Wojdyla D, Say L, Gulmezoglu AM, Van Look PF. WHO analysis of causes of maternal death: a systematic review. *Lancet (London, England).* 2006; 367(9516):1066-74.
- [6] Black RE, Cousens S, Johnson HL, Lawn JE, Rudan I, Bassani DG, et al. Global, regional, and national causes of child mortality in 2008: a systematic analysis. *Lancet (London, England).* 2010; 375 (9730):1969-87
- [7] Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: When? Where? Why? *The Lancet.* 365(9462):891-900.
- [8] Leth RA, Moller JK, Thomsen RW, Uldbjerg N, Norgaard M (2009) Risk of selected postpartum infections after cesarean section compared with vaginal birth: a five-year cohort study of 32,468 women. [Crossref] *Acta Obstet. Gynecol. Scand.* 2009 Sep; 88(9):976-83. doi: 10.1080/00016340903147405
- [9] van Dillen J, Zwart J, Schutte J, van Roosmalen J, Maternal sepsis: epidemiology, etiology and outcome. *Curr Opin Infect Dis.* 2010 Jun; 23(3):249-54. doi: 10.1097/QCO.0b013e328339257c
- [10] Horan TC, Culver DH ,Gaynes RP, Jarvis WR ,Edwards JR ,Reid CR . Nosocomial infection in surgical patients in the United States, January 1986-June 1992. *Infect Control Hosp. Epidemiol.* 1993 Feb;14 (2):73-80. doi: 10.1086/646686
- [11] McGowan JE Jr.Cost and benefit of perioperative antimicrobial prophylaxis: methods for economic analysis. *Rev Infect Dis.* Sep-Oct 1991;13 Suppl 10:S879-89
- [12] Burke JF. The effective period of preventive antibiotic action in the experimental incision and dermal lesions.

*Surgery*. 1961 Jul;50:161-8

[13] WHO recommendation on routine antibiotic prophylaxis for women undergoing elective or emergency caesarean section. *Maternal and child survival program*. 01 September 2015.

[14] Weinberg M, Fuentes JM, Ruiz AI (2001) Reducing infections among women undergoing cesarean section in Colombia by means of continuous quality improvement methods. *Arch Intern Med*. 2001 Oct 22;161(19):2357-65. doi: 10.1001/archinte.161.19.2357.

[15] Mangram AJ, Horan TC, Pearson ML, et al. Guideline for prevention of surgical site infection 1999. *Am J Infect Control*. 1999 Apr;27(2):97-132; quiz 133-4; discussion 96

[16] Dharan S, Pittet D. Environmental controls in operating theatres. *J. Hosp. Infect* .society. volume 51 issue 2, P79-84, June 01, 2002

[17] Humphreys H. Preventing surgical site infection. Where now? *J Hosp Infect*. 2009 Dec;73(4):316-22. doi: 10.1016/j.jhin.2009.03.028

[18] G. Dock Dockery, *Lower Extremity Soft Tissue & Cutaneous Plastic Surgery Book* • Second Edition • 2012

[19] World Health Organization (WHO), author. WHO guidelines on hand hygiene in health care: a Summary. *First global patient safety challenge. Clean care is safe care*. Geneva: WHO; 2009.

[20] Osler T (1995) Antiseptics in surgery. In: Fry DE (Ed.) *Surgical infections* (1stedn). New York: Little, Brown, & Co. 119-125.

[21] Gastmeier P, Brauer H, Forster D, Dietz E, Daschner F, et al. A quality management project in 8 selected hospitals to reduce nosocomial infections: a prospective, controlled study. *Infection Control & Hospital Epidemiology*, Volume 23, Issue 2, February 2002, pp. 91 - 97

[22] Wenzel RP. Minimizing surgical-site infections. *N Engl J Med*. 2010 Jan 7;362(1):75-7. doi: 10.1056/NEJMe0908753.

[23] Schulster L, Chinn RY CDC, author; HICPAC, author. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) *MMWR Recomm Rep*. 2003 Jun 6;52(RR-10):1-42.

[24] ANSI/ASHRAE/ASHE, author. Ventilation of Health Care Facilities. *ASHRAE Standards Committee* on June 21, 2008. 170-2008

[25] Tran TS, Jamulitrat S, Chongsuvivatwong V, et al. Risk factors for post cesarean surgical site infection. *Obstet. Gynecol*. 2000 Mar;95(3):367-71. doi: 10.1016/s0029-7844(99)00540-2

[26] Gibbons C, Bruce J, Carpenter J, Wilson AP, Wilson J, Pearson A, et al. Identification of risk factors by systematic review and development of risk adjusted models for

surgical site infection. *Health Technol. Assess.* 2011 Sep;15(30):1-156, iii-iv. doi: 10.3310/hta15300

[27] van Walraven C, Musselman R. The surgical site infection risk score (SSIRS): a model to predict the risk of surgical site infections.. *PLoS One.* 2013 Jun 27;8(6):e67167. doi: 10.1371/journal.pone.0067167. Print 2013.

[28] Sehgal R, Berg A, Figueroa R, et al. Risk factors for surgical site infections after colorectal resection in diabetic patients. *J Am Coll Surg.* 2011 Jan;212(1):29-34. doi: 10.1016/j.jamcollsurg.2010.09.011. Epub 2010 Nov 30.

[29] Howard RJ, Lee JT .Surgical wound infections: epidemiology, surveillance, and clinical management .East Norwalk, CT: *Allyn & Bacon*; 1995. pp. 401–412. [Google Scholar]

[30] Kagansky N, Berner Y, Koren-Morag N, Perelman L, Knobler H, et al. (2005) Poor nutritional habits are predictors of poor outcome in very old hospitalized patients. *The American Journal of Clinical Nutrition*, Volume 82, Issue 4, October 2005, Pages 784–791

[31] Hussey LC, Leeper B, Hynan LS (1998) Development of the Sternal Wound Infection Prediction Scale. *Heart Lung.* Sep-Oct 1998;27(5):326-36. doi: 10.1016/s0147-9563(98)90053-x

[32] BioMedHTC Archived 26 September

2009.

[33] Chen, Chi-Yu; Chen, Yen-Hsu; Lu, Po-Liang; Lin, Wei-Ru; Chen, Tun-Chieh; Lin, Chun-Yu (2012). "Proteus mirabilis urinary tract infection and bacteremia: Risk factors, clinical presentation, and outcomes". *Journal of Microbiology, Immunology and Infection* .Volume 45, Issue 3, June 2012, Pages 228-236

[34] Hickson , E., Harris, J. & Brett, D. A Journey to Zero: Reduction of Post-Operative Cesarean Surgical Site Infections over a Five-Year Period. *Surg. Infect (Larchmt)*. 2015 Apr 1; 16(2): 174–177.doi: 10.1089/sur.2014.145

[35] Del Monte, M. C. C. & Pinto Neto, A. M. Post discharge surveillance following cesarean section: The incidence of surgical site infection and associated factors. *Am J Infect Control.* 2010 Aug;38(6):467-72. doi: 10.1016/j.ajic.2009.10.008. Epub 2010 Mar 12

[36] Corcoran, S. et al. Surgical site infection after cesarean section: Implementing 3 changes to improve the quality of patient care. *Am J Infect Control.* 2013 Dec; 41(12):1258-63. doi: 10.1016/j.ajic.2013.04.020. Epub 2013 Aug 9

[37] De Nardo, P. et al. Post-caesarean section surgical site infections at a Tanzanian tertiary hospital: a prospective observational study. *J Hosp. Infect.* 2016 Aug;93(4):355-9. doi: 10.1016/j.jhin.2016.02.021

[38] Mariam Hantash Abdel Jalil1, Khawla Abu Hammour1, Mervat Alsous2, Wedad

Awad1, Rand Hadadden1, Faris Bakri3,4 & Kamil Fram5. Surgical site infections following caesarean operations at a Jordanian teaching hospital: Frequency and implicated factors. *Scientific Reports*. 2017 Sep 22;7(1):12210. doi: 10.1038/s41598-017-12431-2

[39] Al-Mulhim FA, Baragbah MA, Sadat-Ali M, Alomran AS, Azam MQ (2014) Prevalence of surgical site infection in orthopedic surgery: a 5-year analysis. *International Journal of Surgery*. May-Jun 2014;99(3):264-8. doi: 10.9738/INTSURG-D-13-00251.1.

[40] Khadijah Yousef AL-Aali. Evaluation of Surveillance for Surgical Site Infections and Drug Susceptibility Patterns, Taif, Saudi Arabia. *Annals of Clinical and Laboratory Research*. 2016, 4:2