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Comparative Study on Antibiogram of *Staphylococcus epidermidis* Isolated from Clinical Samples and from Healthy Skin of the same Patient

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A B S T R A C T

Staphylococcus epidermidis is the most common normal flora of human skin. There is a delicate balance between skin barrier and innate immunity to maintain healthy skin and disturbance of the balance can predispose the host to a number of cutaneous and systemic infections. Aim-The present study is intended to find out the frequency of *Staphylococcus epidermidis* (*S. epidermidis*) of the patient normal flora causing skin infections by comparing the antibiotic sensitivity pattern of the strains isolated from clinically proven cases and strains from the healthy skin sites of the same patient. Methodology-Two types of *S. epidermidis* strains were collected, fifty strains isolated from clinically and microbiologically proven skin infections and fifty *S. epidermidis* strains isolated from the healthy skin of the same patient. Strains were stored in nutrient agar slopes at 4^0 C. Antibiotic sensitivity of these two groups of strains were performed on Mueller Hinton agar by standard Kirby-Bauer method and the antibiogram was compared to find out the frequency at which same strains of patient's skin flora is isolated from active skin infections. Result- The strains of *S. epidermidis* from lesions exhibited high resistance against penicillin 87%, ampicillin 64%, erythromycin 64%, clindamycin 60% and ciprofloxacin 52% respectively. Linezolid and amoxiclav were the two antibiotics to which maximum strains of *S. epidermidis* from lesion was sensitive, 92% each. Increased resistance rate 60% was observed against clindamycin. Statistically significant (p-value < 0.05) difference in antibiogram of two groups *S. epidermidis* indicate that *S. epidermidis* strains of patient may not always cause wound infection, instead either the strains acquired extra virulence among the skin flora or strains acquired from external source establishes wound infection. Methicillin resistance was 8% among strains from lesion compared to zero percent among skin flora strains. Conclusion-It is observed that majority of the *S. epidermidis* strains isolated from skin infection exhibited higher rate of drug resistance compared to the strains isolated from the healthy skin of the same patient.-So it can be concluded that majority of wound infection caused by *S. epidermidis* is not directly derived from the skin flora, instead either the infective strains evolved from skin flora or acquired from exogenous source. Probably different strains of *S. epidermidis* present on the skin which acquire virulence properties cause infection. As per the study methicillin resistance was 8% among *S. epidermidis* strains isolated from lesions and no methicillin resistance was detected among *S. epidermidis* strains isolated from normal skin.

Introduction

Human beings harbor a wide array of microorganisms on their body as commensals. Skin is the largest organ with ecosystem consist of 1.8 m^2 of diverse habitats (Chiller *et al.,* 2001). Members of normal flora form part and parcel of the host and play an important role in the body function and disease production. Colonization depends on the ecology of the skin surface. *Staphylococcus* especially *Staphylococcus aureus* and *S. epidermidis* are the most commonly isolated species from clinical specimen in microbiology laboratory with exception of Enterobacteriaceae. *S. epidermidis* is the most commonly isolated bacteria from skin samples, regarded now as important opportunistic bacteria causing infections related to prosthetic material like intravenous catheter, other indwelling polymer bodies and surgical wound. It colonizes predominantly the axilla, head and nares of human body (Marina Sabate Bresio *et al.,* 2017).

S. epidermidis, as part of normal flora of skin, generally have a benign relationship with the host. However they can cause serious infections on the same host if they cross protective barriers of host body. It is established that commensals acquire certain virulence characters during their pathogenic mode of life (Morgan M. Brown *et al.,* 2020) *S. epidermidis* has been considered as highly diverse species, although particular strains have been recognized as colonizing patients and causing infections in a particular place or hospital settings.

Significant number of *S. epidermidis* isolates are resistant to different antibacterial like erythromycin, clindamycin, gentamicin etc. The frequency of antibiotic resistance in *S. epidermidis* is due to antibiotic over dose. Studies showed that, resistance against methicillin is 75-90% among hospital isolates of *S. epidermidis,* which is even higher than the resistance rate of *Staphylococcus aureus* (Diekema *et al.,* 2001). The ubiquity of *S. epidermidis* as skin commensal make this bacterium as an optimal carrier and reservoir of antibiotic resistant gene.

There is evidence suggesting that methicillin resistance genes were transferred from *S. epidermidis* to *Staphylococcus aureus.* (Ziebuhr *et al.,* 2006). *S. epidermidis* is the most common species among coagulase negative staphylococcus isolated from clinical samples. It is a common skin commensal. *S. epidermidis* usually causes opportunistic infections. It readily grows on implanted devices, so it cause infections like peritonitis in patients receiving ambulatory peritoneal dialysis (Voneiff *et al.,* 2002).

S. epidermidis as part of the normal microbial flora of skin, generally have a benign relationship with the host and normally don't cause infections. But in case of damage to the skin and mucous jjmembrane such as by trauma, implanted foreign bodies, these bacteria can gain entry to the host internal system (Von Eiff *et al.,* 2002).

S. epidermidis have the ability to adhere to host or foreign body surface. Moreover they are capable of avoiding host immune system and produce factors which damage the host. Such characters enable *S. epidermidis* to present as pathogen. *S. epidermidis* becoming increasingly important infectious agents of nosocomial bacteremia, mainly because of increasing use of different prosthetic devices and other invasive procedures.

Most of the infections caused by *S. epidermidis* are associated with formation of biofilm on medical devices such as indwelling devices such as catheter or implanted devices (Von Eiff *et al.,* 2005).

Studies on strains present in a person's anterior nares of healthy adults shows that, there are multiple strains in each individuals. About twenty four different strains of *S. epidermidis* residing on human skin (Hu *et al.,* 1995)

Antibiotic resistance among *Staphylococcus epidermidis*

The emergence of multidrug resistant strains of *S. epidermidis* is a major challenge in treating

infections with these organisms. Bacteria can resist antibiotics when they colonize surface of implanted devices as biofilm. Mohamed *et al.,* (2007) investigated the presence of antibiotic resistant strains in the nasal mucosa of medical staff, and found that 34% of *S. epidermidis* were slime producers and overall 67% of *S. epidermidis* strains were multiple drug resistant. Mack *et al.,* (2007) reported high rate of methicillin resistance among *S. epidermidis* strains isolated from hospital environment. Olson *et al.,* (2010) demonstrated high rate of methicillin resistance (47%) among *S. epidermidis* from nasal mucosa against 29% resistance by *Staphylococcus aureus*.

Increased rate of vancomycin resistance was reported by Foster *et al.,* (2016). Methicillin resistance was 39 % among nosocomial strains of *S. epidermidis* as per Muhammad Irfan *et al.,* (2016). In another study by Manikantan *et al.,* (2005) Methicillin resistance rate was 57%.

Materials and Methods

The isolates were identified by standard biochemical tests and stored in15 % glycerol broth at ¯20°C. The two groups of *Staphylococcus epidermidis* strains were subjected to antibiotic sensitivity test by standard Kirby-Bauer's antibiotic sensitivity test and the antibiogram pattern is recorded.

Fifty strains of *S. epidermidis*, isolated from wound infections and from healthy skin sites of the same patients, admitted at Kannur medical college hospital, in the Department of Surgery, Gynecology, Orthopedics, were used for the study.

After obtaining Institutional ethic committee approval, sterile moistened swabs were collected from healthy skins of patients whose clinical sample yielded *S. epidermidis* on culture of clinical samples.

The swabs were gently rubbed on cubital fossa of arm and transported to the laboratory immediately. The procedure of taking skin swabs does not cause any irritation and discomfort, which was explained to the patient before taking the swab. The swabs were inoculated into nutrient agar and blood agar medium and incubated for 24 hours at 37^0 C. Out of 73 cases with clinically and microbiologically proven *S. epidermidis* infection, only 50 skin swabs collected yielded *S. epidermidis* on culture.

The growth obtained were identified by biochemical reactions. The strains were identified by the following biochemical tests-

Tube Coagulase test, Novobiocin sensitivity test, Anaerobic growth on thioglycollate, Mannitol fermentation. (Cunhe *et al.,* 2004; Mackie and Mc'Cartney's, 1996).

Inclusion criteria

Clinical samples which yield pure and heavy growth of *S. epidermidis* on culture were included in the study.

Skin swabs were collected from those patients whose clinical sample yielded *S. epidermidis*

Exclusion criteria

Samples which yield mixed growth or scanty growth of *S. epidermidis* on bacterial culture.

The identified strains were stored in 15%glycerol broth at- 20°C for further study.

Both the groups of *S. epidermidis* strains were subjected to antibiotic sensitivity test on Muller-Hinton agar (Himedia, Mumbai) by standard Kirby-Bauer disc diffusion technique as per CLSI criteria. (CLSI, 2016) The following antibiotics were used. Amoxicillin, ampicillin, gentamicin, erythromycin, clindamycin, vancomycin, penicillin, ciprofloxacin, teicoplanin and cefoxitin.

The antibiotic sensitivity or resistant pattern of the two types of *S. epidermidis and* methicillin susceptibility were recorded and the result was analyzed using appropriate statistical formula.

Results and Discussion

As per the present study, the strains of *S. epidermidis* isolated from clinical samples, the highest rate of antibiotic resistance showed against penicillin (87%), ampicillin (64%), erythromycin (64%), clindamycin (60%), and ciprofloxacin (52%) respectively. There is clear difference in antibiotic susceptibility pattern between pathogenic strains and *S. epidermidis* from healthy skin flora. The resistance towards different antibiotics is less among commensal strains compared to pathogenic strains isolated from the same patient. Methicillin resistance was 8% among strains isolated from lesions and no methicillin resistance observed among *Staphylococcus epidermidis* isolated from healthy skin.

On comparing antibiotic resistance of *S. epidermidis* isolated from clinical samples and healthy human skin, there was increased resistance among strains isolated from clinical samples than strains from healthy skin of the same patient. According to the present study vancomycin and linezolid are found to be the antibiotics to which maximum strains of *Staphylococcus epidermidis* were sensitive. (Table 1).

Human skin is the first line of defense against environmental and pathogenic challenges. It is densely populated by flora of bacteria and fungi. Normal flora form part and parcel of the host that are normally interact with each other and with immune system to promote skin health and homeostasis (Grice *et al.,* 2009). Several bacteria are isolated from skin, including *Corynebacterium, Propionibactertium granulosum, Propinibacterium avidum, Staphylococcus aureus, Finegoldia magna, Peptostreptococcus magnus* and *Acinetobacter*. Several of these bacteria only occasionally colonize the skin and are present in low numbers. However the two most predominant skin commensals are the gram positive cocci, *S. epidermidis* and gram positive rod *Propionibacterium acnes*, respectively. (Findley and Grice, 2014) However most of these commensals can also function as opportunistic pathogens, being able to cause infections once an opportunity arise whether this opportunity consist of an impaired immune system, dis-regulated microbiome, breaches of barriers or changes of localization for the bacteria. The classic distinction between pathogen and commensals is based on genetic differences among bacterial species or strains (Boulffard *et al.,* 2012). Both metagenomics sequencing studies and traditional culture methods have proved that coagulase negative *staphylococci* (CoNS) are the abundant colonizers of all skin sites. There are about 38 species of CoNS that are genetically and functionally uncharacterized (Miragaia *et al.,* 2007). Invasive procedure, anticancer drugs, prostheses, catheterization etc. are the common risk factors to get infection by CoNS. Another harmful consequence of normal flora is bacterial synergism between a member of the normal flora and a potential pathogen i.e. one organism facilitate the growth of another to grow or survive. Synergism also occurs during treatment, when a penicillin resistant staphylococcus shares its drug resistance with pathogen that are otherwise susceptible to the drug, It is proven that the behavior of *S. epidermidis* is highly context and strain dependent (Kloos and Myssel White, 1975). *S. epidermidis* has been documented as an emerging pathogen causing many health care associated infections. Probably different strains of *S. epidermidis* present on the skin and whichever stains acquire virulence properties cause infection. These infections are an increasing cause of major concern not only due to high distribution of methicillin resistance, but also due to the ability to form biofilm. Due to its capacity to form biofilm on implanted foreign bodies, *S. epidermidis* has emerged as an important opportunistic pathogen in patient receiving prosthetic device. *S. epidermidis* causes approximately 20% of orthopedic implant related infections (Thuan H. Nguyen and Mathew, 2017). Blood stream infections especially catheter related *S. epidermis* infection results in approximately 13% of prosthetic valve endocarditis (Chu *et al.,* 2009) A high rate of methicillin resistance, 85.5 % and multidrug resistance 92% were reported by Freitas *et al.,* (2014) from

Portugal. 71% from United Nations by Rachel *et al.,* (2012). Antibiotic resistance pattern and patient demographic data is important in selecting the antibiotic. Resistance rate of *S. epidermidis* were different in various age group Saleh *et al.,* (2023). A study by Mohammed G *et al.,* shows that 17% strains from patients were multidrug resistant compared to 1.7 % of strains isolated from healthy persons and more than 50% of the strains isolated from healthy skin were resistant to erythromycin, clindamycin and fusidic acid. Same study reveals that 20% of *S. epidermidis* strains isolated from healthy skin were resistant to teicoplanin against zero percent resistance among strains isolated from patient's lesion (Muhammed G. Elladi *et al.,* 2019). As per the present study there is clear difference in antibiotic resistance pattern of *S. epidermidis* isolated from lesion and healthy skin (p.-<0.05) No MRSA strains were isolated from healthy skin.

Methicillin resistant strains pose a therapeutic challenge in treating infection produced by *S.aureus* and *S. epidermidis*. Francois *et al.,* (2010) observed 19.2% methicillin resistance among Coagulase negative *staphylococcus epidermis*. Whereas Farrell *et al.,* (2011) observed 70% methicillin resistance. According to Hao Chen *et al.,* (2018). methicillin resistance was maximum among coagulase negative staphylococcus and linezolid has excellent in-vitro activity comparable to vancomycin. Muhammed Irfan *et al.,* (2016), Pakistan observed 39% MRSE among pathogenic strains. A study from Brazil, Luiza pinhero *et al.,* (2014) detected 81% methicillin resistance among *S. epidermidis* isolated from blood culture. As per our study, highest resistance was showed against penicillin and amoxicillin and methicillin resistance was quite low (8%). Saleh A *et al.,* (2023) demonstrated clear difference in antibiotic susceptibility pattern among strains isolated from different age group. The present study result is also in accordance with the above study result.

There is a clear difference between *Staphylococcus epidermidis* isolated from lesions and healthy skin of the same patient in antibiotic susceptibility pattern (p.value <.0.05). Though in majority of cases the source of infection of *Staphylococcus epidermidis* is from patient own skin flora, increased resistance was observed against different antibiotics among the strains isolated from lesions than strain isolated from the normal skin of the same patient.

Table.1 Antibiotic susceptibility pattern of *Staphylococcus epidermis* isolated from lesion and from healthy skin

Antibiotics	***S.epidermidis* from clinical Samples n=50**		***S.epidermidis* from healthy Skin n=50**		**p-value**
	Sensitive (%)	**Resistant (%)**	**Sensitive (%)**	**Resistant (%)**	
Ampicillin	18 (36%)	32 (64%)	36 (72%)	14 (28 %)	0.001
Amoxiclav	46 (92%)	04 (8%)	46 (92%)	04 (8%)	1.00
Erythromycin	18 (36%)	32 (64%)	40 (80%)	10 (20%)	0.001
Vancomycin	48 (96%)	02 (4%)	50 (100 %)	NIL	0.495
Clindamycin	20 (40%)	30 (60%)	40 (80%)	10 (20%)	0.001
Linezolid	46 (92%)	04 (8%)	38 (76%)	12 (24%)	0.054
Ciprofloxacin	24 (48%)	26 (52%)	30 (60%)	20 (40%)	0.229
Gentamicin	22 (44%)	28 (56%)	36 (72%)	14 (28%)	0.005
Teicoplanin	34 (68%)	16 (32%)	40 (80%)	10 (20%)	0.254
Cefoxitin	36 (72%)	04 (8%)	50 (100%)	Nil-(0%)	0.036

Fig.1

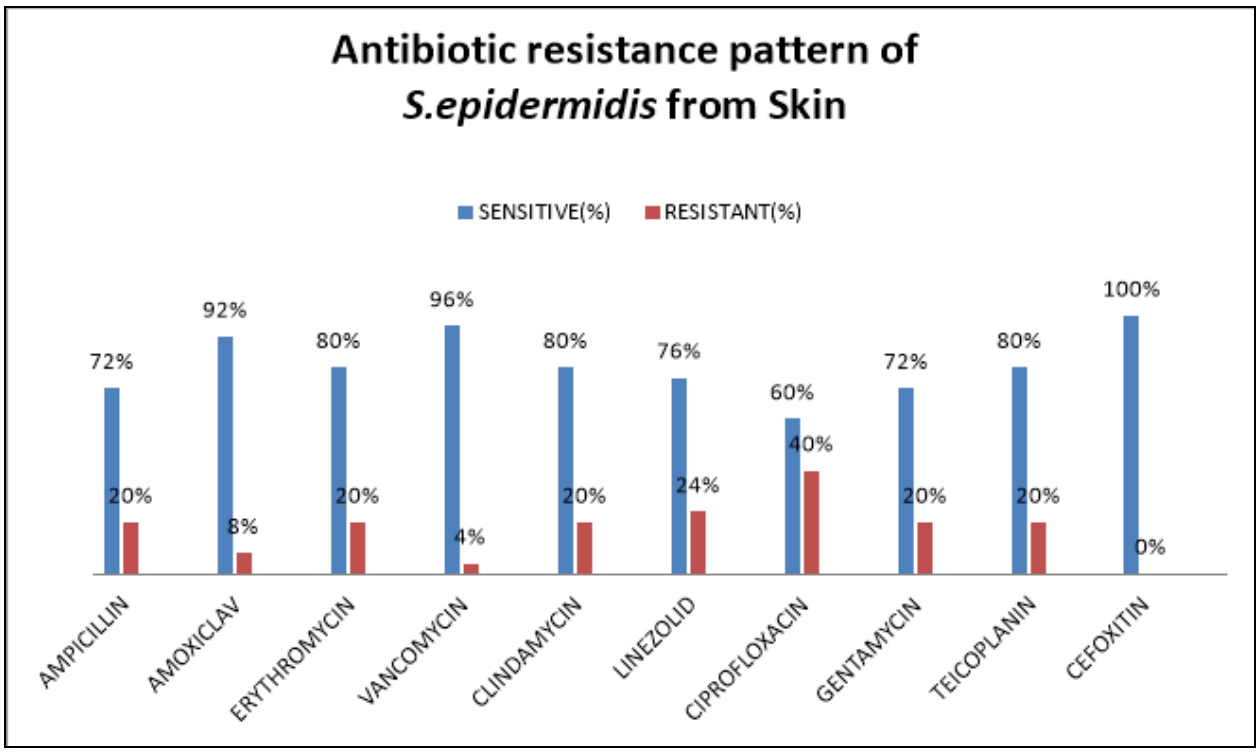
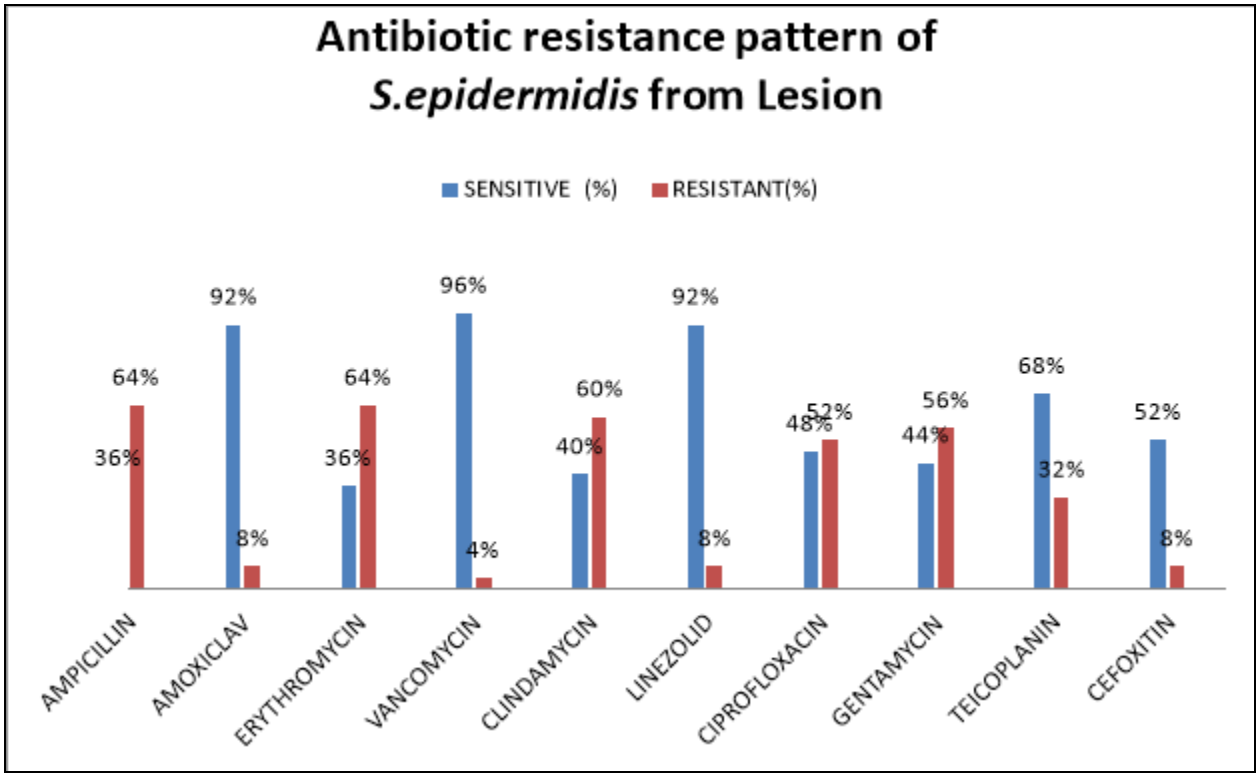

Antibiotic resistance pattern of
S.epidermidis from Skin
SENSITIVE(%)
RESISTANT(%)
72%
20%
92%
8%
80%
20%
96%
4%
80%
20%
76%
24%
60%
40%
72%
20%
80%
20%
100%
0%
AMPICILLIN
AMOXICLAV
ERYTHROMYCIN
VANCOMYCIN
CLINDAMYCIN
LINEZOLID
CIPROFLOXACIN
GENTAMYCIN
TEICOPLANIN
CEFOXITIN

Fig.2


Antibiotic resistance pattern of
S.epidermidis from Lesion
SENSITIVE (%)
RESISTANT(%)
36%
64%
8%
92%
36%
64%
4%
96%
40%
60%
8%
92%
48%
52%
44%
56%
32%
68%
8%
52%
AMPICILLIN
AMOXICLAV
ERYTHROMYCIN
VANCOMYCIN
CLINDAMYCIN
LINEZOLID
CIPROFLOXACIN
GENTAMYCIN
TEICOPLANIN
CEFOXITIN

The difference in antibiogram of two groups of *S. epidermidis* shows that the same strains present in the skin is not always directly indicated in infection, than the skin flora strains which acquired extra virulence characters cause wound infection in the same patient. Linezolid and amoxiclav found to be the most effective antibiotics. Methicillin resistance is very high among strains isolated from clinical samples, however no methicillin resistant strains were isolated from healthy skin in the present study. This shows that the normal flora strains which acquired increased virulence probably causes infections or MRSE strains contracted is from exogenous source. Further study is indicated to establish the above

Conflict of interest

Authors declare that no conflict of interest in the study.

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