



Original Research Article

## Incidence of Staphylococcus Aureus in Elective Surgery and Its Correlation with Carrier State - A Study in Rural Set Up

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### ABSTRACT

**Backgrounds:** Surgical site wound infection (SSI) is one of the major issue for surgeon & his patient post operatively. *Staphylococcus aureus* have been recognised as one of the major challenge in control of hospital infections & important pathogen in SSI. The emerging threat of widespread antibiotic resistance poses a serious public health concern.

**Aims, settings & design:** The present prospective study was conducted in 250 general surgery patients over a period of 2 years in between June 2010 to May 2012 in rural set up to find out the incidence of *Staph.aureus* & susceptibility antibiotic for *Staph.aureus* from SSI & to study correlation of pre-operative positive nasal swab for *Staph.aureus* and post-operative SSI.

**Materials & Methods:** A nasal swab was taken for nasal *Staph.aureus* carriage from all patients (n) who underwent elective surgery & surgical staff. Organisms were identified by conventional biochemical methods and antimicrobial susceptibility was performed. There are scoring systems used to asses SSI postoperatively if patient developed SSI.

**Results:** In present study out of 250 patients 24(9.6%) developed SSI. Out of 72 preoperative nasal swab isolates of *Staph.aureus* only 5(6.9%) developed SSI due to *Staph.aureus* & 4 (5.6%) patients develop other organism then *Staph.aureus* which had 0.513 p value which was statistically not significant ( $p>0.05$ ).

**Conclusions:** Though high incidence of SSI is observed in preoperative nasal carriers of *Staph.aureus* but statistical significant relation with development of SSI cannot be established.

**Key words:** Surgical site infection (SSI), *Staphylococcus aureus*, Nasal carrier.

### INTRODUCTION

Surgical Site Infection (SSI) is an infection that occurs somewhere in the operative field following surgical intervention.<sup>[1]</sup> Nosocomial infection are among the ten leading cause of death in the U.S. & more than 20% of nosocomial infection are Surgical Site Infection.<sup>[2]</sup> That

may contribute to longer hospital stays, significantly increase the cost of medical care and are likely to have an important role in the development of antimicrobial resistance.<sup>[3]</sup> Despite the availability of potent antimicrobial agents, improve public health condition & hospital infection control measures, *Staphylococcus aureus* has

remained a major human pathogen. Indeed development of new antibiotics resistance & other epidemiologic condition have re-established this micro – organism as a major pathogen.<sup>[4]</sup>

*Staphylococcus aureus* is a human commensal and a frequent cause of clinically important infections. There is a worldwide increase in the prevalence and infections caused by MRSA. The recent isolation of vancomycin-resistant MRSA strains is a major cause for concern.<sup>[5]</sup>

The anterior nares of the nose is the most frequent carriage site of *Staph.aureus* in human beings.<sup>[6]</sup> Most studies regarding the risks of acquiring *Staph.aureus* infections in the community concern skin & soft tissue infections. Most of these infections are caused by the patient's own *Staph.aureus*, which were already present before hospital admission.<sup>[5,7]</sup>

## **MATERIALS & METHODS**

The present prospective study was carried out in general surgery department over a period of two year between June 2010 and May 2012. All patients who underwent elective surgery during the study period were enrolled in the study. Each of them had a nasal swab taken for *Staph.aureus* on the day of surgery. After surgery, patients were monitored for 4 weeks for the development of SSI. In addition, 38 people of the surgical staff, which is a large majority of the people working in this department, were screened for nasal *Staph.aureus* carriage.

Variables used were Body mass index, H/O Smoking, Alcoholism & Diabetes, Preoperative shaving whether 1 hour or 12 hour before planned operation, Preoperative shower had taken/not, taken using chlorhexidine containing soap, on the night before surgery, Duration of the operation performed, Whether SSI is present

as per CDC criteria for defining SSI, Microorganisms isolated as per the culture and sensitivity of the Pre-operative nasal swab and the wound swab collected from the wound discharge if any & Post operative duration of stay in patient diagnosed to have an SSI.

All preoperative patients irrespective of age & sex undergoing elective surgery that developed SSI postoperatively & cases which yielded *Staph.aureus* from cultured sample. Cases which yielded non – *Staph.aureus* bacteria were excluded.

Sample collection done by the swab was taken from both nostrils consecutively while applying an even pressure preoperatively & wound of SSI postoperatively. The specimens were transported in sterile, leak-proof container to Department of Microbiology. All specimens were smeared for gram staining & inoculated on 5% blood agar, Mueller Hinton agar & MacConkey agar plates and incubated overnight at 37°C aerobically. Identification of bacterial pathogens did by conventional biochemical methods.<sup>[8]</sup>

Susceptibility testing was done on Mueller Hinton Agar plates by Kirby-Bauer Disk Diffusion Technique. The plates were incubated at 37<sup>0</sup> C for 18 – 24 hours and results were tested for vancomycin (Va), oxacillin (Ox), amoxiclav (Ac), ampicillin (A), ciprofloxacin (CIP), co-trimoxazole (COT), cefotaxime (Ce), tetracycline (T), amikacin (Ak) and mupirocin (Mu) antibiotics. oxacillin susceptibility was tested using 1µg disc on Muller Hinton agar with 4% NaCl and plates were incubated at 35<sup>0</sup> C for complete 24 hours. We defined multi-drug resistant (MDR) isolates as those resistant to 3 different antibiotics. The differentiation between major and minor SSI is important in patient.

## RESULTS

**1. Baseline Characteristics Of Patients (N=250) (Table 1):** Maximum patient i.e 30% & 29.2% were within 20 to 40 years & 40 to 60 years age group respectively. Sex wise Male patients were 54% and 46% were female. Body mass index evaluation

revealed that out of 250 patients 5.6% patients were under nourished & 2.8% were obese. While over nutrition was noted in 28.8% patients in the study. 16.8% were smokers & 11.2% were alcoholics. 26.8% patients had a past history of diabetes mellitus.

Table – 1: Baseline Characteristics of Patients (N=250).

Characteristic	Group	No of Patients	Percentage
AGE (YEARS)	<20	51	20.4
	20-40	75	30
	40-60	73	29.2
	60-80	49	19.6
	>80	2	0.8
SEX	Female	115	46
	Male	135	54
BMI (kg/m <sup>2</sup> )	<20 (under Nutrition)	14	5.6
	20-25 (Normal)	157	62.8
	25-30 (Over Nutrition)	72	28.8
	>30 (Obese)	7	2.8
SMOKING	No	208	83.2
	Yes	42	16.8
DIABETES	No	183	73.2
	Yes	67	26.8
ALCOHOL	No	222	88.8
	Yes	28	11.2
TOTAL		250	100

**2. Isolates from Nasal swab of patients & surgical team:** Preoperative nasal swab culture of the patient had Streptococcus spp in 37.6%, CoNs in 30% & 28.8% *Staph.aureus* organism. Total number of surgical team member – 38 & Total number of sample – 912. Organism isolated from nasal swab culture of operation theatre staff revealed that *Strepto spp* 40.5% (369), *CoNs* 31.4% (286), *Staph.aureus* 23.4% (213) & sterile 5.7 % (52).

**3. Antibiotic susceptibility of isolated *Staph.aureus* from Nasal carriers of Patient:** Antibiotic sensitivity of the *Staph.aureus* was found to have maximum sensitivity i.e 100%, 93.1% & 90.3% to vancomycin, mupirocin and oxacillin respectively. Intermediate sensitivity was found in 22.2%, 19.4% & 16% *Staph.aureus* with cotrimoxazole, tetracycline & ampicillin. Maximum resistance was noted by *Staph.aureus* in 25% to tetracycline, 23.6% to ampicillin & co-trimoxazole and

22.2% to ciprofloxacin. 15 (20.83%) isolates of *Staph.aureus* were noted multidrug resistant and 3 (4.16%) isolates noted resistance to oxacillin.

**4. Antibiotic susceptibility of Isolates *Staph.aureus* (N=213) from Nasal carriers of Surgical team:** Antibiotic sensitivity of the *Staph.aureus* was found to have maximum sensitivity i.e 100%, 93.1% & 90.3% to vancomycin, mupirocin and oxacillin respectively. Intermediate sensitivity was found in 22.2%, 19.4% & 16% *Staph.aureus* with cotrimoxazole, tetracycline & ampicillin. Maximum resistance was noted by *Staph.aureus* in 25% to tetracycline, 23.6% to ampicillin & co-trimoxazole, 22.2% to ciprofloxacin. 15 (20.83%) isolates of *Staph.aureus* were noted multidrug resistant and 3 (4.16%) isolates noted resistance to oxacillin.

**5. Microorganism isolated from patient SSI (N=24) (Table 2):** Out of 24 patients *Staphylococcus aureus* was isolated in

37.5% patients having surgical site infection while in 29.2% patient *E.coli* was found.

**Table – 2: Microorganism Isolated from Patients SSI (N=24).**

Organism	No of isolates	Percentage
Staphylococcus aureus	09	37.5
E.Coli	07	29.2
CoNS	05	20.8
Strepto.Spp	03	12.5
Proteus	01	4.2
Bacteroids	01	4.2
Enterococcus	01	4.2

**6. Antibiotic susceptibility of Isolated *Staph.aureus* from SSI (Table 3):**

Sensitivity of *Staph.aureus* isolated from SSI was 100% to vancomycin, 88.88% to mupirocin & 66.66% with oxacillin and

amikacin, while in 55.5% patients *Staph.aureus* had Sensitivity to amoxyclav, ciprofloxacin, co-trimoxazole, cefotaxime. Intermediate sensitivity was noted maximally *i.e* in 22.22% to oxacillin, cefotaxime, tetracycline respectively in the study. Resistance of *Staph.aureus* was noted in 44.44% to ampicillin & tetracycline, and 33.33% to amoxyclav, ciprofloxacin, co-trimoxazole of the isolates from patients with SSI. 7 (77.77%) isolates of *Staph.aureus* were noted multidrug resistant And 1 (11.11%) isolates noted resistance to oxacillin.

**Table 3: Antibiotic susceptibility of Isolated *Staph.aureus* from SSI.**

Staph.aureus	Va	Ox	Ac	A	CIP	COT	Ce	Te	Ak	Mu
S	09	06	05	04	05	05	05	03	06	08
%	100	66.66	55.55	44.44	55.55	55.55	55.55	33.33	66.66	88.88
IS	00	02	01	01	01	01	02	02	01	00
%	0	22.22	11.11	11.11	11.11	11.11	22.22	22.22	11.11	0
R	00	01	03	04	03	03	02	04	02	01
%	0	11.11	33.33	44.44	33.33	33.33	22.22	44.44	22.22	11.11

S –Sensitivity, IS – Intermediate Sensitivity, R – Resistance

**7. Distribution of operative variables of patient in the study (N=250) (Table 4):**

Patients with shaving before 1 hour 13.2% had SSI while in 9.6% patients having shaving before 12 hours had developed SSI. The difference was found to be statistically significant (p<0.05). Shower was taken 6% patients that developed SSI, in 13.8% of those not taken shower before the operative procedure had developed SSI. The

difference of proportion of developing SSI with the Status of shower was statistically significant (p<0.05).

Patients with the operative duration of 60 to 90 minutes 23.3% developed SSI, while Patients with 90 -120 minutes of procedure, SSI was developed in 30.4%. This difference of the operative duration with the development of SSI was statistically highly significant (p<0.05).

**Table 4: Distribution of operative variables of patient in the study (N=250).**

Variable	Group	Total	SSI		pValue
			No	Yes	
Shaving	1 hr Before	114	99(86.8%)	15(13.2%)	0.047*
	12 hr Before	94	85(90.4%)	9(9.6%)	
	Not applicable	42	42(100%)		
Shower	Taken	134	126(94%)	8(6%)	0.036*
	Not Taken	116	100(86.2%)	16(13.8%)	
OT Duration (min)	< 30	74	74 (100%)		0.001**
	30 to 60	92	89(96.7%)	3(3.3%)	
	60 to 90	60	46(76.7%)	14(23.3%)	
	90 to 120	23	16(69.6%)	7(30.4%)	
	>120	1	1(100%)		
Total			226	24	

\*Significant as p<0.05, \* \*Highly significant as p<0.01.

**8. Preoperative Nasal isolates leading to SSI due to *Staph.aureus* organism (Table 5):** Out of 72 preoperative nasal swab isolates of *Staph.aureus* only 6.9% developed SSI due to other than

*Staph.aureus* organism while 87.5% patient did not develop SSI. This difference of the development of SSI due to *Staph.aureus* in nasal swab positive was statically not significant ( $p < 0.05$ ).

**Table 5: Preoperative Nasal isolates leading to SSI due to *Staph.aureus* organism.**

Preoperative Nasal Swab Isolates		SSI			Total
		No	Yes		
			Staph. aureus	Other than Staph. aureus	
Strepto Sp.	Count	88	2	4	94
	% within Preop isolates	93.6%	2.1%	4.3%	100%
CoNS	Count	66	4	5	75
	% within Preop isolates	88.0%	5.3%	6.7%	100%
Staph.aureus	Count	63	5	4	72
	% within Preop isolates	87.5%	6.9%	5.6%	100%
Sterile	Count	9	-	-	9
	% within Preop isolates	100.0%	-	-	100.0%
Total	Count	226	11	13	250
	% within Preop isolates	90.4%	4.4%	5.2%	100%

**9. Correlation of some parameters with Development of SSI (Table 6):**

Out of 250 patients 24 patients had developed SSI in the study this development of SSI was positively correlated to Age,

BMI, Smoking history and Diabetes. While there was no correlation found with Alcohol and preoperative organism in nasal swab culture.

**Table 6: Correlation of some parameters with Development of SSI.**

CORRELATION						
SSI	AGE	BMI	SMOKING	ALCOHOL	DIABETES	Preoperative organism report
Correlation	0.129*	0.224**	0.144*	0.030	0.171**	0.043
Sig.(2-tailed)	0.042	0.000	0.023	0.641	0.007	0.501
N	250	250	250	250	250	250
* Correlation is significant at the 0.05 level (2-tailed)						
** Correlation is significant at the 0.01 level (2-tailed)						

Pearson correlation for parametric and Spearman's rho correlation for non parametric data.

**10. Effect of SSI on Postoperative stay in Hospital:** Out of 183 patients 1.6% of those with SSI had 1 to 4 days of post operative hospital stay. More than 4 days of hospital stay was noted in 31.3 % patients with SSI. The difference of the patient hospital duration with the presence of SSI was highly significant ( $p < 0.01$ ).

pathogen involved in SSI, and a main risk factor for the development of SSI was proven to be *Staph.aureus* nasal carriage.<sup>[10,11]</sup>

**DISCUSSION**

Post operative infection in any hospital depends upon the type of work load and hospital environment.<sup>[9]</sup> A considerable amount of medical literature showed that *Staph.aureus* appears to be the major

In our preoperative patient positive nasal swab is 28.8% & 23.4% in staff for *Staph.aureus*. A study in USA in 2006, prevalence of *Staph.aureus* nasal carriage to be 32% (152) & 33.3% in volunteers of hospital in Nigeria, study by A.Onanuga et. (154). In the study of Nicola Best et al, Auckland, New Zealand, the prevalence of *Staph.aureus* carriage was 18%, was at the lower end of the range of prevalence rates found in other

population.<sup>[12]</sup> This prevalence of nasal carriage of *Staph.aureus* further support the fact that Anterior Nares remains a principal reservoir of this organism and there is need to eliminate its virulent strains because of their involvement in the most severe community and hospital associated *Staph.aureus* infection in colonized individuals.<sup>[5,13]</sup>

In present study a definite increase in the incidence of SSI is seen. This may be due to various reasons like – environment, condition of the patient imposing him for surgery, chronic disorder like diabetes mellitus & Hypertension, addictions like smoking & alcohol.<sup>[9,14-16]</sup>

Nasal colonization with *Staph.aureus* increase the risk of surgical site infection but they did not establish significant relationship.<sup>[17,18]</sup> In order to discriminate autoinfection from cross infection, bacterial isolates should be typed by random amplification of polymorphic DNA, pulsed-field gel electrophoresis of DNA macro restriction fragments but these are not routinely possible in rural set up.

Preoperative antiseptic showering, preoperative hair removal with depilatory 12 hour prior to surgery reduce the SSI.<sup>[19,20,21]</sup> Prolonged duration of the operation result in increased exposure of operation site to air, prolonged trauma, stress of prolonged anesthesia and sometimes blood loss lead to increase in number of SSI.<sup>[14,22,23]</sup>

Our study results are comparable with similar study conducted in Sudan and stated almost similar results.<sup>[17]</sup> All strains were fully susceptible to oxacillin, gentamicin, vancomycin and rifampin but were resistant to penicillin. A large proportion of the strains were resistant to cotrimoxazole (28%) and tetracycline (62%). Multidrug resistance was documented on several occasions. No differences in antibiotic susceptibilities were observed when isolates from staff personnel

were compared to the isolates from patients. The observed resistance to erythromycin, co-trimoxazole, ampicillin may also be as a result of their uncontrolled usage in the environment which favors the increasing number of resistant strains due to selection pressure.<sup>[24]</sup> This is basically due to the effect of beta- lactamase produced by *Staph.aureus*. The uncontrolled availability of the agent in every drug vendors, which leads to its frequent use and misuse exert greater selection pressure which leads to its frequent use and misuse exert greater selection pressure for the resistant strains.<sup>[25]</sup>

vancomycin, a drug reserved for the treatment of *Staph.Aureus* infection in our set up, as in our study *Staph.aureus* exhibited 100% susceptibility to vancomycin. Our study reported a 32.89% multi – drug resistant *Staph.aureus* isolates from anterior nares of carrier individuals. Findings from other researchers gave high multi drug resistant *Staph.aureus* in hospital and community associated infections.<sup>[26,27]</sup> This call for strategies for ethical use of antimicrobial agents and elimination of nasal carriage of *Staph.aureus* so as to reduce the incidence of *Staph.aureus* infections.

## CONCLUSIONS

Despite modern surgical and sterilization techniques and prophylactic use of good antibiotics, SSI remains a major contributory factor of patient's morbidity. The overall rate of SSI is 9.6%. More attention is required in clean surgical procedures where the rate is around 5.85%, the universally acceptable rate being less than 2%. This can be achieved by taking proper measures to improve our operation theatres and wards environments and methods of sterilization. The common correctable risk factors are malnutrition, obesity, presence of infective foci, diabetes, hygienic conditions and duration of

operation. These achievable preventive measures should be taken to save the economic burden on the patient, hospital and the community as a whole.

Improper and prolonged use of antibiotics should be avoided as it can lead to the development of resistant strains of micro-organisms. The results emphasize the need to discourage antibiotic's abuse (a strong contributing factor of antimicrobial drug resistance in bacteria) in order to prevent the return of the consequences of a pre-antibiotic era. It also supports the need to implement strategies for elimination of nasal carriage of *Staph.aureus*, so as to prevent severe multi-drug resistant *Staph.aureus* infections in our environments.

Though high incidence of SSI is observed in preoperative nasal carriers of *Staph.aureus* but statistical significant relation with development of SSI cannot be established.

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