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Postoperative Wound Infection in Surgical Stomatology: Evaluation of Risk Factors and Organism Pattern

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Abstract

A total of 304 patients were studied between the period of February 2011 and January 2012 in the department of Surgical Stomatology, Crimea State Medical University named after S.I Georgievsky, Simferopol and the probable risk factors of POWI, the organism pattern in such infections and their antibiotic sensitivity were evaluated.

The study revealed that the overall infection rate during this period was 11.8% (male-11.5%; female-12.4%).

This study identified poor oral hygiene, hemoglobin level below 10 gm% at the time of presentation, ASA status III and above, surgery of Class III and Class IV wounds, and duration of surgery more than 3 hours as high risk factors in the development of POWI following surgery in our department.

In addition, it also pointed out that the age at which our patients may become liable to develop POWI could be a decade earlier than the internationally accepted age of above 50 years and identified personal habits like smoking and betel leaf chewing, duration of preoperative hospital stay, presence of other infection, sex, occupation and pattern of disease as low risk factors.

This study also revealed that *Staph. aureus* and *Strep. viridans* are the main causative organisms in the development of POWI following surgery at CSMU.

It was also found that many strains of *Staph. aureus*, *Strep. viridans*, beta-hemolytic *Streptococcus* and *E. coli* have now developed resistance against multiple commonly used drugs including ceftriaxone. The sensitivity of ceftriaxone, cephradine, cloxacillin and gentamycin to various causative organisms were found to be similar.

Keywords: *Postoperative Wound Infection; Surgical Stomatology; Ceftriaxone; Cloxacillin*

Introduction

All surgeons are concerned with postoperative wound infection (POWI) because it can convert a superior technical result into a disaster [1]. In addition it also has medico - legal significance. All departments and surgeons therefore, should ensure that their infection rates are comparable to those in other units [2].

Infection of surgical wounds was a major postoperative problem till Joseph Lister put forward the concept of aseptic technique in surgical procedures in 1867. There was a further dramatic lowering in the incidence of POWI with the discovery of penicillin by Alexander Fleming in 1928 and its therapeutic use by Florey in 1941 [3].

The rate of POWI is traditionally predicted using the operative wound classification cited by Krukowski., *et al* [4]. according to which the rate of infection is less than 2% for Clean wounds (class I), about 5% for clean contaminated-wounds (Class II), about 20% for contaminated wounds (Class III) and up to 40% for Dirty wounds (Class IV). In contrast, Lizan- Garcia., *et al.* [5] reported overall POWI rate of 11.4%, ranging from 2.7% for clean surgery to 21.3% for dirty surgery. Similarly, Karen L Stierman in 1998 put the rate of infection in the above mentioned wound classes as 1 - 5%, 8 - 11%, 15 - 17% and greater than 27% respectively. Sregay and colleagues [6] in 1991 reported an alarmingly high incidence of POWI (28.3%), AT Crimea State Medical University. In contrast, Keith [7] in 1989 had reported an overall infection rate of only 2.55% in the same hospital and Maria [8] in 1999 reported an overall POWI rate of 8.99% in abdominal surgery in the same hospital. Different observation by different authors in the rate of POWI therefore justifies the attempt made by Haley., *et al.* [9] in 1985 to identify individual risk factors that may alter the rate of wound infection in each class of operative wound.

The factors that influence the development of POWI may be broadly grouped into factors contributing to wound contamination (sterilization, disinfection, aseptic technique, temperature and humidity control, air flow etc.), factors that makes a patient a high risk patient (metabolic diseases, liver diseases, immuno-compromised and immuno-suppressed patients etc.) and risk factors (age, sex, operative wound class, American Society for Anesthesiologist category, duration of surgery etc) [10].

During the last decade many studies have been conducted to identify and categorize the individual risk factors that may influence the development of POWI in different surgical specialties for various procedures. Velasco., *et al.* [11] pointed out in 1995 that among the many possible risk factors for POWI following head and neck cancer surgery, five variables namely contaminated or infected wounds, a surgery lasting longer than 5 hours, an American Society of Anesthesiologist (ASA) preoperative assessment score 4 of 5, age over years and prior radiotherapy were independent of each other and highly predictive.

The pathogens implicated in the development of wound infections remain largely the human microorganisms from the endogenous organ micro flora and the exogenous environment. Barna and colleagues [12] in their study (1983 - 1992) on peri-maxillary infections found the predominance of anaerobic streptococci (33.6%) closely followed by staphylococci (32.5%) and mixed organisms (23.04%.

Likewise, Hossain M and Molla MR [13] in their study (1995) on Dento-alvelor infections found the predominance of *Streptococcus* (60%) followed by *Pseudomonas* (14%) *Staph. aureus* (10%), *Proteus* (6%) and *Enterococci* (5%). Rubin and colleagues [14] on the other hand found polymicrobial infection in 22 (96%) out of 23 cases of postoperative wound infections following major contaminated head and neck surgeries.

Prophylaxis is an attempt to attack organisms before they have a chance to induce infection. Choosing an antibiotic for prophylaxis depends upon multiple factors and should be based on the type of operation, kinetics and the toxicity of the drugs, microbiologic characteristics of the operative site and antibiotic sensitivities specific to the particular hospital environment [15].

In order to minimize POWI, the various assumed potential risk factors must be correctly identified and categorized so that timely and appropriate preventive measures can be under taken. In addition, the pattern of organisms causing POWI should be determined and their sensitivity to various antibiotics evaluated. This in turn would help professionals in selecting a suitable cost-effective antibiotic [2]. With this idea, the present study was under taken to evaluate the risk factors concerning POWI at Crimea State Medical University named after S.I Georgievsky (CSMU) and also to identify the organism pattern and their antibiotic sensitivity.

Hypothesis

Multiple risk factors are responsible for postoperative wound infection in surgical stomatology.

Objectives of the Study

General objectives:

1. To know the relationship between various risk factors and postoperative wound infection in the department of surgical stomatology, Crimea State Medical University named after S.I Georgivesky, Simferopol and to find out the organism pattern and their antibiotic sensitivity.

Specific objectives:

1. To find out the rare of postoperative wound infection in the department of surgical stomatology, Crimea State Medical University named after S.I Georgivesky, Simferopol.
2. To identify and categorize the risk factors of postoperative wound infection.
3. To find out the organism pattern and their antibiotic sensitivity.

Patients and Methods

Type of study: Cross-sectional study.

Place of study: Department of surgical stomatology, Crimea State Medical University named after S.I Georgievsky, Ukraine.

Period of study: February 2011 to January 2012.

Study population: All patients undergoing elective surgery irrespective of age and sex who fulfilled the inclusion and exclusion criteria.

Sample size: 304 (males-183, females-121).

Sample size estimation: A representative's sample was calculated by using the following formula.

$$n= \frac{z^2 pq}{e^2} \times deft$$

Where

n= estimated sample size

p= prevalence of postoperative infection=11.4%=0.114

q=1-p= 0.886

z= 1.96 value of z corresponding to 95% confidence interval

e= margin of error (% relative error) =0.1

deft= design effect which is assumed to be 1.5

$$n= \frac{1.96^2 \times 0.114 \times 0.886}{0.1^2} \times 1.5$$

$$= 58.2$$

Inclusion criteria

1. Those who gave consent to be included in the study.
2. Those undergoing elective surgery under General anesthesia.

Exclusion criteria

1. Non-cooperative patients.
2. Immunosuppressed patients
3. Patients with metabolic (diabetes, uremia, jaundice) renal and liver disease.

Variables

1. Socioeconomic
    a. Age
    b. Sex
    c. Occupation

d. Monthly household income

2. Personal habit
    a. Tobacco (smoking)
    b. Alcohol
    c. Drug abuse

3. Clinical:
    a. Oral hygiene: The oral hygiene status of the patients was assessed by Simplified Oral Hygiene Index (OHI-S) developed by Greene and Vermillion. The clinical levels of oral hygiene that can be associated with group OHI-S scores are as follows [32]:
        - Good: 0.0 - 1.2
        - Fair: 1.3 - 3.0
        - Poor: 3.1 - 6.0
    b. Presence of other infections
    c. Preoperative ASA category
    d. Operative wound classification

4. Preoperative hospital stay
5. Investigations:
    a. TC DC ESR Hemoglobin
    b. Blood sugar; SGPT, SGOT; S. urea, S. creatinine (for exclusion)
    c. Culture sensitivity

6. Intraoperative:
    a. Duration of surgery

Results and Observations

This was a prospective study conducted at the department of Surgical Stomatology, CSMU for a period of 12 months between February 2011 and January 2012. A total of 304 patients (males 183 females 121) who underwent elective surgery under general anesthesia in the department of Surgical Stomatology, CSMU, Simferopol, were studied. On analysis of the data the following observations were made.

Age in years	Sex						P value
	Male		Female		Total		
	No.	%	No.	%	No.	%	
< 10	29	15.8	24	19.8	53	17.4	
10 - 19	37	20.2	35	28.9	72	23.7	
20 - 29	36	19.7	22	18.2	58	19.1	
30 - 39	40	21.9	12	9.9	52	17.1	
40 - 49	16	8.7	9	7.4	25	8.2	
50+	25	13.7	19	15.7	44	14.5	
Total	183	100.0	121	100.0	304	100.0	
Mean ± SD	27.2 ± 16.5 (0.5 - 72.0)		24.9 ± 18.32 (0.67 - 78.0)		26.3 ± 17.3 (0.50 - 78.0)		0.269

Table 1: *Age and sex distribution of the study patients.*
P value reached from unpaired student's test (p > 0.05).

The mean age of the male patients was 27.2 ± 16.5 years ranging from 0.5 to 72.0 years and the mean age of the female patients was 24.9 ± 18.32 years ranging from 0.67 to 78.0 years. Analysis revealed that the mean age of the male patients was higher than the female patients, but the mean difference was not however statically significant (p > 0.05). It was also found that among the males the highest percentage was in the age group 30 - 39 years (21.9%) followed by 20.2% in the age range 10 - 19 years, 19.7% in the age range 20 - 29 years, whereas among the female patients, the highest percentage was in the age range of 10 - 19 years (28.9%) followed by 19.8% in the age group of less than 10 years and 18.2% in the age group 20-29 years.

Variables	Sex						P value
	Male (n = 183)		Female (n = 121)		Total (n = 304)		
	No.	%	No.	%	No.	%	
Occupation							
Unemployed and preschool	7	3.8	7	5.8	14	4.6	
Laborer/Farmer	22	12.0	18	14	40	13.15	
Service	80	43.7	6	5.0	86	28.3	0.001
Housewife	0	0.0	10	8.26	10	3.28	
Student	74	40.4	80	66.11	164	53.94	
Monthly income (UAH)							
< 2000	3	1.6	6	5.0	9	3.0	
2000 - 3999	166	90.7	110	90.9	276	90.8	
4000+	14	7.7	5	4.1	19	6.3	
Mean ± SD(Tk.) (Range)	2679.23 ± 770.9 (1000 - 6000)		2481.82 ± 582.4 (1500-5000)		2600.66 ± 707.6 (1000-6000)		0.017

Table 2: *Distribution of patients by occupation and monthly family income.*
P value reached from chi square analysis.
UAH: Ukrainian Hryvnia.

Regarding occupation, the highest percentage were students (53.94%) followed by service holders (28.3%), laborer and farmers (13.15%), unemployed and preschool (4.6%) and 3.28% were either housewives. Analysis revealed that the proportion of laborers were higher in males (18%) compared to females (14%). 43.3% of males were service holders and female service holder were 6%.

The mean household income of the patients was Hryvnia 2600.66 ± 707.6 ranging from Hryvnia 1000 to 6000. The mean family income of the male patients was Hryvnia 21679.23 ± 770.9 and the female patients was Hryvnia 2481.82 ± 582.4. Analysis revealed that the mean family income was higher among the male patients compared to female patients and the mean differences was statistically significant (p < 0.01). It was also found that majority of the patients had income in the range of Hryvnia riven 2000 to 3999.

Personal habit	Sex						P value
	Male (n = 183)		Female (n = 121)		Total (n = 304)		
	No.	%	No.	%	No.	%	
No habit	116	63.4	97	80.2	213	70.1	0.002
Smoker	59	32.2	21	17.35	80	26.31	
Alcohol	8	4.4	3	2.47	11	3.61	
Drug abuse	1	0.8	0	0	1	0.3	

Table 3: *Distribution of patients by personal habit.*
P value reached from chi square analysis (no habit vs. having personal habit).

Among the studied patients, 70.1% had no personal habit. 26.31.% were smokers, 3.61% had the habit of alcohol consumption, and 0.3 had habit of drug abuse. The proportion of personal habit was higher among the male patients (36.6%) than female patients (19.8%). The differences was statistically significant ($p < 0.002$).

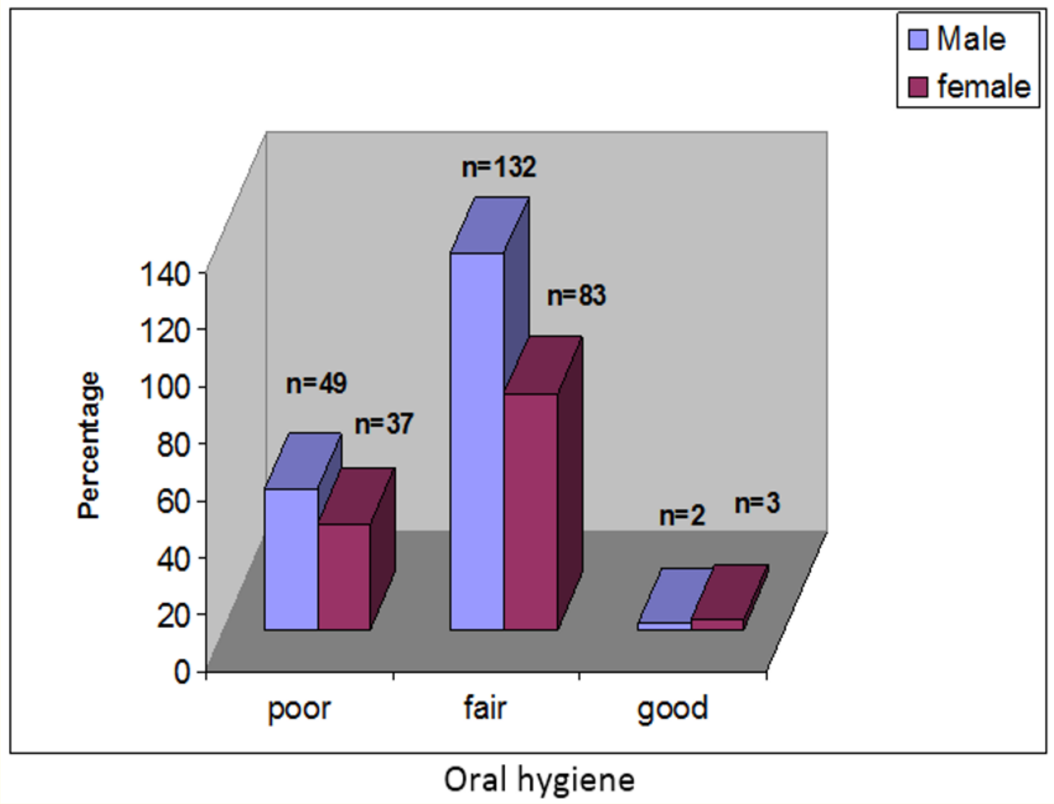

Figure 1: *Bar diagram showing the distribution of patients by oral hygiene.*

Analysis of the collected data revealed that 30.6% of the females had poor oral hygiene, 68% had fair oral hygiene and 0.8% had good oral hygiene. Likewise, among males 26.8% had poor oral hygiene, 72.1% had fair oral hygiene and 1.1% had good oral hygiene. Regarding the overall oral hygiene status of the patients of both the sexes 70.7% had fair oral hygiene, 23% had poor oral hygiene and only 1.0% had good hygiene. Though the proportion of poor oral hygiene was higher among the female patients compared to male patients (26.8%), the difference was however not statistically significant ($p = 0.471$).

Figure 2 shows the pattern of disease of the patients studied. Traumatic disease (23.4%) formed the highest percentage followed by benign neoplasm (23.0%), congenital diseases (20.4%), infective diseases (19.7%), malignant neoplasm (7.9%) and cystic diseases (5.6%).

ASA classification	Sex						P value
	Male (n = 183)		Female (n = 121)		Total (n = 304)		
	No.	%	No.	%	No.	%	
Category I	95	51.9	65	53.7	160	52.6	0.423
Category II	73	39.9	40	33.1	113	37.2	
Category III	7	3.8	8	6.6	15	4.9	
Category IV	8	4.4	8	6.6	16	5.3	

Table 4: *Distribution of patients by ASA status.*
P value reached from chi square analysis.

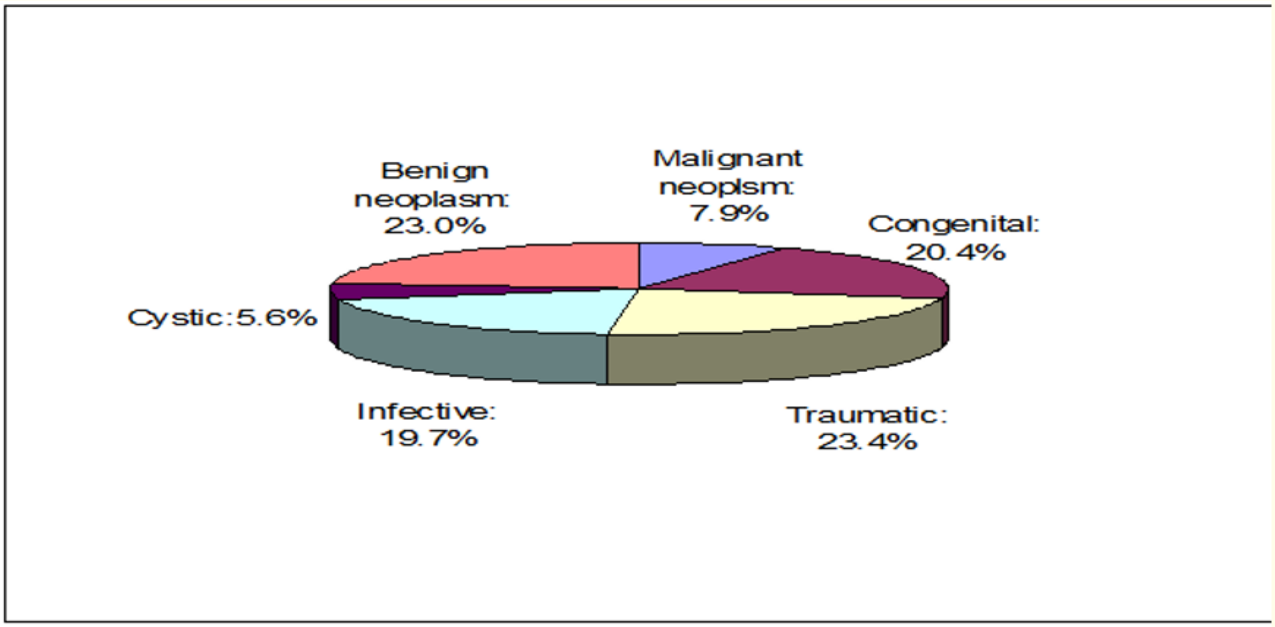

Figure 2: *Pie diagram showing the percentage distribution on of disease.*

Above table shows the ASA category of patients undergoing surgery. It was found that the highest percentage (52.6%) were in category I followed by 37.2% in category II, 5.3% in category IV and 4.9% in category III wounds. Analysis found no statistically significant difference between male and female patients (p > 0.05).

Wound status	Sex						P value
	Male (n = 183)		Female (n = 121)		Total (n = 304)		
	No.	%	No.	%	No.	%	
Class I	13	7.1	11	9.1	24	7.9	0.836
Class II	129	70.5	86	71.1	215	70.7	
Class III	8	4.4	6	5.0	14	4.6	
Class IV	33	18.0	18	14.9	51	16.8	

Table 5*: Distribution of patients by operative wound status.*
P value reached from chi square analysis.

Among the studied patients, the highest percentage had class II wound (70.7%) followed by class IV wound (16.8%), class I would (7.9%) and class III wound (4.6%). No statistically significant difference was however found between male and female patients (p > 0.05) regarding operative classification of wounds

Parameters	Wound infection				P Value
	Infected (n = 36)		Non- infected (n = 268)		
	No.	%	No.	%	
Age in years					
< 10	2	3.8	51	96.2	
10 - 19	10	13.9	62	86.1	
20 - 29	6	10.3	52	89.7	
30 - 39	7	13.5	45	86.5	
40 - 49	7	28.0	18	72.0	
50+	4	9.1	40	90.9	
Mean ± SD (Range)	29.13 ± 15.7 (5.00 - 70.00)		25.91 ± 17.5 (.50 - 78.00)		0.294
Sex					
Male	21	11.5	162	88.5	0.808
Female	15	12.4	106	87.6	
Occupation					
Preschool and unemployed	0	0.0	14	100.0	0.326
Service	2	9.1	20	90.9	
Laborer	13	15.1	73	84.9	
Housewife	9	15.5	49	84.5	
Student	12	9.7	112	90.3	
Monthly income (Taka)					
< 2000	0	0.0	9	100.0	
2000 - 3999	33	12.0	243	88.0	
4000+	3	15.8	16	84.2	
Mean ± SD (Range)	2625.0 ± 750.0 (2000 - 6000)		2597.4 ± 703.1 (1000 - 6000)		0.862

Table 6: *Relationships between wound infection and selective demographic parameters.*
P value reached from unpaired student's test (p > 0.05).
Other p value obtained from chi square test (p > 0.05).

Above table shows the relationship between POWI and selective demographic variables. The mean age of the infected patients was 29.13 +/- 15.7 years and that of non-infected cases was 25.91 +/- 17.5 years. It was evident that the proportion of wound infection was higher in age group 40 - 49 years (28.0%) followed by 13.9% in the age group of 10 - 19 years, 13.5% in the age group 30 - 39 years and lowest in the age group less than 10 years (3.8%). Though, the age of the infected patients was higher than the non-infected patients, the mean difference was not statistically significant (p > 0.05).

It was also evident that the proportion of wound infection was higher among female patients (12.4%) than male patients (11.5%), but the difference was not statistically significant (p > 0.05).

Similarly, the rate of wound infection was higher among the housewives (15.5%) followed by laborers (15.1%), students (9.7%) and lowest among service holders (9.1%). But no statistical association was found with wound infection and occupation of the patients (p > 0.05).

The mean income of the infected cases was Griven 2625 +/- 750 ranging from Griven 2000 to 6000 and that of non-infected cases was Griven 2597.4 +/- 703.1 ranging from Griven 1000.0 to 6000.0. The mean income of infected cases was higher than the non-infected cases, however, the mean difference was not statistically significant (p > 0.05).

Personal habit	**Wound infection**				**P Value**
	Infected (n = 36)		**Non- infected (n = 268)**		
	No.	**%**	**No.**	**%**	
No habit	22	61.1	191	71.3	0.211
Smoker	8	22.2	53	19.8	
Drug abuse	0	0.0	1	0.4	
Alcohol	6	16.7	21	7.8	

Table 7: *Relationship between wound infection and personal habit.*
P value reached from chi square analysis (no habit vs. having habit).

Analysis found no statistically significant difference between wound infection and personal habit (p > 0.05), however, the proportion of wound infection was higher among the cases having habit of smoking (22.2%) and alcohol consumption (16.7%).

Oral hygiene	**Wound infection**				**P Value**
	Infected (n = 36)		**Non- infected (n = 268)**		
	No.	**%**	**No.**	**%**	
Fair	19	8.8	196	91.2	
Good	0	0.0	3	100.0	
Poor	17	19.8	69	80.2	

Table 8: *Relationship between wound infection and Oral hygiene.*
P value reached from chi square analysis (Average vs. poor).

Above table shows the relationship between POWI and oral hygiene. Postoperative wound infection was found to be highest in patients with poor oral hygiene (19.8%) followed by those with an average oral hygiene (8.8%) and good oral hygiene (0%). The proportion of postoperative wound infection was higher among the patients with poor oral hygiene compared with average oral hygiene, whereas non-infection was higher with average oral hygiene and the relationship was statistically significant (p = 0.007).

History of infection	**Wound infection**				**P Value**
	Infected (n = 36)		**Non- infected (n = 268)**		
	No.	**%**	**No.**	**%**	
Yes	2	40.0	3	60.0	0.108
No	34	11.4	265	88.6	

Table 9: *Relationship between wound infection and previous history of infection.*
P value reached from fisher's exact test.

The proportion of wound infection was higher among the patients with previous history of infection (40.0%) compared to no history of infection (11.1%), however, no statically significant association was found in terms of wound infection and previous history of infection ($p > 0.05$).

Figure 3 shows the incidence of POWI in the department of Surgical Stomatology, CSMU, and Hospital. Out of 304 patients, 36 (11.8%) developed POWI and 268 (88.2%) did not develop wound infection. Analysis showed that 11.5% of the male patients and 12.4% of the female patients developed POWI, but the difference was not statically significant ($p > 0.05$).

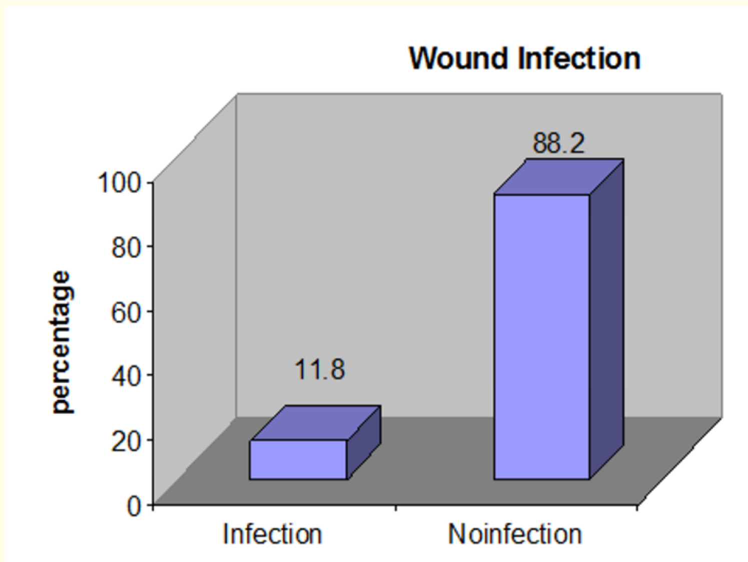

Figure 3: *Bar diagram showing postoperative wound infection.*

Figure 4 shows the pattern of bacteria involved in POWI. It was evident that the highest percentages were infected with *Staphylococcus aureus* (41.7%) followed by *Streptococcus viridians* (36.1%), mixed *Staphylococcus aureus/Streptococcus viridians* (8.3%), *Esch. coli* (8.3% and beta hemolytic *Streptococcus* (5.6%).

Parameters	Infected (n = 36)	Non-infected(n=268)	P value
Total WBC count	9505.56 ± 1167.4 (6500 - 12000)	9131.72 ± 1146.7 (6200 - 13500)	0.068
Neutrophil	64.81 ± 4.5 (56 - 75)	63.42 ± 4.0 (54 - 75)	0.056
Lymphocyte	26.14 ± 3.4 (20 - 36)	26.91 ± 2.8 (20 - 38)	0.136
Eosinophil	2.33 ± 1.1 (1 - 6)	2.71 ± 1.2 (1 - 8)	0.083
Monocytes	6.72 ± 2.3 (2 - 12)	6.96 ± 2.2 (1 - 16)	0.550

Table 10: *Relationship between wound infection and Hematological parameters.*
P value reached from unpaired student's test.
Figure in parenthesis indicate range.

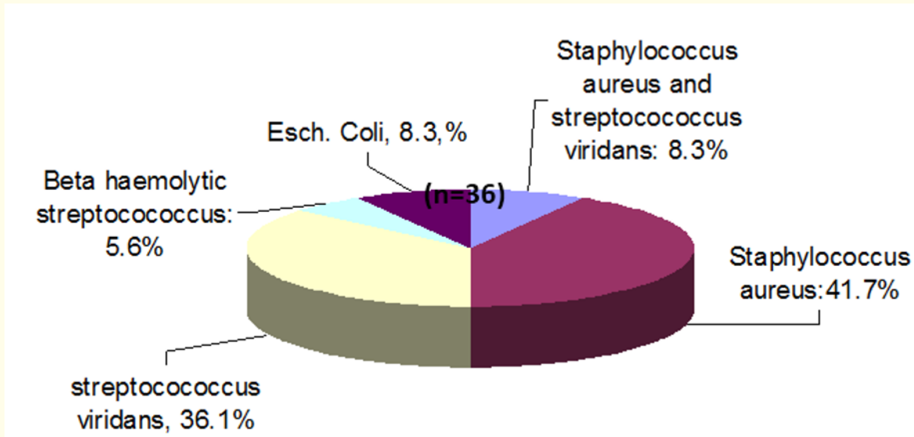

Figure 4: *Pie diagram showing the pattern of bacterial infection.*

Above table shows the hematological parameters of the study patients. Analysis showed that no statistically significant mean difference between infected and non-infected cases ($p > 0.05$), however, the total count of white blood cell and neutrophil counts were slightly higher among the infected cases than the non-infected cases.

Parameters	Wound infection				P Value
	Infected (n = 36)		Non- infected (n = 268)		
	No.	%	No.	%	
Hemoglobin					
Up to 10	16	24.6	49	75.4	
10.1 - 12	17	10.2	150	89.8	
12.1	3	4.2	69	95.8	
Mean ± SD (gm%)	10.89 ± 1.1 (9.00 - 12.50)		11.61 ± 1.0 (8.00 - 13.00)		0.001

Table 11: *Relationship between wound infection and laboratory investigation.*
P value reached from unpaired student's test.
Figure in parenthesis indicate range.

Analysis found that the mean hemoglobin level at the time of presentation for infected patients was 10.9 ± 1.1 gm% and that of non-infected cases was 11.6 ± 1.0 gm% and the mean difference was statically significant ($p < 0.001$). The rate of postoperative wound infection was found to be highest among the patients with hemoglobin level 10 gm% or less (24.6%) followed by those with 10.1 to 12.0 gm% (10.2%) and above 12 gm% (47.2%).

On analysis it was noted that the mean erythrocyte sedimentation was higher among the infected cases (14.39 mm in 1st hr) compared to non-infected cases (9.24 ± 11.7mm in 1st hr) and the mean difference was statistically significant ($p < 0.01$).

Disease pattern	Wound infection				P Value
	Infected (n = 36)		Non- infected (n = 268)		
	No.	%	No.	%	
Congenital	2	3.2	60	96.8	0.292[ns]
Traumatic	9	12.7	62	87.3	
Infective	8	13.3	52	86.7	
Cystic	3	17.6	14	82.4	
Benign neoplasm	11	15.7	59	84.3	
Malignant neoplasm	3	12.5	21	87.5	

Table 12: *Relationship between wound infection and pattern of disease.*
P value reached from chi square analysis
Ns= Not Significant (p > 0.05).

The above table shows the relationship between postoperative wound infection and the pattern of disease. It is evident from the table that the highest percentage of patients with cystic lesions (17.6%) developed postoperative wound infection followed by benign neoplasm (15.7%), infective diseases (13.3%), traumatic (12.7%), malignant neoplasm (12.5%) and congenital diseases (3.2%). However, the difference was not statistically significant.

ASA Category	Wound infection				P Value
	Infected (n = 36)		Non- infected (n = 268)		
	No.	%	No.	%	
Category I	10	6.3	150	93.8	0.010
Category II	19	16.8	94	83.2	
Category III	4	26.7	11	73.3	
Category IV	3	18.8	13	81.3	

Table 13: *Relation between wound infection and ASA status.*
P value reached from chi square analysis.

It was evident from the analysis that the proportion of wound infection was highest among the patients with ASA category III (26.7%) followed by 18.8% in category IV, 16.8% in category II patients and lowest among the patients of category I patients (6.3%). Analysis revealed that the postoperative wound infection significantly increased with ASA category of III and above (p < 0.01).

Preoperative wound class	Wound infection				P Value
	Infected (n = 36)		Non- infected (n = 268)		
	No.	%	No.	%	
Class I	2	8.3	22	91.7	0.001
Class II	16	7.4	199	92.6	
Class III	3	21.4	11	785.6	
Class IV	15	29.4	36	70.6	

Table 14: *Relationship between wound infection and operative wound class.*
P value reached from chi square analysis.

The above table shows that the proportion of wound infection was highest among the patients of wound class IV (29.4%) followed by class III (21.4%), class I (8.3%) and lowest in class II (7.4%). Analysis found the incidence of postoperative wound infection to be significantly higher in patients with class III and class IV wounds compared to the patients in other classes (p < 0.001).

Parameters	Wound infection				P Value
	Infected (n = 36)		Non- infected (n = 268)		
	No.	%	No.	%	
Preoperative stay (days)					
Up to 7	6	15.8	32	84.2	
8 - 14	7	12.5	49	87.5	
15 - 21	8	10.3	70	89.7	
22 - 28	6	12.0	44	88.0	
28+	9	11.0	73	89.0	
Mean ± SD (days)	20.8 ± 14.1 (2.00 - 71.00)		21.0 ± 12.4 (1.00 - 69.00)		0.001***
Post-operative stay (days)					
Up to 7	7	7.7	84	92.3	
8 - 14	8	5.6	136	94.4	
15 - 21	9	25.7	26	74.3	
22 - 28	7	41.2	10	58.8	
28+		29.4	12	70.6	
Mean ± SD (days)	18.6 ± 12.1 (1.00 - 57.00)		11.4 ± 7.7 (1.00 - 47.00)		0.014**
Duration of hospital stay (days)					
Up to 7	2	33.3	4	66.7	
8 - 14	1	4.2	23	95.8	
15 - 21	1	2.6	37	97.4	
22 - 28	7	10.9	57	89.1	
28+	25	14.5	147	85.5	
Mean ± SD (days)	39.4 ± 19.2 (6.00 - 89.00)		32.4 ± 14.8 (3.00 - 87.00)		0.011**
Duration of operation (minutes)					
< 60	0	0	21	100.0	
60 - 120	7	8.8	73	91.3	
120 - 180	21	13.7	132	91.3	
180+	8	16.0	42	84.0	
Mean ± SD (days)	146.9 ± 58.5 (60 - 360)		128 ± 46.4 (30 - 250)		0.027*

Table 15: *Relationship between wound infection and hospital stay and duration of operation.*

P value reached from unpaired student's test. Figure in parenthesis indicate range.

**P < 0.05; **p < 0.01; ***p < 0.001.*

The preoperative hospital stay for infected cases was 20.8 +/- 14.1 days and that for non-infected cases was 21.0 +/- 12.4 days. However, no statically mean duration of preoperative hospital stay was found between two groups of patients (p > 0.05).

Regarding postoperative hospital stay, the mean duration of hospital stay was significantly high among the infected cases (18 +/- 12.1 days) compared to non-infected cases (11.4 +/- 7.7 days) (p < 0.001). Consequently, the total mean duration of hospital stay was significantly high among the infected cases (39.4 +/- 19.2 days) than the non-infected cases (32 +/- 14.8 days) and the mean duration was statistically significant (p < 0.01).

Another important point identified is that the mean duration of operation was significantly high among the infected cases (146.9 +/- 58.5 minutes) than the non-infected cases (128.1 +/- 46.4 minutes) and the mean difference was statistically significant (p < 0.05). It was found that the highest percentage of patients were infected in the group where the duration of surgery exceeded 180 minutes (16%) followed by the group in which surgery lasted between 120 to 180 minutes (13.7%). Only 8.8% of the patients were infected when the surgery lasted for 60 to 120 minutes and none of the patients with duration of surgery less than 60 minutes was infected.

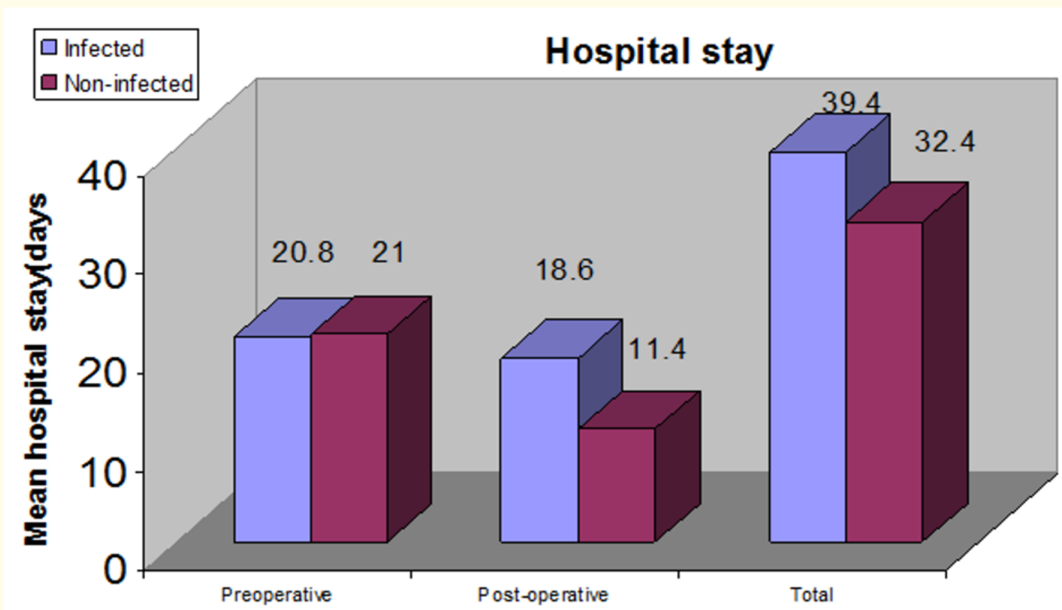

Figure 5: *Bar diagram showing the mean duration of hospital stay (days).*

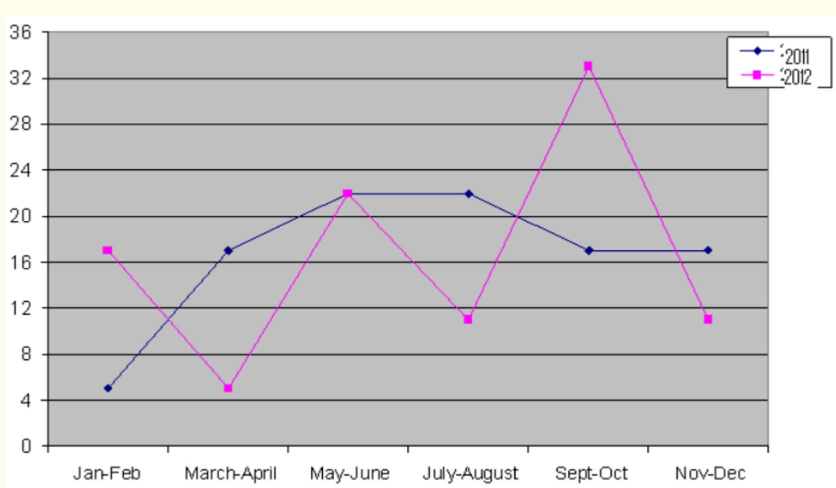

Figure 6: *Line diagram showing the trends of hospital infection.*

The line diagram in figure 6 shows the trend of postoperative wound infection during the period of February 2011 and January 2012. The rate of infection was highest in the months of July and August 2012 and lowest in November - December 2012.

In the year of 2011 the incidence of wound infection showed a rising trend up to the month of June then formed a plateau till the month of July-August after which it stated declining till November - December 2012. In the year a fluctuating trend was observed with the highest in the month of July-August and the lowest in the month of November-December.

Antibiotic	Number	Staph. aureus	Strep. Viridians (%)	Beta hemolytic streptococci	E. coli (%)
▯Amikacin	13	100.0	100.0		100.0
▯Fusidic acid	11	100.0	100.0	100.0	100.0
Cefotaxime	26	76.9	54.5	100.0	33.3
▯Ceftriaxone	34	76.5	66.7	100.0	33.3
▯Cloxacillin	33	76.5	61.5	100.0	33.3
Cephradine	33	75.0	64.3	100.0	33.3
Gentamycin	32	73.3	66.7	100.0	33.3
Augmentin	23	66.7	100.0	100.0	100.0
Cefaclor	12	57.0	20.0	100.0	0.0
Erythromycin	29	56.3	45.5	50.0	0.0
Ciprofloxacin	35	55.6	53.3	50.0	33.3
Cephalexin	30	53.8	57.1	100.0	33.3
Cefixime	8	50.0	50.0	-	0.0
Azithromycin	2	50.0	-	-	-
Cotrimoxazole	17	12.5	20.0	0.0	0.0
Ampicillin	34	11.1	0.0	50.0	0.0
Amoxycillin	5	0.0	0.0	0.0	0.0
Bacitracin	1	0.0	-	-	-
Carbenicillin	2	0.0	-	-	0.0
Penicillin	1	0.0	-	-	-

Table 16: *Pattern of antibiotic sensitivity against specific bacteria.*

Above table shows the pattern of antibiotic sensitivity against specific bacteria. It was evident that staphylococcus aureus, was 100% sensitivity to amikacin and fusidic acid, more than 75% sensitive to ceftriaxone, cephradine, cloxacillin and gentamycin and was between 50% and 70% sensitive to augmentin, cefaclor, erythromycin, cephalexin, cefixime, azithromycin and erythromycin. It showed less than 15% sensitivity to amoxicillin. Penicillin, bacitracin and carbenicillin.

Likewise, *Streptococcus viridians* showed 100% sensitivity to amikacin, fusidic acid and augmentin; between 50% and 70% sensitive to ceftriaxone, cefotaxime, cephradine, cloxacillin, gentamycin, ciprofloxacin, and cephalexin. It was totally insensitive to ampicillin and amoxycillin.

Beta hemolytic *Streptococcus* was found to be 100% sensitive to fusidic acid, ceftriaxone, cefotaxime, cephradine, cefaclor, cephalexin, cloxacillin, gentamycin and augmentin and 50% sensitive to erythromycin, ciprofloxacin and ampicillin. It, however showed no sensitivity to amoxicillin.

Similarly, *E. coli* was 100% sensitive to amikacin, fusidic acid and augmentin, and 33.3% sensitive to ceftriaxone, cefotaxime, cephradine, cephalexin, cloxacillin, gentamycin, augmentin and ciprofloxacin. It, however showed sensitivity to penicillin, amoxicillin, cotrimoxazole and erythromycin.

Discussion

In this cross-sectional study carried between February 2011 and January 2012, 36 out of 304 patients (11.8%) developed postoperative wound infection which is slightly higher than that reported by Natasha., *et al.* [5] (11.4%) in 1997. Similarly, Maria in 1999 reported an overall infection rate of 10.09% following abdominal surgery in CSMU, 6th Hospital and Simferopol while Asim[6] and Cristina[7] reported an overall infection rate of 24.2% and 3.49% respectively.

The reason behind our infection rate being slightly higher than that reported by Natasha [5] could be due to the difference in the study population. Likewise, great variation in the rate of wound infection at different centers could be due to the difference in the definition of wound infection and duration for which the patients were followed up. D J Byrne., *et al.* [33] therefore, suggests that for the comparison of infection rates between multiple centers to be more meaningful, an objective wound infection scoring system should be used and the period of follow up should be identified.

This study also revealed an increased vulnerability in our population to develop POWI from the age of 40 years and above. Though the result was statistically not significant, the finding however, contradicts with the statements of authors like Cruse and Frood [20], Northy [21] and Valesco., *et al.* [11] who categorized age above 50 years as a potential risk factor. The cause of this vulnerability could be due to poor socioeconomic status of our patients with consequent malnutrition, anemia and poor oral hygiene.

There was no significant difference in the development of POWI between two sexes. Likewise, no difference was observed in relation to socioeconomic status or occupation of the patients.

This study shows that 19.8% of the patients with poor oral hygiene subsequently developed wound infection while as only 8.7% of the patients with fair oral hygiene and none with good oral hygiene developed infection. This suggests that oral hygiene status is an important parameter that can influence the development of wound infection in surgeries performed by intraoral combined intraoral-extraoral approach. It also indicated that preoperative measures to improve Oral Debris Index Score (the clinical levels of oral cleanliness for debris) by regular tooth brushing and rinsing with medicated mouthwashes alone is not sufficient to have a positive impact in the reduction of POWI. Therefore, measures like scaling to improve Calculus Index Score should also be invariably performed in a patient undergoing Maxillofacial Surgery.

No statistically significant difference was found with various habits of patients, though it was noted that the rate of infection was higher in smoking (22.2%) and alcohol consumption 13.1%).

Valesco., *et al.* noticed a significant rise in the incidence of infection in ASA category IV and V. In contrast; a statistically rise in the incidence of POWI was noted from Category III and above in our series. This could be due to the difference in local factors like poor oral hygiene in our patients.

In this study, the rate of wound infection in Class III and Class IV was found to be significantly higher than in other groups and was comparable with the figure suggested by American National Research Council Criteria by Krukowski., *et al* [4]. However, the rate of infection in our study was higher in Class I wounds (8.3%) in comparison to Krukowski's [4] estimation of below 2% for Class I wounds. The reason behind this could be the fact that in both the cases that subsequently developed infection in this rather small group, surgery had lasted more than 4 hours. This observation therefore, suggests that the infection rates for various classes of wound cited by Krukowski., *et al.* in 1984 can be modified by other parameters and at the same time supports the fact that the duration of surgery is an independent risk factor in the development of wound infection.

The study patients in this series had a hemoglobin level between 8 gm% and 13 gm% at the time of presentation. All the patients with the hemoglobin level below 10 gm% given blood transfusion before surgery and also intraoperatively and postoperatively whenever deemed necessary. In spite of all the measures taken to maintain an optimum hemoglobin level perioperatively, the patients who at the time of presentation had hemoglobin level below 10gm% showed a highly significant increased rate of POWI (24.6%) followed by those who presented with hemoglobin level between 10 gm% and 12 gm% (10.2%), only 4.2% of the patients with hemoglobin level above 12 gm% at the time of presentation developed POWI. This liability to develop POWI could be attributed to the fact that patients with anemia especially if chronic are more likely to be systemically compromised.

Regarding the association between POWI and the underlying pathology no significant difference was noticed though it was seen that the rate of POWI was highest in surgery for cystic lesions and lowest for the congenital diseases. The possible reason could be the tendency of our patients to seek treatment late, usually only after functionally compromised or often only after the development of secondary infection and associated pain. The presence of infection naturally makes the patients prone to develop infection. Often, the size of the lesion at the time of presentation necessitates extensive surgery which usually also prolongs the duration of surgery. In addition, bone grafts were not used to reconstruct the bony defects. All these factors could have added up to make this group of patients more vulnerable to develop wound infection.

This study also revealed that the longer the duration of surgery higher the probability of infection. 16% of the patients with a duration of surgery greater than 180 minutes developed POWI while as none with duration of surgery less than 60 minutes developed POWI. This finding could be related to increased chances of bacterial contamination and reduced effect of the prophylactic antibiotics that occurs in lengthy operative procedures.

Wound infection is a major cause of delayed discharge from hospital and a drain in resources. Olson., *et al.* in 1993 stated that estimation of prolongation of hospital stay for individual patients due to surgical wound infection ranges from 6 to 14 days. Likewise, Davies and Kibbler [29] found that hospital acquired infections prolonged the length of hospital stay in an average by 7 days. Lizan-Garcia [5] also found the hospital stay to be prolonged by about 7 days. In our study, the duration of postoperative hospital stay of infected patients was in an average 7.2 days more than that of the non-infected group.

On analysis, it was found that the trend of wound infection in this study carried out between 2011 and 2012 the highest rate of infection occurred in the months of July - August 2012 and lowest in the months of November and December 2012. In the year 2011 there was a rising trend followed by a plateau between June and July and declining trend thereafter. In contrast, there was a fluctuating trend in the year 2012. The cause of increased rate of infection in July - August, 2012 could be due to damp weather at that time promoting over saturation of organisms in the environment and also encouraging proliferation of organisms in the wound so it could simply be a chance finding that needs further study on a larger group of patients for a longer duration of period.

In our study, the majority of organisms causing wound infection were Gram positive aerobic bacteria of which *Staphylococcus aureus* was found to be the commonest (41.7%) followed by *Streptococcus viridians* (36.1%), mixed (*Staphs aureus/Strep.viridans*-8.3%) and beta-hemolytic *Streptococcus* (5.6%). *Escherichia coli* (8.3%) was the only Gram-negative aerobic organism found to cause POWI. This infection contradicts with the normal phenomenon of mixed infections in peri-maxillary region and in all probabilities is due to the method of prophylaxis that is used at our institute (ceftriaxone and metronidazole).

Regarding sensitivity of organisms to various antibiotics, 100% of *Staphylococcus aureus*, 100% of *Streptococcus viridians*, 100% beta hemolytic *Streptococcus* and 100% of *E. coli* were sensitive to amikacin and fusidic acid while as 76.5% of *Staph. aureus*, 66.7% of *Strep. viridans*, 100% of beta-hemolytic *Streptococcus* and 33.3% of *E. coli* was sensitive to ceftriaxone.

The sensitivity of cloxacillin, cephradine and gentamycin to various organisms causing POWI was comparable to that of ceftriaxone (approximately 75%).

Only 11.1% of *Staphylococcus* and 50% of beta-hemolytic *Streptococcus* were found to be sensitive to ampicillin while as *Strep. viridans* and *E. coli* was resistant. All the organisms were resistant to amoxycillin.

Keith in 1999 reported from her study conducted in CSMU 6th hospital that 100% of *Staphylococcus aureus*, beta-hemolytic *Streptococcus* and *E. coli* were sensitive to ceftriaxone. This study however, revealed that many strains of *Staphylococcus aureus, Streptococcus viridans*, beta-hemolytic *Streptococcus* and *E. coli* have now developed resistance against multiple drugs including ceftriaxone. This could be due to the widespread indiscriminate use of the drugs in the last five years.

Conclusion

The measures taken to improve oral hygiene of the patients by improving Oral Debris Index score alone (post meal tooth-brushing and oral rinse with medicated mouthwash) is inadequate to have a significant impact in the reduction of POWI. Therefore, measures to improve Calculus Index Score (scaling) should also be invariably carried out.

Gentamycin, cephradine and cloxacillin exhibited a comparable antibiotic sensitivity pattern to that of ceftriaxone against various causative organisms. Therefore, the current practice of indiscriminate use of ceftriaxone should be checked out and other cheaper alternatives with equally good results like gentamycin and cephradine could be used.

This study is a limited scale study in a limited period of time. To clarify the outcome of this study, a broad based study for a longer duration with larger number of patients needs to be carried out.

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Bibliography

1. Kurkowski ZH., *et al*. "Infection after abdominal surgery: five prospective study". *British Medical Journal* 288 (1984): 278-280.
2. Lizan-Garcia M., *et al*. "Risk factors for surgical-wound infection in general surgery: a prospective study". *Infection Control and Hospital Epidemiology* 18.5 (1997): 310-315.
3. Leaper DJ. "Wound infection: Bailey and Love's Short Practice of surgery". 22nd edition. London: ELBS with Chapman and Hall (1995): 63-74.
4. Becker GD. "Identification and management of the patients at the high risk for wound infection". *Head Neck Surgery* 8.3 (1986): 205-210.

5. Velasco E., *et al*. "Risk factors for surgical wound infection development in head and neck cancer surgery". *Revista do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo* 50.1 (1995): 58-62.

6. Rubin J., *et al*. "Bacteriologic analysis of wound infection following major head and neck surgery". *Archives of Otolaryngology-Head and Neck Surgery* 114.9 (1998): 969-972.

7. Remy H Blanchaet Jr and Alexander E Pazoki. "Antibiotic: Prophylactic Use in Head and Neck Surgery". EMedicine's Public Health Center (2004).

8. Haley RW., *et al*. "Identifying patients at high risk of surgical wound infection". *American Journal of Epidemiology* 121.2 (1985): 206-215.

9. Barna M., *et al*. "Infection in the oral and maxillofacial areas: their prevalence (1983-1992) and the evolution of the antibiotic sensitivity to the microbes involved". *Revista Medico-Chirurgicala a Societatii de Medici si Naturalisti din Iasi* 99.3-4 (1995): 203-210.

10. Keith. "Postoperative wound infection: organism pattern and antibiotic sensitivity". Department of surgery, CSMU simaska (1993): 131.

11. Northy D. "Microbial surveillance in a surgical intensive care unit". *Surgery, Gynecology and Obstetrics* 139.3 (1974): 321-326.

12. Seropian R and Reynolds BM. "Wound infections after preoperative depilatory versus razor preparation". *American Journal of Surgery* 121.3 (1971): 251-256.

13. Shapiro M., *et al*. "Risk factors for infection at the operative site after abdominal or vaginal hysterectomy". *New England Journal of Medicine* 307.27 (1982): 1661-1666.

14. Hansis M. "Path physiology of infection- a theoretical approach". *Injury* 27.3 (1996): SC5-SC8.

15. Francesc Gudiol. "Surgical antibiotic prophylaxis: tradition and change". *International Journal of Clinical Practice, Supplement* 95 (1998): 39-43.

16. Cruse PJE and Frood R. "A five year prospective study of 23,649 surgical wounds". *Archives of Surgery* 107.2 (1973): 206-210.

17. Al-Fallouji MAR. "Surgical Wound Infection: Postgraduate Surgery". 2nd edition. Oxford: Butterworth-Heinemann (1998): 180.

18. Ronald Lee Nichols. "Surgical Wound Infection". *The American Journal of Medicine* 91.3B (1991): S54-S64.

19. Downy MS and Lamy CJ. "Postoperative Wound Infection: General Principles and Considerations". *Clinics in Podiatric Medicine and Surgery* 7.3 (1990): 405-431.

20. Hakan Coskun and Levent Erisen Oguz. "Factors affecting wound infection rates in head and neck surgery". XVI World Congress of Otorhinolaryngology Head and Neck Surgery. Sydney, Australia (1997).

21. Slattery III WH., *et al*. "Prophylactic Antibiotic Use in Clean, Uncontaminated Neck Dissection". *Laryngoscope* 105 (1995): 244-246.

22. Antoniadis K and Maggoudi D. "The use of prophylactic antibiotics in oral and maxillofacial surgery". *Hellēniko Periodiko gia Stomatikē kai Gnathoprosōpikē Cheirourgikē* 5.2 (1990): 53-58.

23. Widdison AL., *et al*. "Survey of guidelines for antimicrobial prophylaxis in surgery". *Journal of Hospital Infection* 25.3 (1993): 199-205.

24. Davies A and Kibbler C. "Prevention of infection in surgical practice: Clinical Surgery in General 3rd edition". London: Churchill Livingstone (1999): 211.

25. Johnson., *et al*. "Comparison of ampicillin/Sulbactam versus Clindamycin in the prevention of infection of patients undergoing head and neck surgery". *Head and Neck* 19.5 (1997): 367-371.

26. Blair EA., *et al*. "Cost analysis of antibiotic prophylaxis in clean head and neck surgery". *Archives of otolaryngology-Head and Neck Surgery* 121.3 (1995): 269-271.

27. Spolsky V W. "Epidemiology of Gingival and Periodontal Disease: Clinical Periodontology". 8th edition Singapore: Harcourt Asia PTE LTD (1999): 61-79.

28. Byrne DJ., *et al*. "Wound infection rates: the importance of definition and post-discharge wound surveillance". *Journal of Hospital Infection* 26.1 (1994): 37-43.

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