Prospective Analysis of Wound Infection Following Cesarean Section

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Research article

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Abstract

Background: To study the risk factors among women who develop postoperative wound infection following caesarean section, and to analyze the microbiological pattern and antibiotic sensitivity.

Method: This prospective hospital-based cross-sectional study conducted in government Lady Goschen Hospital, Mangalore, between October 2016 to March 2018, enrolled women who developed surgical site infections (SSI) within 30 days of caesarean delivery performed in the hospital. Descriptive statistics were used for socio-demographic variables and appropriate univariate and multivariate analysis used to find the association between continuous and categorical variables with a p-value of <0.05 taken as statistically significant.

Results: Out of 4540 cesarean deliveries, 52 (1.1%) cases developed SSI. Surgical site infections were found significantly associated with maternal age above 25years, BMI>27Kg/m^2 ($p<0.001$), hypertension, diabetes ($p<0.001$), the urgency of caesarean delivery, prolonged operative duration, technique and suture material ($p<0.001$) used. Poliglecaprone (monofilament) was found suitable for subcutaneous tissue and skin closure. Out of 38 cases with microbial growth, 52% cultured Staphylococcus aureus with 60% displaying methicillin resistance, followed by Diphtherioids (22%) and Pseudomonas (10.5%). Majority isolates showed higher sensitivity to Linezolid, Clindamycin and Vancomycin.

Conclusion: Apart from maternal factors, the surgeon's operative skill & technique, and suture material also contribute significantly to the development of SSI. A developing trend towards resistance to higher antibiotics was noted among Methicillin-resistant Staphylococcus aureus. Gentamicin and Linezolid were found as effective as second-line agents. Hence maintenance of quality asepsis and a hospital-based antibiotic policy is vital.

Background

In India there has been a rising trend, rather doubling (17.2%) in the caesarean delivery rate, as per National Family Health Survey (NFHS)- 4 especially in Chattisgarh (98%), Telangana (58%), Kerala (36%), Tamil Nadu (34%) and Karnataka (23.6%), above the recommended WHO level of 15% [1]. This rising rate has well-documented risks for the woman in the current and subsequent pregnancies [2]. They are associated with substantial morbidity, increased hospitalization and expenditure.

Wound infection accounts for the second most common surgical adverse event following cesarean deliveries, accounting for 3-15% [3].The incidence of surgical site infection (SSI) is attributed to a multitude of factors, about the general physical health of the patient, the site of surgery, the institutional hygiene, supplemented by the emergence of antimicrobial resistance.

As per the National Nosocomial Infection Surveillance (NNIS) system guidelines (United States), SSI is defined as that which occurs within 30 days of surgery in the part of the body where the surgery took place. It is classified as superficial incisional, deep incisional and organ/space infections. Superficial infections include skin or subcutaneous tissue and diagnosis require more than or equal to one of the following: pus discharge, positive wound culture, diagnosis made by attending physician and wound separation [3]. Deep infection involves fascial or muscle layer and diagnosis involves more than or equal to one of the following: Deep pus, abscess, spontaneous dehiscence [4].

An organ or space SSI may show a discharge of pus coming from a drain placed through the skin into a body space or organ [5]. As per the NNIS, the most common organism isolated in SSI is Staphylococcus aureus, approximately about 15%–20% of cases followed by gram-negative bacilli (especially pseudomonas), coagulase-negative staphylococci, *Enterococcus* species, and *Escherichia coli.* To develop target prevention strategies, identifying the risk factors is prudent which can be broadly classified as host-related, pregnancy-related and procedural variables.

Host related factors include- maternal age, obesity, personal hygiene, immunocompromised status, presence of other medical comorbidities, previous surgeries. Obstetric factors include- hypertension (HTN), gestational diabetes mellitus, multiple pregnancy, prelabour rupture of membranes, and prolonged labour.

Procedural details include- preoperative preparation, duration of surgery, the skill of the operating surgeon, the suture material used, and importantly the empirical antibiotic. Although many interventional strategies have been enforced to reduce the incidence of SSI based on various clinical trials, an initiative towards identifying the modifiable risk factors, the drawbacks of common surgical techniques and developing a hospital-based antibiotic policy, is required. This would eventually aid in stratifying women at risk. This study is aimed at exploring and thus alleviating the above-mentioned lacunae, in reducing the risk of SSI.

Methods

It was a time-bound cross-sectional study, conducted at Government Lady Goschen Hospital, Mangalore, from October 2016 to March 2018, after the approval of the Ethics Committee of Kasturba Medical College, Mangalore. All patients undergoing elective or emergency caesarean delivery in our hospital during the study period were followed up until discharge (usually on day 5, if no comorbidities), for the development of wound infection. Those who developed SSI within 30 days postoperatively were included, after taking informed consent for participation.

Patients presenting with symptoms and signs of wound infection following caesarean delivery were recruited as per the CDC definition criteria. These patients were assessed for the presence of the following demographic and obstetric risk factors such as advanced maternal age, parity, BMI, immune compromise- HIV, steroid intake, diabetes mellitus, HTN, anaemia, chronic cough- TB, and bronchial asthma. History of abdominal surgeries was collected along with details of the surgery and labour details. The wound culture and sensitivity reports were collected and details of the microbiological pattern and antibiotic sensitivity were recorded.

Data analysis: The association between variables of interest were tested using Chi-square test. Descriptive statistics were used for socio-demographic variables and appropriate univariate and multivariate analysis were used to find the association between continuous and categorical variables and a p-value of <0.05 was taken as the level of significance.

Result

During the study period, out of the 4540 cesarean deliveries, 52 cases developed SSI, which included only superficial and deep SSI. No cases of organ space infections were observed. Among the 52 cases of SSI, 28 patients developed SSI within 10 days postoperatively. Among the 52 cases, 29 patients (55%) were above 25 years of age (p<0.001) (Table 1). There was also a highly significant (p<0.001) risk noted among obese women (Table 1), those with hyperglycemic and hypertensive disorders of pregnancy (p<0.001). Other prominent host factors observed were bronchial asthma, anaemia and previous abdominal surgeries (Table 1), apart from advancing maternal age. Multigravidas (34 cases, 64%) had almost twice the risk compared to primigravidas (18 cases, 36%). Duration of prelabour rupture of membranes (PROM) was not found to be significantly associated. Out of 31 patients who had h/o PROM, 28 cases had PROM of more than 6hours (p=0.056) (Figure 1).

On analysing the surgical details, it was found that emergency caesarean deliveries contributed to 94% cases of SSI (p<0.001), it was found that the incidence of SSI increased with surgeries lasting more than 45minute, (p<0.001) (Figure 2). Among the suture materials used in our hospital, polyglactin was found favourable for rectus sheath closure (Figure 3) while poliglecaprone 25 (monofilament) was associated with a significantly lesser risk when used for subcutaneous tissue (Figure4) and skin closure (Figure 5).

Among the 52 cases infected, 11 cases had involvement of rectus sheath, out of which more than 50% cases sutured with Polypropylene and Polydioxanone developed an infection (Table 2); 29 cases had involvement of subcutaneous tissue, of which, 25 cases were sutured with polyglactin (Table 3).

On studying the bacteriological profile of the 52 cases of SSI, it was found, only 38 wounds showed microbial growth. Among the 38 cases, 52% swabs grew Staphylococcus aureus, of which 60% were resistant to Methicillin. Some of the other organisms isolated were Pseudomonas, Diphtheroid, E. coli and Klebsiella (Figure 6). Staphylococci (Methicillin-Sensitive Staphylococcus aureus (MSSA)) and Pseudomonas were found highly sensitive to Gentamicin and Linezolid. Methicillin-Resistant Staphylococcus aureus (MRSA) and Diphtheroid (80%) were found sensitive to Vancomycin. The E. coli showed high sensitivity to Gentamicin and Cefotaxime, while Klebsiella showed towards Linezolid and Clindamycin (Figure 7).

Out of 12 cases of MRSA, high resistance was noted for Cephalothin and Erythromycin, and a developing trend for resistance to higher antibiotics like Carbapenems. Diphtherioids were highly resistant to Ciprofloxacin while E. coli and Klebsiella showed high resistance to Piperacillin. Pseudomonas was predominantly resistant to Erythromycin (Figure 8).

Discussion

Risk factors: As per the NNIS system, it is well known that SSI is the second most common postoperative infection following caesarean deliveries, with an incidence ranging from 3 to 15%. In India, as per a study conducted at Lady Hardinge Medical College New Delhi, the infection rate was 24.2%. In our study, the approximate (excluding those lost to follow up) incidence of SSI in our hospital during one and a half years was 1.1%, which is much lower than the general incidence rate in various other studies done in India. In a study done by Anjum et al in 2017, at a tertiary care centre Tumkur in Karnataka, the SSI rate following a lower segment caesarean section (LSCS) was 16%, and another done by Priayanka Dahiya et al at a first referral unit in India in 2016, it was 9%. Studies done in the USA reported an incidence of 3.15% [18].

Based on studies done earlier, certain risk factors were identified as causative for SSI, namely obesity, diabetes mellitus (DM), HTN, PROM, emergency caesarean deliveries, chorioamnionitis, longer operative time, poor antimicrobial prophylaxis. Regarding the effect of maternal age, there have been controversial results in various studies although with increasing age due to the senescence of cells and poor host immune response mechanisms the risk of SSI is proposed to increase. In this study, the majority of cases (55%) of SSI were above 25years age and this was statistically significant. This was similar to studies conducted by Anjum et al and Wloch C.et al (2012), while a study was done by Olicer Ezechi et al (2009) in Nigeria showed 75% SSI cases below 25years age, replicating the outcomes from the study by Ashish Pathak et al (2017) in rural India [8-10]. A few have also reported an absence of any association between maternal age and SSI [3, 18].

Host related and obstetric risk factors found to have a statistically significant association for SSI in this study were obesity and multiparity ($p = 0.013$). Obesity as an independent risk factor correlated with studies done by Anjum et al (2017), Fathia et al (2012), and C Wloch et al (2012) (BMI>35kg/m^2, $p < 0.01$) [5, 7, 8]. Fathia et al reported an increase in SSI with BMI>35kg/m^2, $p = 0.005$ [7]. Multiparity was also found to be a significant risk factor in the studies by Hansa Dhar et al (2014) and Filbert J Mpogoro et al (2012) [11, 23]. Majority of patients in our study were multiparous, moreover among them, those with previous h/o LSCS had an added risk, and this may have confounded the results. Among those with comorbidities in our study, hypertensive disorder of pregnancy and DM were highly significant in causation with a p-value <0.001 which correlated with studies by Anjum et al (2017), Rita Andersen (2011) [5, 12]. In the study by Rita Andersen among diabetic women obesity increased the risk by more than two-fold. In hypertensive disorders of pregnancy, the risk can be attributed to the increased rate of surgical intervention in preeclampsia, eclampsia which is supplemented by generalised oedema, and hypoalbuminemia [12]. The results of the study done by Bhadauria AR et al stated was found to be more among the patients having a pre-existing illness such as anaemia 21.13%, obesity 13.62%, DM 8.45% and HTN 4.69% (Table 4) [13].

Emergency surgeries, in general, are found to have a higher risk due to lack of adequate time for action of antibiotics, second stage labour, h/o PROM among them, and the possibility of improper preoperative preparation, that was also found significant in this study with p<0.001 among the emergency LSCS. Several other studies observed higher SSI rates in the emergency LSCS than elective cases [5, 14-18].

In this study, the reduced incidence of SSI with longer duration of PROM (more than 12hours), can be attributed to the early initiation and prolonged course of injectable antibiotics (continued for 5 days postoperatively, unlike for other cases with PROM <12 hours where postoperatively injectable preparations are given only for 2 days). This was following the study by Fathia et al, that had more SSI rate among those with PROM < 8hours, but it was not statistically significant, whereas Hansa Dhar et al and Olicer C Ezechi et al, showed a significant association with PROM (p<0.001) [7, 9, 11].

Surgical aspects:

Longer duration of surgery, mostly beyond 1 hour carried a significant association in our study (p=0.001), and also in the studies done by Fathia et al, Wloch C and Filbert J Mpogoro [7, 8, 23]. Martin et al study revealed, an operative time longer than 75th percentile increased the risk of SSI by 1.84 times [22]. The probable etiologies for an increase in SSI risk being: complicated surgery, inadequate tissue concentration of antibiotic, tissue trauma, breach of sterile technique, increased blood loss, and prolonged exposure to environmental pathogens (Table 5).

Skin closure by subcuticular sutures was found to have a higher risk of wound infection compared to mattress sutures, but this may have been confounded by the fact that mattress sutures were used for those with an obvious risk factor like obesity, uncontrolled DM or eclampsia, while the majority were sutured as subcuticular sutures. Staples were not used for any case. A Cochrane review has thus concluded that there is insufficient data on standardisation of any particular technique or material for LSCS wound closure.

Microbiological profile:

Out of the 52 swabs collected, 73% (38 cases) showed growth of an organism, while 27% showed absence of any microbial growth. Of the 38 cases, 52% showed growth of Staph aureus that was the same as the study by Fathia et al where Staph aureus comprised 50.4% of the growth while studies by Wloch C et al and Anjum et al showed 40% and 43% growth of Staph aureus among SSI [5, 7, and 8]. Among the 19 cases with Staph aureus growth, 60% constituted MRSA. Another study by Bhattacharya et al also showed the highest culture of Staph aureus (35%) among the SSI, (of which MRSA was 26%), others being E. coli (20%), Klebsiella (18%), Pseudomonas (8%) and Acinetobacter (7.5%) [19]. In our study, the other organisms isolated included Diphtheroids (12%), E. coli (10.5%), Klebsiella (7%), Pseudomonas (7%), and Acinetobacter (2%). The main gram-negative offenders in our study were E. coli, followed by Klebsiella and Pseudomonas, this was similar to that in studies done by Bhattacharya and Anjum et al [5, 19]. No growth of Streptococci was obtained.

The highest sensitivity was observed for aminoglycosides like Gentamicin and glycopeptides like Linezolid and Vancomycin. Methicillin-resistant Staphylococcus aureus showed a higher sensitivity for

Clindamycin and Linezolid, while MSSA were more sensitive to Gentamicin and Clindamycin. Gentamicin was effective against E. coli and Pseudomonas. In a study conducted in Mumbai Lilani SP et al in 190 patients, Pseudomonas showed high resistance to Gentamicin [20]. In our hospital, gentamicin was rarely used as a postoperative antimicrobial, unless indicated so lesser were the chances of antibiotic resistance. Unlike other studies, Diphtheroids being a component of normal skin flora were the second most common contaminating microbe cultured, they showed relatively high sensitivity towards Vancomycin.

As stated in several other studies, the most effective antibiotics for gram-positive infections were Linezolid and Vancomycin (90.9% and 81.8% bacteria). However, because of emerging drug resistance, the use of these antibiotics for empirical therapy cannot be recommended. These are preferable to be used only in life-threatening infections or resistance to other commonly used drugs. Among the gram-negative organisms, Ceftazidime or Gentamicin could be used as second-line therapy.

As per the study by Das R et al, for gram-negative infections, a combination of Piperacillin + Tazobactam or Cefoperazone + Sulbactam and Amikacin [21]. It was found that 60% of staphylococcal infections were methicillin-resistant. These MRSA also showed an increasing trend towards resistance to higher antibiotics like Carbapenems. There was no Vancomycin-resistant Staphylococcus aureus (VRSA) isolated. In a study from Northern India, two (0.25%) VRSA strains were reported [20]. Gram-negative organisms were also noted to have developed resistance to broad-spectrum antibiotics like Piperacillin (Table 6).

Conclusions

Surgical site infection has increased the morbidity significantly in the postoperative period, thus requiring a prolonged hospital stay and surgical reintervention. A multitude of predisposing factors for SSI have been identified such as DM, HTN, obesity, anaemia, duration of surgical procedure and surgical technique, to be systematically incorporated into initiatives taken for the prevention and surveillance of postoperative wound infection. Considering the relatively low risk of wound infection as compared to other regions in our country, Cefotaxime can be continued as the first line of drug for empirical antibiotic therapy in our hospital. A developing trend towards resistance to higher antibiotics was noted among MRSA. Gentamicin and Linezolid were found to be effective second-line agents in the present study. Hence maintenance of quality asepsis and a hospital-based antibiotic policy is vital.

Abbreviations

1. National Family Health Survey (NFHS)
2. Surgical site infection (SSI)
3. National Nosocomial Infection Surveillance (NNIS)
4. Methicillin-resistant Staphylococcus aureus (MRSA)

5. Methicillin-sensitive Staphylococcus aureus (MSSA)
6. Diabetes mellitus (DM)
7. Hypertension (HTN)
8. Lower segment caesarean section (LSCS)
9. Prelabour rupture of membranes (PROM)
10. Vancomycin-resistant Staphylococcus aureus (VRSA)

Declarations

Ethics approval and consent to participate: All procedures performed in this study involving human participants were under the ethical standards of the institutional ethical committee- Institutional Ethical Committee Kasturba Medical College Mangalore (IEC KMC MLR) 09-16/186 and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from all individual participants included in the study.

Consent for publication: Not applicable

Availability of data and material: The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest: All the authors declare there is no competing interest.

Funding: Not applicable

Author Contribution: All authors have read and approved the final manuscript.

BDR and SAS: Protocol/project development

SAS: Data collection or management

SAS and BDR: Data analysis

BDR: Supervision

SMZ, BDR and SAS: Manuscript writing/editing

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Tables

Table 1: Patient characteristics

Age distribution among those with SSI.		
Range	**Frequency**	**Percentage**
Less than 20	2	3.5%
20-25	21	41.9%
26-30	12	22.6%
31-35	13	25%
36-40	4	6.5%
Distribution of BMI		
18.5-22.9 (normal)	10	19.4%
23.0- 27.9 (overweight)	10	19.4%
More than or equal to 27.0 (obese)	32	61.3%
Prevalence of comorbidities		
Gestational hypertension	10	19.4%
Eclampsia	2	3.2%
Gestational diabetes mellitus	5	9.7%
Overt Diabetes Mellitus	2	3.2%
Bronchial Asthma	5	9.7%
Previous surgeries	5	9.7%
Anaemia	3	6.5%

Table 2: Rectus sheath closure suture material & incidence of SSI.

Suture material	A total number of cases. n =52	No. of cases with rectus sheath involvement. n = 11	Percentage of cases infected
Polyglactin	36	1	2.78%
Polydioxanone	9	6	66.6%
Polypropylene	7	4	57.1%

Table 3: Subcutaneous tissue closure suture material & incidence of SSI.

Suture material	A total number of cases. n =52	No. of cases with subcutaneous tissue involvement. n = 29	Percentage of cases infected (%)
Polyglactin	43	25	53.5
Poliglecaprone 25	9	4	44.4

Table 4: Comparison of maternal risk factors published in previous studies.

Factors	Present study	Afzal and Nawaz; BJMMR, 14(2): 1-6, 2016	C Wloch et al.; BJOG, vol 119, issue 11	Hansa Dhar et al.; SQUMJ, 2014 May; 14(2)	Olicer C Ezechi, et al.; Nigeria, 2009 Sept.	Filbert j Mpogoro et al; Tanzania, 2012
Age	45% < 25yrs	80.2% cases b/w 20 – 34yrs age	35% > 35yrs	NS	70% below 25yrs	-
BMI	61% obese	51.8% >/= 25	19.2% >/= 35 P < 0.01	Higher in obese p= 0.018	51.3% > 25	-
Parity	65% multi	NS	NS	70% multigravid	NS	-
Period of Gestation	70% term	NS	11% > 40 weeks	NS	NS	-
PROM	60%	16.5% had PROM	NS	57.5% PROM p<0.001	14.5% P=0.02	-
HTN	39%	52%	-	-	-	Higher risk p=0.02
DM	13%	74.5 %	-	-	-	NS
Anaemia	6.5%	58.7%	-	-	-	Higher risk p= 0.03
Previous surgeries	9.7%	-	-	-	-	38%

Table 5: Comparison of surgical details of previous studies conducted.

Surgical details	Present study	Afzal and Nawaz; BJMMR, 14(2): 1-6, 2016	C Wloch et al; BJOG, vol 119, issue 11	Filbert j Mpogoro et al; Tanzania, 2012
Type	94% emergency	83.6% emergency LSCS	NS	92% in emergency
Duration of surgery	75% > 45min.	NS	19% > 60min	Prolonged P=0.015

Table 6: Comparison of microbial pattern and antibiotic sensitivity.

	Present study	C Wloch et al; BJOG, vol 119, issue 11	Hansa Dhar et al; SQUMJ, 2014 May; 14(2)	Filbert j Mpogoro et al; Tanzania, 2012
Common causative organism	52% Staph aureus (60% MRSA)	40% Staph aureus, E.coli 6%	31.27% Staph aureus, E. coli 19%	Staph aureus 28%
Common sensitive antibiotics	Gentamicin, Linezolid	NS	Gentamicin (24.6%), Cephalosporins (22.7%)	Vancomycin, Cephalosporins, Ciprofloxacin.
Common resistant antibiotics	Piperacillin, Erythromicin	NS	Ampicillin, Amox+ Clavulanate	NS

Figures

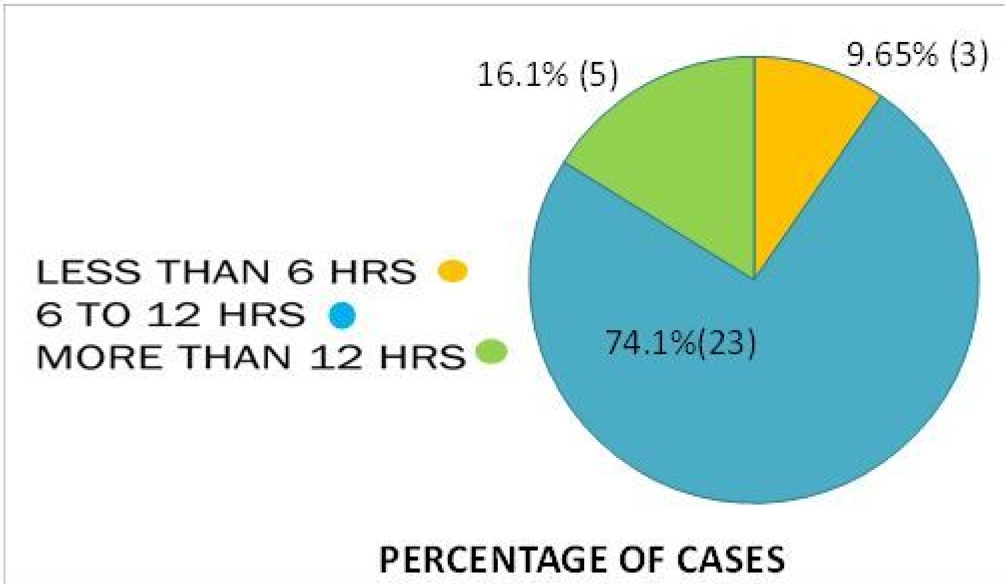

Figure 1

Duration of rupture of membranes.

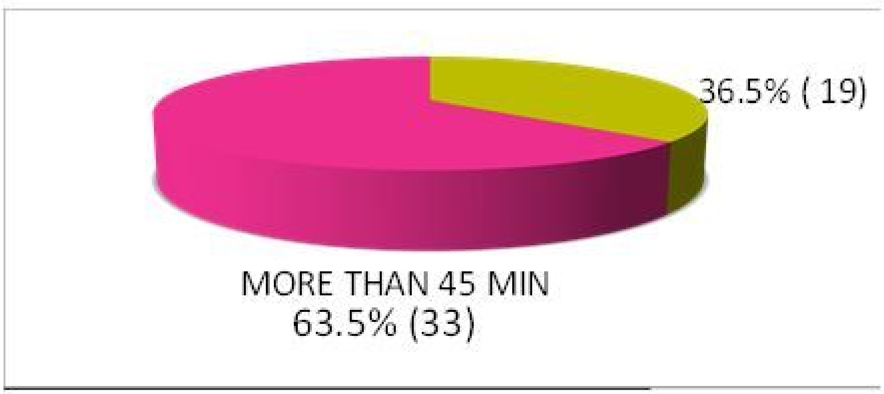

Figure 2

Duration of surgery.

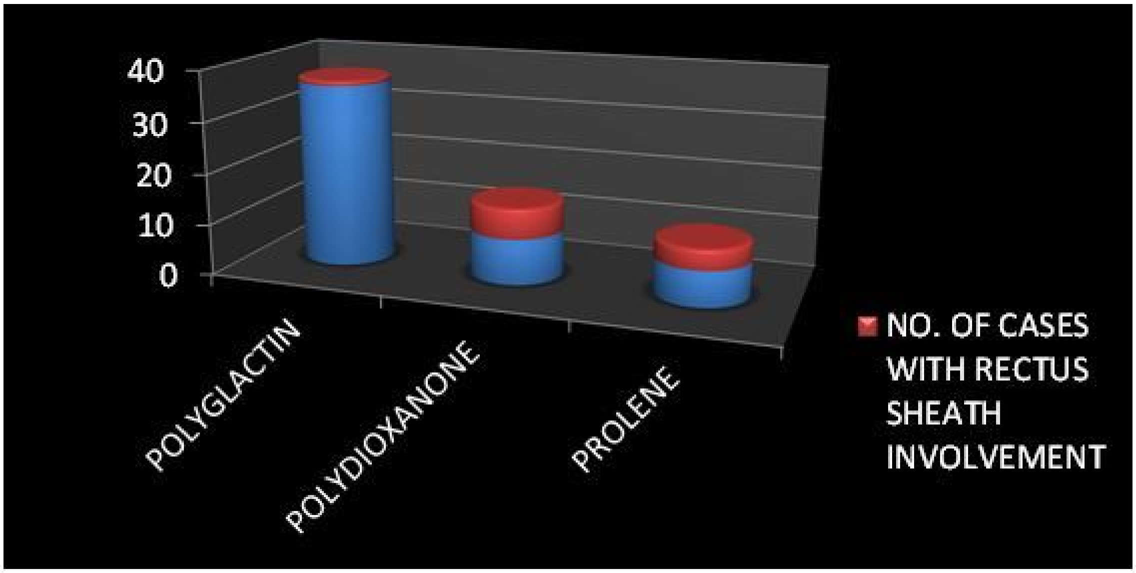

Figure 3

Suture material for rectus sheath closure.

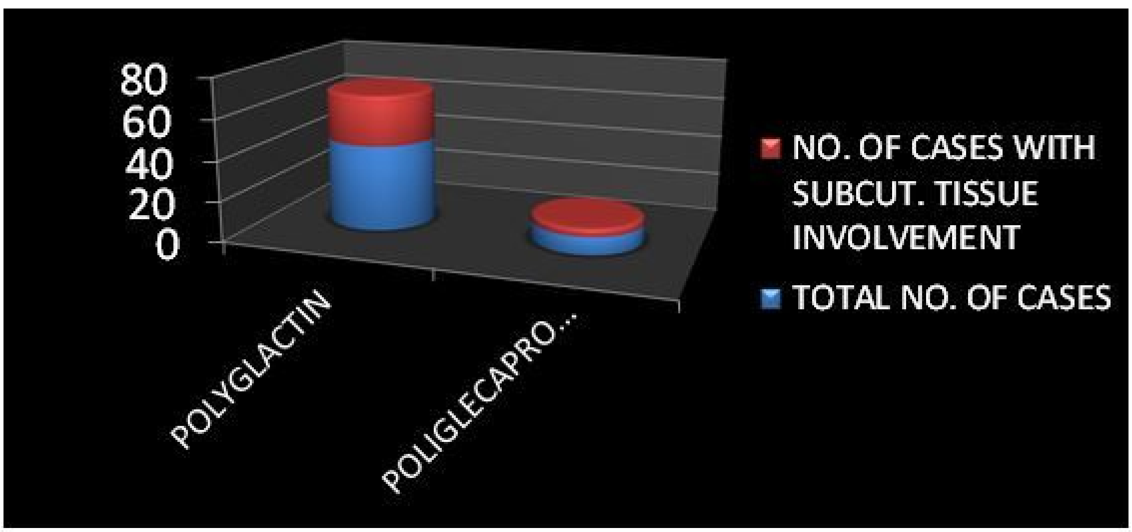

Figure 4

Suture material for subcutaneous tissue closure.

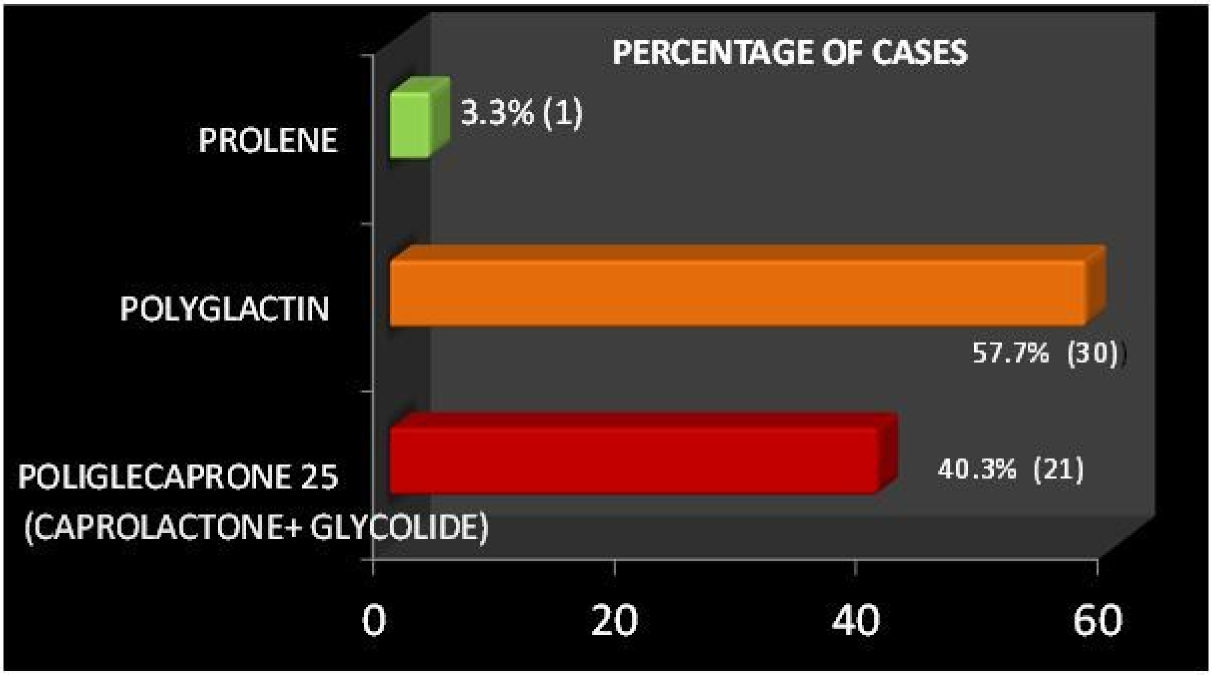

Figure 5

Suture material for skin closure.

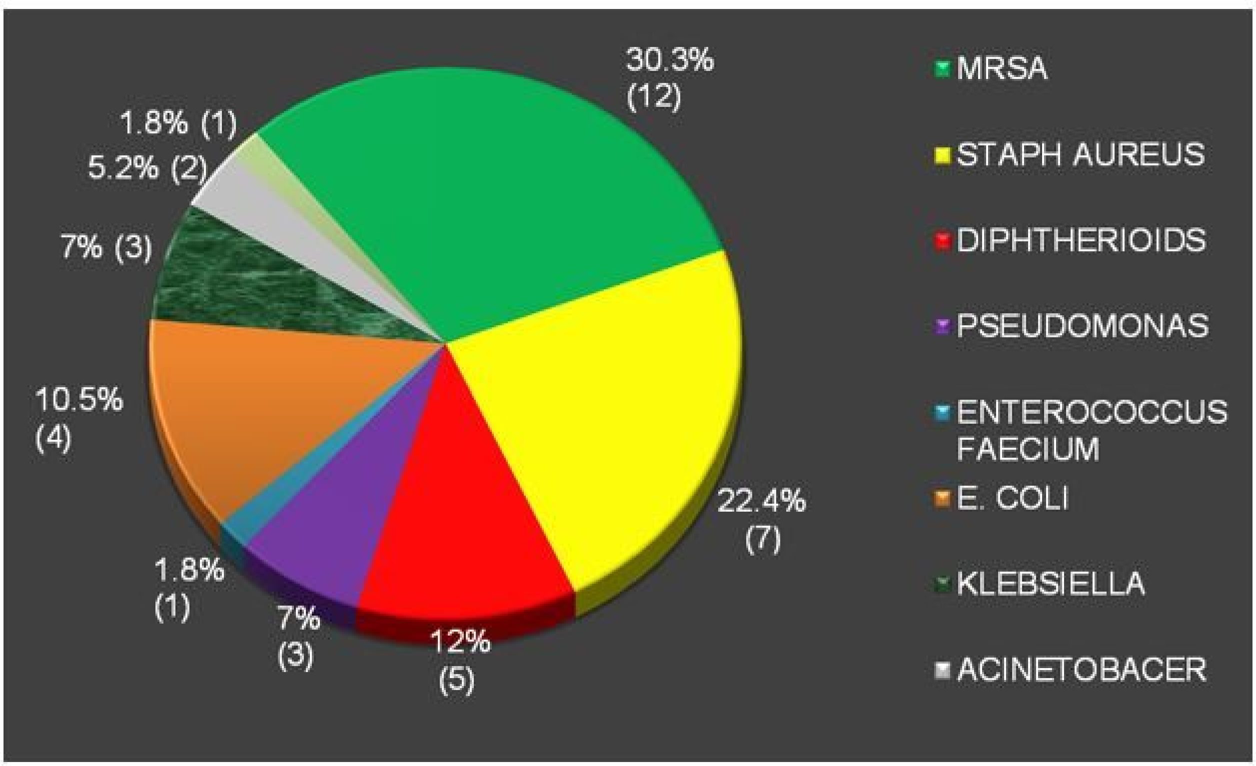

Figure 6

Bacteriological spectrum.

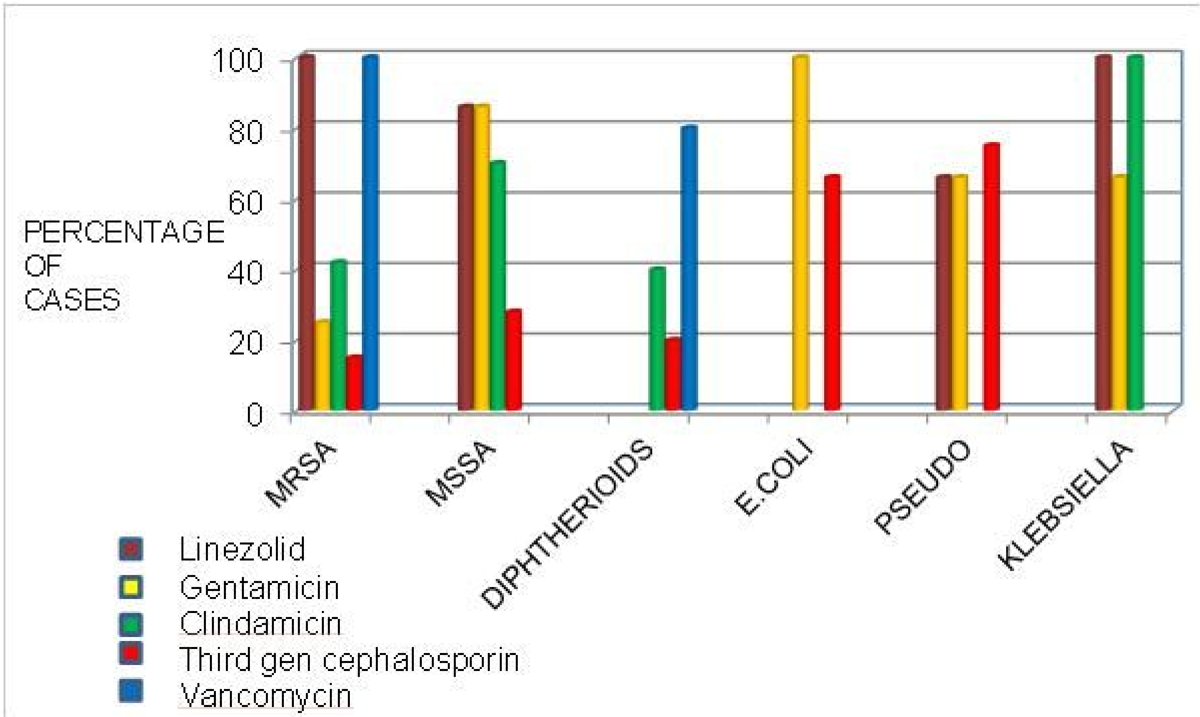

Figure 7

Antibiotic sensitivity profile.

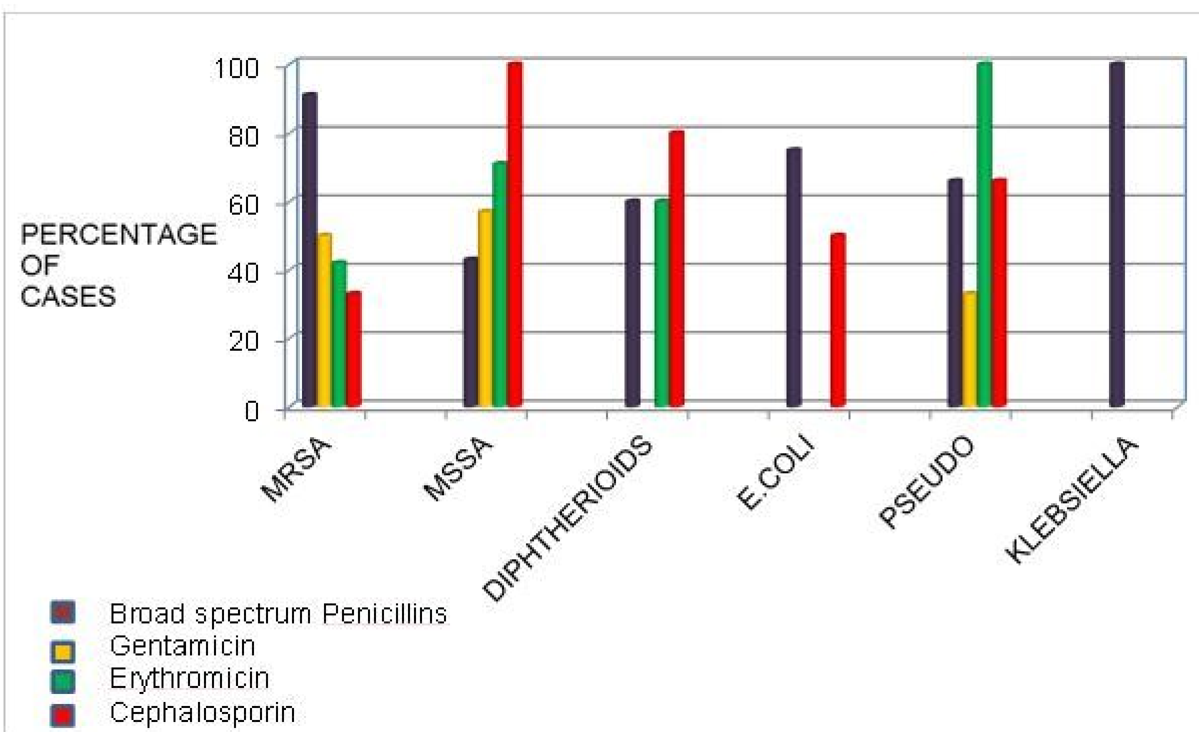

Figure 8

Antibiotic resistance profile.