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Major Article

Algerian postcaesarean surgical site infections: A cross-sectional investigation of the epidemiology, bacteriology, and antibiotic resistance profile

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Key Words:
Cesarean section
ESBL
vanA gene

Background: Surgical site infections (SSIs) are one of the most common health care–associated infections in low and middle-income countries. The aims of this cross-sectional descriptive study were to estimate the frequency of postcaesarean infection with associated clinical characteristics and the antibiotic resistance profile of bacterial isolates.

Methods: Patients who underwent a cesarean section at the obstetrics and gynecology department of the hospital in Annaba, Algeria were included. Each woman was followed postoperatively for 30 days and sociodemographic data were collected. Culture-based microbiological methods were used to identify the causative bacteria and determine their antibiotic resistance phenotype and molecular characterization.

Results: Among 1,810 patients, we recorded 36 (1.9%) SSIs. Most patients had undergone an emergency delivery (75%) and low educational level (72.2%). The most frequent maternal pathologies were Body Mass Index ≥ 30 (63.9%), scarred uteri (58.3%), anemia (55.6%), and an American Society of Anaesthesiologists score between II and III (33.3%). Of the 43 bacteria isolated, *Enterobacteriaceae* were the most frequent (62.8%), predominated by *Escherichia coli* strains (43.5%), a majority of which were extended-spectrum β-lactamases carriers (62.9%). Although gram-positive cocci were less frequent (37.2%), a majority of *Enterococcus faecalis* (56.2%) were observed and 2 strains of vancomycin-resistant *Enterococcus faecium* harboring the *vanA* gene were identified.

Conclusions: Extensive surveillance of at-risk populations should be integrated to prevent the occurrence of SSIs.

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BACKGROUND

Surgical site infections (SSIs) are ranked second among nosocomial infections and are estimated to affect 2 million people per year, with between 5% and 15% requiring hospitalization.[1] In high-income countries, SSI rates following gynecological surgery are reported to be similar to those for other surgical procedures.[2] In cesarean (CS) deliveries, the SSI rate is between 3% and 15% in the United States,[3,4] and a cumulative rate of 2.9% has been reported from 20 European Union countries.[5] CS section is the most common obstetric surgical procedure worldwide. Its global rates (including both emergency and elective) are ranging from 5% to 20% and are continuing to rise in both developed and developing countries.[6,7] In sub-Saharan Africa, where CS constitutes up to 80% of the surgical workload, high rates

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of SSIs after CS have been reported: 19% in Kenya,[8] 16.2% in Nigeria,[9] and 10.9% in Sierra Leone.[10] These infections are the underlying cause of 11% of maternal deaths and a quarter of newborn deaths, and multiple complications.[10] In Africa, the rate of postoperative infection remains high (between 15% and 25%) leading to an increased length of hospitalization, higher treatment costs, and a heavier workload for health care staff.[11]

To date, very few data are available on SSIs in Algeria. One study in 2015 reported an SSI rate of 5.4% in general surgery in northern Algeria.[12] Contamination of the surgical site can be caused either by exogenous microorganisms related to the environment or to contact with staff, or by endogenous microorganisms related to the commensal flora of the patient.[13] Despite the use of prophylactic antibiotics before and after surgery, in combination with other infection control measures, SSIs remain a significant risk for postoperative patients. Treatment based on empirical antibiotic therapy may select resistant mutants and lead to treatment failure in some cases.[14,15] The implementation of a program combining surveillance and the prevention of nosocomial infections has led to a reduction in the frequency of these infections in many countries, including Algeria.[12] To our knowledge, the present study is the first in Algeria to report the frequency and clinical characteristics of patients with SSIs after undergoing a CS section, as well as the microbiological profile of associated bacteria.

METHODS

Study design

A descriptive cross-sectional study with prospective data collection was conducted on women admitted between January 2020 and September 2021 in the obstetrics and gynecology department of the hospital.

Patient's characteristics

Patients admitted to the obstetrics and gynecology department who underwent a CS section were included in this study, as recommended by the US Center for Disease Control.[16] The surgical wound was inspected at the time of the first dressing and then daily until discharge. The patient was then followed for 30 days postoperatively. Case definitions and diagnostic criteria for SSIs were conducted if the patient had one or more of the following signs: purulent discharge, localized pain or tenderness, localized swelling, local erythema or warmth, whether or not associated with fever, and confirmed by isolation of a bacteria on pus cytobacteriological evaluation.

The inclusion criteria were all patients who underwent a CS section in the hospital and who presented with an SSI within 24 hours of the operation until 30 days after the operation, and who answered all questions in the survey form. Patients who had undergone a CS section outside the hospital were excluded from the study.

Patient preparation and prevention

All the operations followed the same strict hygiene protocol established by our hospital facility. This consisted of an antiseptic treatment with a vaginal pessary the day before the operation, extensive disinfection of the abdominal region with an antiseptic solution on the day of the operation, and again before entering the operating room. Moreover, the admission of first-generation antibiotic prophylaxis cephalosporin (cefalexin) 30 minutes before surgery. After the surgical procedure, preventive antibiotic therapy was systematically administered for 48 hours (cefalexin 1 g 4 times per day, metronidazole 500 mg twice a day, gentamicin 80 mg twice a day). The dressing was first checked 48 hours after the operation. After the first signs of infection, a combination of antibiotics is prescribed to patients according to availability (Table 2).

Data and sample collection

Data were collected from medical records including delivery and operating room records using a special proforma, and with the consent of each patient included in the study. Demographic, clinical, and obstetric characteristics of each case were recorded, including place of residence, age, antenatal care, antibiotic prophylaxis, parity, medical complications such as diabetes mellitus, hypertension and anemia, duration of the CS surgery, and length of hospital stay (Tables 1 and 2).

Isolates and identification

All pus samples were immediately transported to the laboratory for further processing. Each pus sample was first enriched on brain heart infusion broth (Condalab) for 24 hours at 37°C. The culture was then performed on MacConkey agar (Beckton Dickinson) and Columbia blood agar (bioMérieux) at the same time. Isolated bacterial strains were identified using matrix-assisted laser desorption-ionization mass spectrometry (MALDI-TOF-MS) (BrukerDaltonics)[17] at the Institut Hospitalo-Universitaire Méditerranée Infection in Marseille, France.

Antibiotic susceptibility testing

Antibiotic susceptibility testing was carried out on Mueller-Hinton agar (bioMérieux) using the standard disk diffusion method according to the European Committee on Antimicrobial Susceptibility Testing recommendations.[18] Three different panels of 16 antibiotic disks (i2a) were used for *Enterobacteriaceae, Enterococcus spp*, and *Staphylococcus spp* isolates, respectively (Fig 2). For vancomycin-resistant strains, minimum inhibitory concentrations of vancomycin were determined using the E-test method (bioMérieux) and interpreted in accordance with European Committee on Antimicrobial Susceptibility Testing guidelines.

Molecular characterization

All *Enterobacteriaceae* strains were tested for the presence of extended-spectrum β-lactamases (ESBL) genes (bla_{SHV}, bla_{TEM}, and $bla_{CTX\text{-}M}$), carbapenemase genes (bla_{KPC}, bla_{NDM}, bla_{VIM}, and $bla_{OXA\text{-}48}$), and colistin resistance genes (*mcr-1*, *mcr-2, mcr-3, mcr-4, mcr-5*, and *mcr-8*) using real-time Polymerase Chain Reaction (PCR).[19,20] Standard PCR was performed to confirm the presence of RT-PCR amplified genes. Sanger sequencing was performed on all positive standard PCR products to screen for genetic variants. All gram-positive cocci strains were screened for the *vanA* and *vanB* genes, as previously described.[21]

Statistical analysis

Results for variables related to wound infection complications were collected in a structured proforma and analyzed using the statistical package for the social sciences version 23. Continuous variables were expressed as descriptive statistics, mean, standard deviation (SD) and categorical variables were expressed as frequencies, and the χ^2 test was applied to find the association between different variables. *P*-values of less than .05 were considered to be significant.

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RESULTS

Demographic and clinical data

Of a total 1,810 CS procedures performed during our study period, 36 patients manifested a postsurgical infection. These 36 patients constituted our sample series, representing an incidence of 1.9%. Twenty-seven of these CS procedures were carried out in emergency (75%).

The medical predictive variants related to post-CS infection were mainly characterized by scarred uteri as the only common surgical antecedent (58.3%). Patient-related maternal pathologies were anemia (55.6%), diabetes (27.7%), pre-eclampsia associated with diabetes (11.1%), and an American Society of Anaesthesiologists score of between II and III (33.3%) (Table 1).

Socially, the patients in our study had a low educational level (72.2%). All operations were performed according to Altemeier's contamination class 2. The patients in our study series were referred for CS section surgery following various obstetric indications including fetal distress (51%), macrosomia (25%), breech position (12%), fluid reversal (9%), and retroplacental haematoma (3%) (Table 2). Nevertheless, no hemorrhage was recorded in these cases of SSI.

The mean age of the patients was 33.93 ± 8.28 years with extremes ranging from 24 to 43 years. The median Body Mass Index (BMI) ≥ 30 was 30.80 ± 5.60 in 63.9%. Regarding gynecological history, indicated by parity ≥3, it was 2.50 ± 1.50 in 30.6% (Table 2).

The mean time to infection after surgery was 6.29 ± 4.956 days. The average duration of the CS section was reported as 48.04 ± 10.93 minutes, and duration > 60 minutes was observed only for 13.9% of cases. Among the biological parameters confirming infection, we have an average CRP of 84.44 ± 61.83 mg/L in 88.9% of cases, and the average length of postoperative stay is 10.76 ± 6.24 days. However, the length of the postoperative stay for some patients was > 16 days in 19.4%. The demographic and clinical characteristics of patients with SSIs after the CS section were described in Table 2.

Bacterial strains and microbiological tests

Of 36 culture-positive samples, 64% were found to be monomicrobial samples and 36% were polymicrobial samples. A total of 43 bacterial isolates were recovered. From all bacterial isolates, we identified 62.8% *Enterobacteriaceae* (*Escherichia coli, Enterobacter cloacae, Klebsiella pneumoniae,* and *Proteus mirabilis)* and 37.2% gram-positive cocci (*Enterococcus faecalis*, *Enterococcus faecium*, *Staphylococcus aureus*, and *Staphylococcus epidermidis*). For the monomicrobial samples, *E coli* was the main isolate (43.5%) followed by *K pneumoniae* and *E cloacae* (17.4%), *E faecalis* and *S epidermidis* (8.7%). For the polymicrobial samples, we observed the combination of *E cloacae* and *E faecalis* (53.8%), followed by *E coli* and *S aureus* (23%), *E coli* and *E faecium* (15.4%) and *K pneumoniae* and *S epidermidis* (7.8%) (Fig 1).

Of all the strains isolated, 63% showed multidrug resistance, defined as nonsusceptibility to three or more of the antibiotics. For *Enterobacteriaceae,* high resistance was expressed to amoxicillin (88%), amoxicillin-clavulanic acid (84%), ceftriaxone (72%), amikacin (84%), and ciprofloxacin (60%). The same isolates showed low resistance to ertapenem (7%) and fosfomycin (3%), but were fully susceptible to piperacillin-tazobactam, imipenem, and colistin (Fig 2a).

From the gram-positive cocci, *Enterococcus* species were the most resistant to the antibiotics tested, with resistance to penicillin and amoxicillin (77%), ceftriaxone (76%), rifampicin (70%), minocycline and linezolid (62%), erythromycin (47%), gentamicin (24%), vancomycin (8%) (Fig 2b). Resistance to vancomycin was expressed in both *E faecium* strains with a minimum inhibitory concentration > 256 µg/mL.

All isolated *Staphylococcus spp*, were found to be sensitive to almost all antibiotics tested, except to penicillin and fusidic acid (60%), erythromycin (30%) and nitrofurantoin (20%) (Fig 2c).

AMX: Amoxicillin; AMC: Amoxicillin + clavulanic acid; CF: Cefalotin; FEP: Cefepime; CRO: Ceftriaxone; ERM: Ertapenem; IMP: Imipenem; TZP: Piperacillin/tazobactam; SXT: Sulfamethoxazole-trimethoprim; PT: Pristinamycin; CIP: Ciprofloxacin; Fos: Fosfomycin; DOX: Doxycycline; GM: Gentamicin; AK: Amikacin; FT: Nitrofurantoin; CO: Colistin; PG: Penicillin G; OX: Oxacillin; CX: Cefoxitin; E: Erythromycin; VAN: Vancomycin; TEC: Teicoplanin; MN: Minocycline; LZD: Linezolid; RA: Rifampicin; FA: Fusidic acid; CL: Clindamycin.

Molecular characterization

Of the 27 *Enterobacteriaceae* isolated, 62.9% of the strains carried ESBL genes. *E cloacae* was the majority producer of ESBL genes ($bla_{\text{CTX-M-15}}$, $bla_{\text{TEM-206}}$) followed by *E coli* ($bla_{\text{CTX-M-15}}$, $bla_{\text{TEM-206}}$), and *K pneumoniae* ($bla_{\text{SHV-187}}$, $bla_{\text{CTX-M-15}}$) (Fig 1, Table 3). The presence of carbapenemase and *mcr* genes was not detected in all our isolates. Vancomycin resistance expressed by the *vanA* gene in both *E faecium* isolates was detected (Fig 1).

DISCUSSION

To our knowledge, this is the first study in Algeria that provides an overview of the rate of post-CS section infection with their predictive factors, as well as the first to provide the antibiotic resistance profile of associated bacteria. We report a rate of 1.9% in Algeria, which is low compared to similar studies elsewhere in Africa, with an incidence of 10.9% in Sierra Leone,[10] 7.3% in sub-Saharan Africa,[22] and 5% in Tunisia.[23] Furthermore, this rate is low compared to studies carried out in Egypt with 5.3%[24] and in Brazil with 3.4%.[25] In contrast, our results are in line with other studies in developed countries such as 1.2% in Norway,[26] 1.75% in Italy,[27] and 1% in France.[28] This discrepancy could be attributed to differences in the quality of care and surgical services between countries. Differences in sample size, sociodemographic backgrounds, and length of hospitalization between studies also play a significant role in these variations.[10,11,29]

However, the low frequency of SSIs observed in our study could be explained by the preventive measures adopted and which are strictly followed, according to a hospital hygiene protocol applied to all women scheduled by our service for a programmed intervention. In some cases where the surgery takes place in an emergency, as in

Table 1
Basic obstetric characteristics of ISS

		Maternal pathology related to postcaesarean SSI	
		χ^2	*P*-values
ASA			
I	24 (66.7)	2	.10
II and III	12 (33.3)		
Maternal pathology			
No systemic disease	2 (5.6)		
Anemia	20 (55.6)	10	.0003
Diabetes	10 (27.7)	3.30	.03
Pre-eclampsia/diabetes	4 (11.1)	0.10	.30
Surgical history			
Scarred uteri	21 (58.3)	0.30	.20
No abnormality detected	15 (41.7)		

ASA, American Society of Anaesthesiologists; *Min*, minimum; *Max*, maximum.

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Table 2
Demographic and clinical characteristics of patients with SSIs following cesarean section

Variables		Effectif n (%)	Mean ± SD	Median (Min-Max)
Educational level	≥10 years of study	10 (27.8)	-	-
	< 10 years of study	26 (72.2)		
Age	< 30	13 (36.1)	33.93 ± 8.28	31.50 (24-43)
	≥30	23 (63.9)		
Body mass index (kg/m^2)	< 30	13 (36.1)	30.80 ± 5.60	31 (23-44)
	≥30	23 (63.9)		
Parity	< 3	25 (69.4)	2.50 ± 1.50	1 (1-6)
	≥3	11 (30.6)		
Time from intervention to infection(days)	≤7	23 (63.9)	6.29 ± 4.956	6 (2-25)
	> 7	13 (36.1)		
Plan of the intervention	Elective	9 (25)	-	-
	Emergency	27 (75)		
Presence of premature rupture of membranes	Yes	9 (25)	-	-
	No	27 (75)		
Type of anesthesia	General	9 (25)	-	-
	Spinal anesthesia	27 (75)		
Hemostasis	Good	27 (75)	-	-
	Difficult	9 (25)		
Draining	Yes	3 (8.3)	-	-
	No	33 (91.7)		
Indication for CS	Fœtal distress	18 (50)	-	-
	Macrosomia	9 (25)		
	Breech position	5 (14)	-	-
	Fluid reversal	3 (8)		
	Retroplacental haematoma	1 (3)		
Doctor grade	Medical interns	32 (88.9)	-	-
	Assistant and professor	4 (11.1)		
Duration of CS (min)	< 60	31 (86.1)	48.04 ± 10.93	45 (35–75)
	> 60	5 (13.9)		
CRP (mg/L)	< 6	4 (11.1)	84.44 ± 61.83	64 (6–258)
	> 10	32 (88.9)		
Antibiotic therapy	Cefacet/Gentamicin/Bactrim	12 (33)	-	-
	Cefacet/Gentamicin/Flagyl	9 (25)	-	-
	Cefacet/Gentamicin	6 (17)	-	-
	Flagyl/Claforan/Gentamicin	4 (11)	-	-
	Claforan/Gentamicin	3 (8)	-	-
	Bactrim/Flagyl/Gentamicin	2 (6)		
Postoperative stay (days)	≤16	29 (80.6)	10.76 ± 6.24	10 (2–34)
	> 16	7 (19.4)		

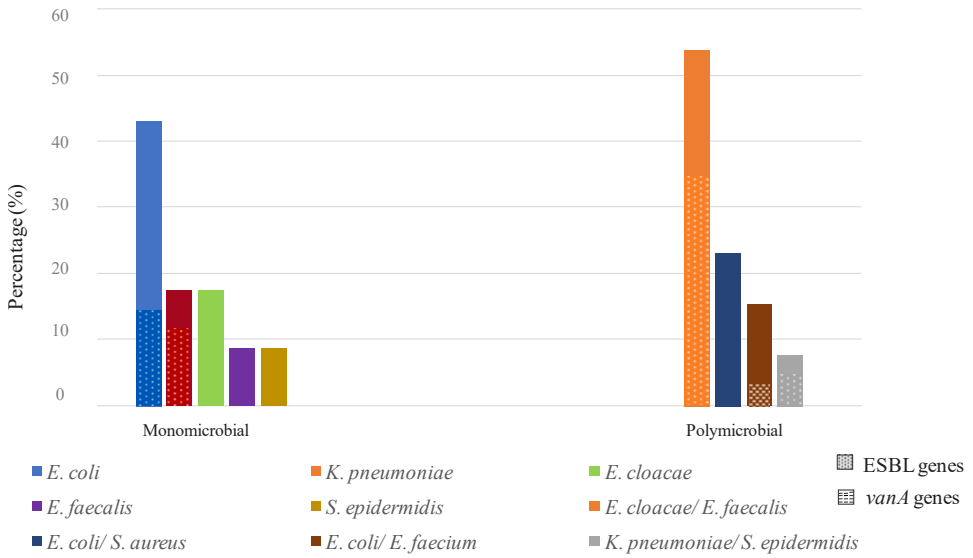

Fig. 1. Distribution of the different bacterial species isolated according to the type of microbial contamination (monomicrobial: 64% and polymicrobial: 36%) and the proportion of their antibiotic resistance genes detected in SSIs after cesarean section.

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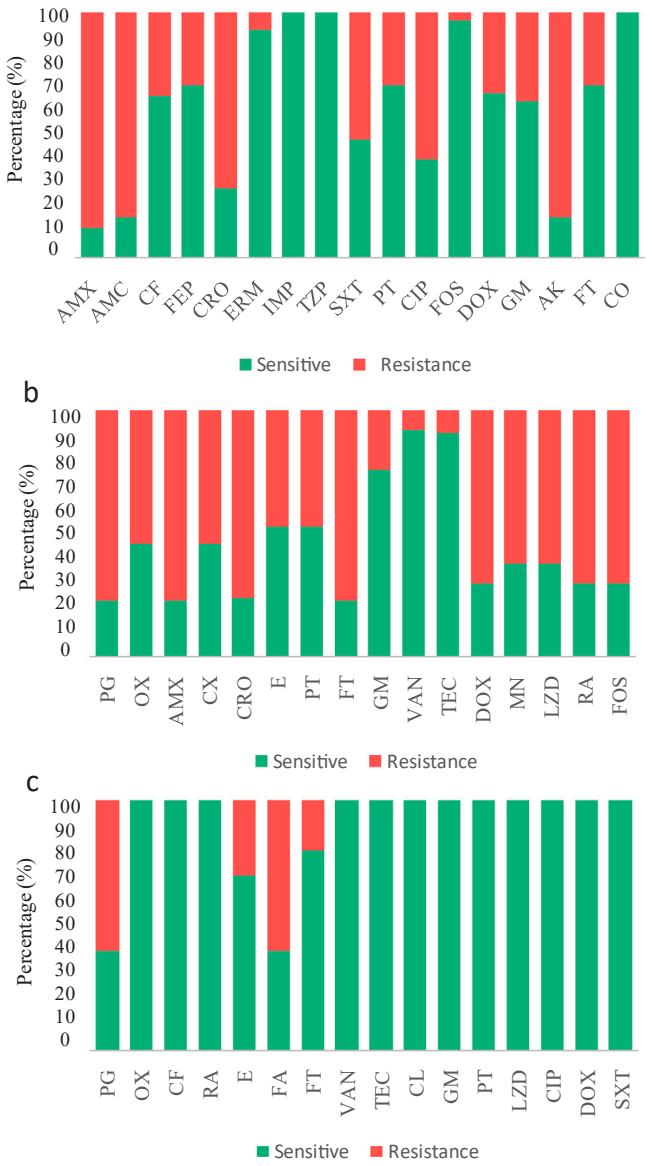

Fig. 2. Susceptibility and resistance patterns of *Enterobacteriaceae* (A), *Enterococcus spp* (B), and *Staphylococcus spp* (C) strains.

the majority of patients in our study (75%), this protocol may not be followed or may be interrupted. This is considered to be a predictor of an SSI. Similarly, many authors have reported that emergency CS surgery was strongly correlated with a high risk of infections.[29,30] In addition, risk factors for SSIs were indicated by differences in the variety of comorbidities, surgical history, prolonged length of hospital stay, choice of antibiotic therapy, and accuracy of data obtained.[24,31] In low-income countries, the health care system is fragile and not very accessible for populations with a low socio-economic status. Moreover, these populations often have a low level of education and are less aware of their clinical condition. Prenatal care, prevention of maternal pathologies, and risk factors for SSI after CS are underdeveloped.[32,33]

Furthermore, it has been shown that a high BMI is the most important predictor of the risk of SSIs after the CS section.[24,31] In our series, 63.9% of women who underwent SSIs had a BMI ≥ 30. However, the relationship between age and SSIs is not yet clear. A study published in Kosovo showed the risk of developing an SSI was significantly lower in the under-35 age group, in cases where the operation lasted less than 1 hour.[31] Our results report that the most affected age group was 33.93 ± 8.28 years (63.8%), which is similar to studies conducted in England and Egypt, with a mean age of 33.10 ± 5.20 years[34] and 31.20 ± 4.90 years,[23] respectively, but higher than the Sierra Leone study, with a mean age of 26.4 ± 0.7 years.[10] Regarding the conditions under which the operation was performed, 86% of the cases lasted less than 1 hour. All infections were superficial wounds and the only common surgical history between our patients was a scarred uterus. Indeed, a scarred uterus can be incriminated as a risk factor for the occurrence of an SSI, since it seems to cause fibrosis of the scarwall.[23] Each case was treated by incision, followed by dressing as required on a daily basis. The median time at which the SSI was diagnosed was 6.29 ± 4.95 days postoperatively for the majority of cases (63.9%). It was previously reported that the risk of SSIs increases 7,4-fold in the presence of other comorbidities, including anemia,[31] pre-eclampsia, and diabetes.[31] This study revealed various clinical features of SSIs after CS sections: 47.2% of the patients were anemic, 27.7% were diabetic and 11.1% had a combination of diabetes and pre-eclampsia. Anemia is considered to be an important factor in postoperative infections due to the attenuation of the immune defense mechanisms.[23,24] Hyperglycemia also encourages the occurrence of SSIs by disrupting the defense mechanism by altering the activity of polynuclear and phagocytosis.[4]

Antibiotic prophylaxis was administered to all patients 30 minutes prior to incision. This antibiotic prophylaxis plays an important role in reducing the rate of SSIs and is one of the most important criteria in the intraoperative patient preparation protocol.[31] Unfortunately, antibiotic supply is a major concern in some countries. Universal preoperative antibiotic coverage is generally rare in low-income wards. Following CS, incomplete antibiotic administration is an important predictor of infection, increasing this risk by 2 and a half times for each missed dose[35] In a context of scarce resources, World Health Organization recommendations no longer support a strategy of prolonged antibiotic prophylaxis[36] Although they are indispensable against infections, their misuse can lead to the development of multiresistant bacteria.[14,15]

Bacteriologic analysis of pus samples from SSIs isolated a total of 43 aerobic bacteria, with pure isolates outnumbering mixed isolates by 64% to 36%. The microorganisms most often responsible for SSIs are common human commensals and vary mainly according to the microbial ecology of the department in question or the reservoir, but also according to the degree of contamination of the surgical site. Therefore, the class of the surgical wound plays a role in the purity of isolates according to the Altemeier classification, with clean procedures being associated with monomicrobial isolates, while contaminated and dirty wounds are associated with polymicrobial isolates.[37] In our study, all surgical procedures were clean-contaminated, which explains the predominance of monomicrobial specimens.

Enterobacteriaceae isolates and gram-positive isolates accounted for 62.8% and 37.2% of cases, respectively. This could be attributed to the diversity of habitats of gram-negative bacteria, including inanimate surfaces in hospitals, and the possible contamination of the intestinal tract during surgery. In our study, *E faecalis* was isolated as the most common gram-positive bacteria, which is in agreement with a similar Croatian study.[38] Molecular analysis of resistance phenotypes to different β-lactam antibiotics reveals a prevalence of 39.35% for ESBL-producing *Enterobacteriaceae,* expressed by TEM-206, SHV-187, and CTX-M15. Antibiotic resistance in gram-negative bacilli has become a major public health problem in Algeria over the last 10 years.[39] Indeed, there has been a significant increase in ESBL-producing strains, particularly those carrying the CTX-M-3 and CTX-M-15 enzymes.[40] This resistance, present in different ecosystems, has become endemic.[39] In contrast, the discovery of vancomycin-

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Table 3
Phenotypic and genotypic characteristics of seventeen *Enterobacteriaceae* strains isolated from SSI after cesarean section

						ESBL genes		
Patients	Age(years)	Indication for CS	ISO classification	Strains	Antibiotic therapy	$bla_{SHV-187}$	$bla_{TEM-206}$	$bla_{CTX-M15}$
1	41	Breech	Superficial wound	*E coli*	Bactrim, Flagyl, Gentamicin	-	+	+
2	24	Breech	Superficial wound	*E coli*	Cefalexin, Flagyl, Gentamicin	-	+	+
3	37	Breech	Superficial wound	*E coli*	Flagyl, Gentamicin, Claforan	-	-	+
4	27	Fetal distress	Deep wound	*E coli*	Bactrim, Gentamicin, Claforan	-	-	+
5	41	Retroplacental hematoma	Superficial wound	*E coli*	Cefalexin, Claforan, Gentamicin	-	-	+
6	43	Fetal distress	Superficial wound	*E cloacae*	Cefalexin, Gentamicin	-	-	+
7	35	Macrosomia	Superficial wound	*E cloacae*	Cefalexin, Gentamicin	-	+	+
8	26	Macrosomia	Superficial wound	*E cloacae*	Flagyl, Gentamicin, Claforan	-	+	+
9	27	Breech	Deep wound	*E cloacae*	Cefalexin, Gentamicin, Flagyl	-	+	+
10	32	Fetal distress	Superficial wound	*E cloacae*	Bactrim, Flagyl, Gentamicin	-	+	+
11	28	Fetal distress	Superficial wound	*E cloacae*	Cefalexin, Flagyl, Gentamicin	-	-	+
12	32	Fetal distress	Superficial wound	*E cloacae*	Bactrim, Gentamicin, Claforan	-	-	+
13	37	Breech	Superficial wound	*K pneumoniae*	Bactrim, Flagyl Gentamicin	+	-	+
14	41	Fetal distress	Superficial wound	*K pneumoniae*	Cefalexin, Flagyl, Gentamicin	+	-	+
15	39	Fluid reversal	Superficial wound	*K pneumoniae*	Flagyl, Gentamicin, Claforan	+	-	-
16	42	Fetal distress	Superficial wound	*K pneumoniae*	Cefalexin, Gentamicin, Bactrim	+	-	-
17	29	Breech	Superficial wound	*K pneumoniae*	Cefalexin, Gentamicin, Bactrim	+	-	+

ESBL, extended-spectrum β-lactamases.

resistant *E faecium* through the expression of the *vanA* gene has raised concerns. Although described in the North-West of Algeria, these strains are not very frequent in the country.[21] The presence of these different bacteria may be due to errors in the choice and dosage of prescribed antibiotics and in particular to antibiotic prophylaxis that is not adapted to the local antibiotic sensitivity profile. Antibiotic therapy must, therefore, be adapted to the local ecosystem.

CONCLUSIONS

This study demonstrated a low incidence of SSIs in our hospital. The presence of SSIs is mostly associated with a bacteriological profile, with ESBL resistance in *Enterobacteriaceae*. In addition, sporadic cases of vancomycin resistance in *E faecium* have also been observed.

Nevertheless, the data from our study highlight the need for closer monitoring of patients with comorbidities and risk factors such as overly prolonged operations, emergency surgery, BMI ≥ 30, anaemia, and a scarred uterus. Prenatal care and patient education, especially for this risk population, must be systematic. In addition, it is important to understand the local antibiotic sensitivity profiles. Therefore, regular national epidemiological surveillance is necessary to prescribe appropriate antibiotic therapy. All these measures combined with optimal hygiene practices, will reduce the rate of SSIs and improve patient health.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki and approved by the local ethics committee from the CHU Ibn Roched (No.: 1726). Informed consent was obtained from all subjects involved in the study.

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