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ORIGINAL ARTICLE

Cesarean Surgical Site Bacterial Infection

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ABSTRACT

Background: *The high incidence rate of surgical site infections (SSIs) highlights the need for prioritizing patient demographics, procedures, and surgical factors to be controlled by programs to reduce the infection rate.* ***Objectives:*** *This study detects the prevalence, causative organisms, and explores the relation between the air contamination in the operative theater and the SSI.* ***Methodology:*** *Cross sectional one-year study from January 2019. One hundred and seventy-two women were involved underwent CD. Intraoperative air sampling was performed during 83 surgery and bacterial air contamination were identified. Follow up for the patients 30 days after surgery was done to detect hospital acquired and community acquired SSI. Two samples were taken from the patient wound with SSI. Microbiological identification and antibiotics susceptibility testing for the isolates were done. The clonal relationships between the same species of isolates from air and wound were studied by evaluating the genomic DNA with PFGE analysis.* ***Results:*** *14.5 % was the total SSI rate; 6.4%, developed hospital acquired SSI and 8.1% developed community acquired SSI. Most SSI cases yielded growth of Staphylococcus spp. (39, 3%) followed by Pseudomonas spp. (32.1%) and finally Escherichia coli (28.6%). Six wound isolates belonged to two air isolates pulsotype and the rest of isolates showed unsimilar pulsotype of interest.* ***Conclusions:*** *air contamination one of the causes of SSI and measures are recommended to reduce its incidence, including the implementation of infection prevention practices and the administration of antibiotic prophylaxis with strict surgical techniques. Most common cause of community acquired SSI was bad hygiene.*

INTRODUCTION

The incidence of cesarean deliveries (CD) had risen dramatically over the last few decades and may be complicated by surgical site infection (SSI) especially in low- and middle developing countries. Wound infection may be nosocomial if acquired from the hospital or community acquired if appears after hospital discharge within the follow-up days. The Centers for Disease Control and Prevention defines SSI as an infection occurring within 30 days from the operative procedure in the part of the body where the surgery took place[1,2].

The rate of SSI ranges from 3% to 15% worldwide and they account for about 24% of all nosocomial infections[3,4].

The problem is aggravated in developing countries where resources are scarce, and staffs are always in short supply. The risk for developing SSI has significantly decreased in the last three decades, mainly owing to improvements in hygiene conditions, antibiotic prophylaxis, sterile procedures, and other practices[5].

Despite this decrease, the occurrence of SSI is expected to increase as a result of the continuous rise in the incidence of CD. Post-operative infection make an emotional and physical stress on the mother and may increase maternal morbidity and mortality, also it makes a financial burden on the health care system as it was reported as the most frequent cause of readmissions after surgery and account for $3.2 billion attributable cost per year with estimated additional 11 days of prolonged hospital stay[6,7].

Many factors have been identified as a risk of SSIs, these factors fall into two main categories intrinsic as age, obesity, smoking, pregestational diabetes mellitus and chronic diseases or extrinsic factors as site and procedure-related factors[8]. Sources of microorganisms are the patient's endogenous flora, staff or the hospital environment[9].

Exogenous microorganisms are directed by airborne particles and directly settling on the wound in 30%, so air quality in the operative theater is a major risk factor for post CD SSI[10]. This study detected the prevalence, causative organisms, and explored the relation between the air contamination in the hospital words and the surgical site infection.

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METHODOLOGY

Patients

This prospective study was conducted from the beginning of 2019 to the beginning of 2020. One hundred seventy-two women were involved in this study; admitted to the Obstetric Department of Mansoura University Hospital, attended private Obstetric Outpatient Clinics for CD (emergency or elective), or attended private Dermatology Outpatient Clinic for incisional site care. Consent was taken from each subject. The hospital has a central sterile supply department and a regularly updated disinfection policy. One-gram Unasyn combined with one-gram metronidazole were given one hour before surgery as a prophylaxis. Follow up was done within 30 days after CD. Post cesarean SSI was identified by the presence of purulent discharge with erythematous cellulitis, induration or pain. The study was approved by institutional review board of Mansoura faculty of medicine, Mansoura University.

Air sampling form the operation room

Intraoperative air sampling was performed as described by Pasquarella, blood agar Petri dishes were transported immediately to the laboratory, after incubation, microbiological results were expressed as CFU/m3 [11].

Samples from patients

Two samples were taken from the patient. First was swab from purulent exudates for aerobic culture on blood and MacConkey's agar plates (Oxoid, UK). The second was aspirate on sodium thioglycolate broth (Oxoid, UK) for anaerobic cultures.

Antimicrobial susceptibility

Penicillins, cephalosporins and macrolides are compatible with breastfeeding. Antibiotic susceptibilities were done by using agar screen plates on Müller-Hinton agar (Oxoid, UK). Plates were incubated and zone diameters were measured according to the CLSI[12].

Pulsed field gel electrophoresis typing (PFGE)

The clonal relationships between the related isolates from air and wound were studied by evaluating the genomic DNA with PFGE analysis that was performed according to the CDC protocol[13]. The DNA banding patterns were visualized under UV light after staining with ethidium bromide (0.5 mg/mL). The similarities between the isolates were determined by visual comparison of the isolates band patterns[14].

Statistical analysis

Data were analyzed using SPSS, version 16.0 (IBM, Chicago, USA). Chi-squared tests were used to detect significant differences. Quantitative data were presented as means and standard deviation and described as numbers and percentages. P-value <0.05 was considered as statistically significant.

RESULTS

Prevalence of hospital acquired, and community acquired SSI

The total SSI rate was 14.5 %. Eleven patients (6.4%) developed hospital acquired SSI and fourteen patients (8.1%) developed community acquired SSI.

Demographic data and factors reduced the risk of SSI

The mean age ± SD of the patients was 28.3 ± 7.99 years (range from 19 to 42 years). The average length of stay was 4.2 ± 2.4 days. Factors reduced the risk of SSI included: age less than 35 years (OR 32.45; and P < 0.0001), elective CS (OR 37.63; and P = 0.0005) duration of the operation less than 1 hour (OR 92.08; and P < 0.0001) and proper use of antibiotics (OR 0.0186; and P < 0.0001). Previous cesarean section was not associated with increased risk of SSI, as shown in table1.

Table 1: Clinical and socio-demographic characteristics of patients with SSI following cesarean section

Characters	Positive SSI No.= 20	Negative SSI No.= 152	*OR* 95 % CI	*P value*
Age				
≤35	2	119	32.45	P < 0.0001
>35	18	33	7.16 to 147.05	
Previous CS				
Yes	12	98	0.83	P = 0.7
No	8	54	0.3183 to 2.15	
Type CS				
Emergency	19	51	37.63	P = 0.0005
Elective	1	101	4.89 to 289.06	
Operation time				
≤60 minutes	1	126	92.08	P < 0.0001
>60 minutes	19	26	11.79 to 718.66	
Antibiotic prophylaxis				
Yes	8	148	0.0186	P < 0.0001
No / or not completed	12	4	0.01 to 0.07	
Hospital stay				
≤7 days	14	143	0.1469	P = 0.0013
> 7 days	6	9	0.05 to 0.47	
Socioeconomic standar				
Low	18	86	6.91	P = 0.011
Medium	2	66	1.55 to 30.82	

Isolated bacteria from air and from infected cesarean section wound

A total of 709 organisms were isolated by air sampler from the operative theater during operation and included; Bacillus spp. accounted for 43%, nonhemolytic Staphylococcus 33%, hemolytic Staphylococcus 16.5%, *Enterococcus* sp. 4.7%, and *Klebsiella* sp. 2.8%, as shown in table2 and fig 1.

All anaerobic cultures were negative, on the other hand aerobic cultures reported 28 isolates from 25 infected wound sample, 3 samples had mixed infection, and included; *S. aureus* and *pseudomaonas*, *coagulase negative Staphylococci (CONS)* and *pseudomaonas*, *S. aureus* and *E coli*. Most SSI cases yielded growth of *Staphylococcus spp.* (39,3%) followed by *Pseudomonas spp.* (32.1%) *and finally Escherichia coli* (28.6%), as shown in table 3 and fig 1.

Table 2: Isolated bacteria from air samples

Isolated bacteria	**BC (cfu/m3)**	**%**
Bacillus spp.	305	43
Staphylococci spp. (Nonhemolytic)	234	33
Staphylococci spp. (Hemolytic)	117	16.5
Enterococcus spp.	33	4.7
Klebsiella spp.	20	2.8
Total	709	100

Table 3: Isolated bacteria from wound swabs or aspirates

Bacterial types	**No.**	**%**
Staphylococcus spp. ▪ ***S. aureus (7)*** ▪ ***Coagulase negative staph (4)***	11	39.3
Pseudomonas spp.	9	32.1
E. coli	8	28.6
Total	28	100%

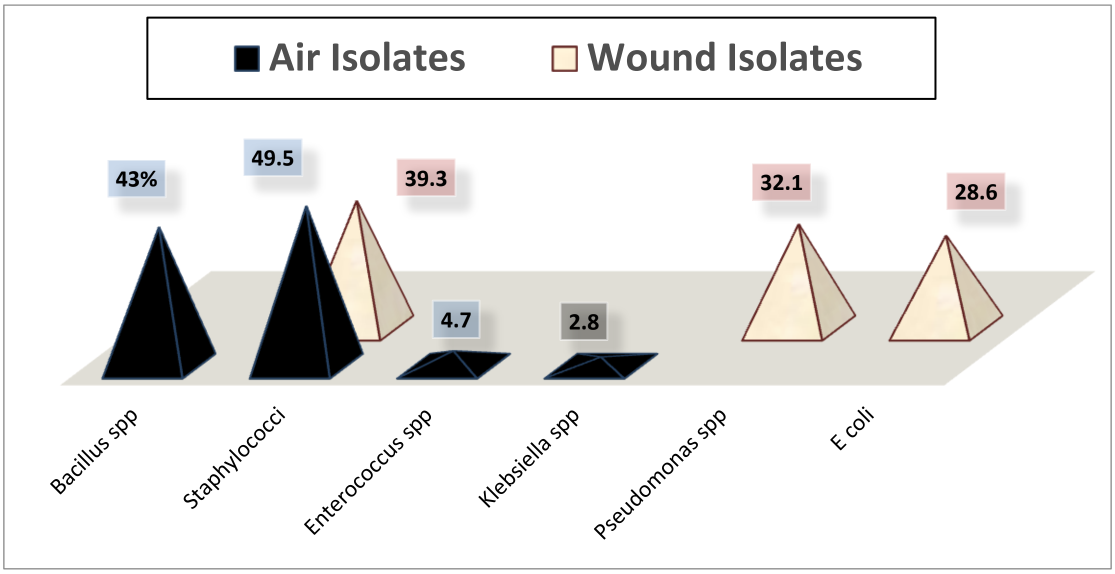

Fig. 1: Isolated bacteria from air and from infected cesarean section wounds

Antimicrobial susceptibility testing

Antibiotic sensitivities were reported for all the isolate from CS wound infection. The Staphylococci spp. showed resistance of *S. aureus* and *CONS*, respectively as follows; 20% and 35% for Oxacillin, 20% and 35% for Cefoxitin, 15% and 10% for Erythromycin, 5% for Gentamycin, and no isolates were resistant to Vancomycin. Regarding *Pseudomonas spp*., 33.3% were resistant to Piperacillin, Piperacillin-tazobactam, and Ceftazidime; 16.7% of strains were resistant to Amikacin, Imipenem, and Aztreonam; and no isolates were Colistin resistant. Regarding *E. coli*, 100% were resistant to Ampicillin; 50% were resistant to Amoxicillin- clavulanate, cefotaxime, cefepime, ceftriaxone, and ceftazidime; 25% were resistant to gentamycin, aztreonam, and Imipenem; and no isolates were resistant to Colistin. Antibiograms for the air isolates were done for typing. Related isolates from air and from infected wound were grouped together for further typing by PFEG.

PFGE

Five *Staphylococcus* air isolates were related to 11 *Staphylococcus* isolates from SSI by the surgery day and antibiotic typing, these 16 isolates were subjected for PFGE typing. The restriction endonuclease patterns obtained with the PFGE following the SmaI treatment showed 10 different patterns. Five isolates belonged to the same pulsotype (one air and four SSI), another three carried similar pulsotypes (one air and two SSI), and the rest five isolates showed unsimilar pulsotype of interest, as shown in Figure 2.

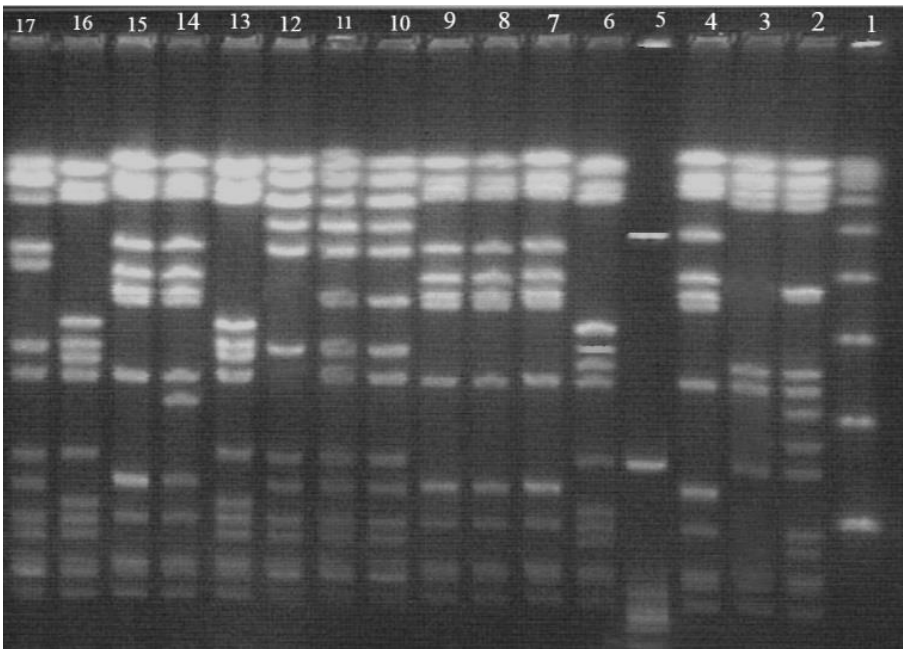

Fig. 2: SmaI restriction endonuclease patterns obtained by PFGE Lane 1, marker; lanes 2, 3, 4, 5, and 6 were DNA for isolated staphylococcus strains from air and the rest were DNA of wound isolates. Lanes 4, 7, 8, 9, 15 strains showed the same pulsotype and lane 6, 13, 16 strains showed the same pulsotype; other 5 strains in other lanes showed different pulsotypes.

DISCUSSION

In this cross-sectional study, the incidence of post section SSI was 14.5 %; hospital acquired infection was 6.4%, less than the community acquired infection which was accounted for 8.1%. These findings supported the previous report which mentioned that SSI is one of the most common complications following cesarean section, and has an incidence up to16%[15, 16]. Higher percentage was reported, 42.1 and 46.1%, for women delivered by primary and secondary caesarean section, respectively[17]. The variation of incidence between studies may be due to changes in the risk factors for each case. In this study factors reduced the risk of SSI included: age less than 35 years, elective CS, duration of the operation less than 1 hour, and proper use of antibiotics which were in agreement with many studies[18,19,20,21]. However, in the current study previous cesarean section was not associated with increased risk of SSI, which wasn't true in Chaim study[22].

In the current study most SSI cases yielded growth of Staphylococcus spp. (39,3%) followed by Pseudomonas spp. and Escherichia coli which was parallel with Scheck study[23], on the other hand, Korol reported that Staphylococcus aureus and E.coli were the most common organisms isolated in SSI, but reported a lower incidence 15%–20%[24]. SSI in relation to cesarean delivery has a distinctive microbial source of pathogens composed of both skin and vaginal origin and this may explain that Staphylococcus spp are the commonest pathogen causing SSI [25]. All patients in the current study received antibiotic therapy for 10 days according to the culture sensitivity test and they get well later with no more complication.

In the existing study four wound isolates belonged to the same pulsotype of one air strain, and another two wound isolates were the same as one air strain pulsotype, which indicates that air pathogens were implanted in the wound and cause SSI. The air in OTs may be a reservoir for bacteria and can be transmitted via dust particles, skin squamous particles, or small droplets. There is a significant relation between bacterial count in the air of OTs and the risk of SSIs; minimal risk when bacterial count is ≤180/m3, and a higher risk counts when bacterial count is ≥700/m3[26]. Although, our yield considered as a low risk count a similar type of bacteria were present as air contaminant caused surgical site infection post section.

CONCLUSIONS

Air contamination one of the causes of SSI and measures are recommended to reduce its incidence, including the implementation of infection prevention practices and the administration of antibiotic prophylaxis with strict surgical techniques. Most common cause of community acquired SSI was bad hygiene.

Conflicts of interest:

The authors declare that they have no financial or non financial conflicts of interest related to the work done in the manuscript.

- Each author listed in the manuscript had seen and approved the submission of this version of the manuscript and takes full responsibility for it.
- This article had not been published anywhere and is not currently under consideration by another journal or a publisher.

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