CHAPTER 2
Review of Literature
2.0 INTRODUCTION

Taxonomically, the genus Staphylococcus is placed in the bacterial family Micrococcaceae, but Staphylococci are phylogenetically unrelated to any other genera in the family. A wide variety of genetic criteria indicate that the genus Staphylococcus forms a coherent and well-defined natural group that is widely divergent from the genus Micrococcus. On the basis of 16sRNA analysis, the genus Staphylococcus belongs to the broad Bacillus-Lactobacillus-Streptococcus cluster. The closest relatives of Staphyloccoci appear to be the pianococci, enterococci, and bacilli.

Staphylococci are Gram-positive spherical bacteria that occur in microscopic clusters resembling grapes. Bacteriological culture of the nose and skin of normal humans invariably yields Staphyloccoci. In 1884, Rosenbach described the two pigmented colony types of Staphylococci and proposed the appropriate nomenclature; *Staphylococcus aureus* (in greek *auri* means gold) and *Staphylococcus albus* (Greek *albus* means white). Classification of Staphylococci was traditionally done by colony morphology and simple biochemical and physiological tests (Baird-Parker, 1974).
Until 1975, Coagulase negative Staphylococci were grouped as *Staphylococcus albus* or *S.epidermidis*, distinguished from *Staphylococcus aureus* by their inability to coagulate plasma. Kloos and Schleifer (1975) extended the existing classification scheme by adding seven new species to the already known *S.epidermidis* and *S.saprophyticus*. Till date there are 32 known Coagulase Negative Staphylococcal species; about 15 species are indigenous in humans.

2.1 *Staphylococcus aureus* AS PATHOGEN

According to Archer, (1998) *Staphylococcus aureus* is a virulent pathogen and is currently the most common cause of infections in hospitalized patients. *Staphylococcus aureus* infection can involve any organ system. The success of *Staphylococcus aureus* as a pathogen and its ability to cause such a wide range of infections are the result of its extensive virulence factors.

*Staphylococcus aureus* is arguably the most important cause of life threatening bacterial infections in both developing and developed world. The most common life threatening
manifestation of *Staphylococcus aureus* infection is bacteremia. The incidence of this infection has dramatically increased in the last decade; the increase has been greater in hospital-acquired cases (Steinberg *et al*, 1996). Lowy, (1998) explained the role of *Staphylococcus aureus* in establishing endocarditis. *Staphylococcus aureus* has a particular affinity for establishing infection in the endothelium causing endocarditis. Up to 60% of cases of *Staphylococcus aureus* bacteremia may be associated with endocarditis or other types of fixed endovascular infection sites. In recent years Gram-positive bacteria have accounted for up to 50% of cases of severe sepsis and septic shock in intensive care units (Sriskandan & Cohen, 1999). Meningitis caused by *Staphylococcus aureus* is highly uncommon accounting for only 1% to 9% of the total cases of bacterial meningitis (Jensen *et al*, 1993).

### 2.2 COAGULASE NEGATIVE STAPHYLOCOCCI AS PATHOGENS

Coagulase-negative Staphylococci have long been regarded as non-pathogenic but their important role as pathogens and their increasing incidence have been recognized and studied in recent years. The number of cases of nosocomial bacteremia due
to coagulase-negative *Staphylococci* has been estimated at 50,000-120,000 per year in the United States (Raad & Bodey, 1992). Banerjee *et al*, (1991) reported that in NNIS (National Nososcomial Surveillance System) data, these bacteremias constituted 8% of all nosocomial infections. Von Eiff *et al*, (2005) studied foreign body related infections. The insertion or implantation of foreign bodies has become an indispensable part in almost all fields of medicine. Medical devices are associated with a definitive risk of bacterial infections. Foreign body related infections (FBRIs), particularly catheter-related infections, significantly contribute to the increasing problem of nosocomial infections. Their ability to adhere to materials and to promote formation of a biofilm is the most important feature of their pathogenicity. Antibacterial chemotherapy is frequently unable to cure these infections, removal of implanted devices is inevitable and has been standard clinical practice. Catheter-related infections are by far the most common cause of bacteremia due to coagulase-negative *Staphylococci*. *S.epidermidis* is responsible for 50-70% of these infections (Archer, 1995). *S.epidermidis* is the most common species (Ing *et al*, 1997) but a number of other species, such as *S.warneri*
(Wood, 1989) and S. lugdunensis (Shuttleworth & Colby, 1992) have also been implicated.

According to Archer (1995), Coagulase negative Staphylococci are responsible for two types of urinary tract infections caused by S. saprophyticus, which affect young female out patients; and nosocomial infections due to other Staphylococci (mainly S. epidermidis), which occur equally in men and women, especially those with urinary catheters.

NNIS data indicated Coagulase-negative Staphylococci as the second most common cause of postoperative surgical site infection after enterococci (NNIS, 1997). Emori & Gaynes, (1993) estimated about 2 million patients annually develop nosocomial infections in United States. The increasing number of antimicrobial agent-resistant pathogens and high-risk patients in hospitals are challenges to progress in preventing and controlling these infections. Staphylococcus aureus remains the most common pathogen isolated overall from nosocomial infections, coagulase negative-Staphylococci, organisms previously considered, as contaminants in most cultures are now predominant pathogens in bloodstream infections. The active involvement and cooperation of the microbiology laboratory are
important in infection control program, particularly in surveillance and the laboratory services for epidemiological purposes.

2.3 ANTIMICROBIAL RESISTANCE

Domin, (1998) reported that antimicrobial resistance results in increased morbidity, mortality and cost of health care. Kollef & Fraser, (2001) attributed this increase in cost of care to prolonged hospitalizations and convalescence associated with antibiotic treatment failures. Intensive care units play a major role in increasing antimicrobial resistance. Intensive care units are unique because they house seriously ill patients in confined environments where antibiotic use is extremely common.

Resistance to antimicrobial agents has been recorded since 1940’s with penicillin resistant *Escherichia coli*. Kirby first demonstrated that penicillin was inactivated by penicillin-resistant strains of *S.aureus* (Kirby, 1944). Bondi and Dietz (1945) subsequently identified the specific role of penicillinase. More than 90% of staphylococcal isolates now produce penicillinase, regardless of the clinical setting. The gene for β-lactamase is part of a transposable element located on a large plasmid, often with additional antimicrobial resistance genes
(e.g., gentamicin and erythromycin). Spread of penicillin resistance primarily occurs by spread of resistant strains.

2.4 METHICILLIN RESISTANCE

Methicillin introduced in 1961 and was the first of the semisynthetic penicillinase-resistant penicillins. Its introduction was rapidly followed by reports of methicillin-resistant staphylococcal isolates (Jevons, 1961). For clinicians, the spread of these methicillin-resistant strains has been a critical one. The therapeutic outcome of infections that results from methicillin-resistant *S. aureus* (MRSA) is worse than the outcome of those that results from methicillin-sensitive strains (Cosgrove, 2003). The difference has been ascribed to the underlying medical problems of the often sicker and older MRSA-infected patients as well as the less effective bactericidal drugs available to treat these infections, rather than to enhanced virulence of the MRSA strains.

First reported in a British hospital, MRSA clones rapidly spread across international borders. Waves of clonal dissemination with different dominant phage types (e.g., 83 complex) were reported in the 1968's and were responsible for a
large proportion of cases (Jessen et al, 1969, & Parker & Hewitt, 1970). Once identified in a new setting, these unique MRSA clones spread rapidly, often becomes the resident clones and accounts for an increasing percentage of nosocomial infections (Panlilio et al 1992, & Couto et al, 1995). Like the penicillin-resistant strains, the MRSA isolates also frequently carried resistance genes to other antimicrobial agents (Lyon, 1984). With introduction of methicillin the methicillin resistant Staphylococcus aureus (MRSA) strains were isolated.

2.5 ROLE OF PBP2a IN METHICILLIN RESISTANCE

Evasion from methicillin challenge is mainly achieved by the synthesis of a penicillin binding protein of low affinity for antibiotics. mecA is responsible for synthesis of penicillin-binding protein 2a (PBP2a; also called PBP2') a 78-kDa protein (Hartman et al, 1984 & Song et al, 1987). PBP2a replaces regular penicillin-binding proteins in cell wall turnover following inactivation by antibiotics. Low affinity penicillin-binding protein PBP2a is expressed in addition to the normal complement of resident PBP2s and mediates methicillin resistance among both Staphylococcus aureus and CoNS (Matsushashi et al, 1986).
meca is composed of 50Kb or more of DNA unique to methicillin resistant strains (Chambers, 1997) and there are no allelic equivalents in methicillin susceptible strains (Hiramatsu, 1995). Since no homologue of meca exists in methicillin-susceptible staphylococci, it has been assumed that meca was acquired from one of several coagulase-negative staphylococcal species (Archer et al, 1994). Couto et al, (1996) identified a meca gene in a methicillin-sensitive S.sciuri with 88% homology on the amino acid level to MRSA. Transduction of the S.sciuri meca into an MSSA resulted in increased resistance to methicillin coupled with the detection of PBP2a (Couto et al, 2003). These studies suggested that S.sciuri was possible source of the meca element in S.aureus. Hiramatsu and associates (Okuma et al, 2002 & Hiramatsu et al, 2002) have speculated that the simultaneous detection of the new type IV SCCmec in different geographic regions of the world potentially reflects its enhanced mobility and multiple simultaneous transmissions from another coagulase-negative staphylococcus species. meca synthesis is regulated by a signal transduction system consisting of the sensor / transducer mecRI and the 14 KDa transcriptional repressor mecI (also known as methicillin repressor) that constitutively blocks meca transcription (Garcia-Castellanos, 2003). The three
dimensional structure of *mecI* reveals a dimmer of two independent winged helix domains, each of which binds to palindromic DNA operator half site, and two intimately intertwining dimerization domains. Signal transducer is a fusion protein (Zhang *et al*, 2004) with penicillin binding and zinc metalloprotease domains. The signal for protein expression is transmitted by site-specific cleavage of both the transducer, which autoactivates and the repressor, which is inactivated, unblocking gene transcription.

2.6 SPREAD OF MRSA

The spread of methicillin-resistant clones is reminiscent of the emergence of penicillin resistance in the 1940s. First detected in hospitals in the 1960s, methicillin resistance is now increasingly recognized in the community (Chambers, 2001). Today, MRSA is a major nosocomial pathogen found in an increasing number of hospitals worldwide. According to NNIS data, the percentage of MRSA among all *Staphylococcus aureus* isolates rose from 2% in 1975 to 29% in 1991 (Jarvis & Martone, 1992, Panillo *et al*, 1992). This is a frightening fact that affects not only large teaching hospitals, but also small hospitals and nursing homes (de Lencastre *et al*, 1994b).
Dzidic & Bedekovic, (2003) has attributed this increase to a combination of microbial characteristics, the selective pressure of antimicrobial use, social and technical changes that enhance the transmission of resistant organisms. The resistance is acquired by mutational change or by the acquisition of resistance-encoding genetic material, which is transferred from other bacteria. According to Kunin, (1993) the spread of antibiotic resistance is related to the overuse of antibiotics in human health care, in animal feeds, increased use of invasive devices, lapses in infection control practices leading to transmission of resistant organisms and the mobility of the world population. The resistance gene sequences are integrated by recombination into several classes of naturally occurring gene expression cassettes and disseminated within microbial population by horizontal gene transfer mechanisms viz, transformation, conjugation or transduction (Tambic et al, 2004). Emergence of multiresistant bacteria and spread of resistance genes should enforce the application of strict prevention strategies, including changes in antibiotic treatment regimes, hygiene measures, infection prevention and control of horizontal nosocomial transmission of organisms (Dzidic & Bedekovic, 2003).
According to Barie, (1998) Gram-positive cocci are causing more serious infections than ever before in surgical patients, mostly among the increasingly aged, ill and debilitated. Invasive procedures disrupt natural barriers to bacterial invasion, and indwelling catheters act as conduits for infection. The use of broad-spectrum antibiotics selects for the emergence of resistant pathogens. Responsible organisms include species from the genera Staphylococcus and Enterococcus.

Overall, approximately two-thirds of nosocomial cases and outbreaks have occurred in critical care units. Major risk factors for colonization and infection in nursing homes include age, underlying conditions, nasal colonization and the presence of indwelling devices such as catheters, tracheostomies and nasogastric tubes. Doebbeling, (1995) also explained risk factors involved in MRSA infections in acute care facility and MRSA bacteremia. Patients with MRSA infections in an acute care facility are more likely to have had a prolonged stay, to receive prior antibiotics and to have underlying disease, than patients infected with methicillin susceptible Staphylococcus aureus. Risk factors for MRSA bacteremia include prolonged hospitalization, intravascular catheterization, and intensive care unit location.
Factors for developing MRSA postoperative wound infections include: antimicrobial therapy, prolonged hospitalization and severity of underlying disease.

2.7 WORLDWIDE PREVALENCE OF MRSA

Pulimood et al, (1996) tested antimicrobial susceptibility of Staphylococcus aureus strains isolated from pus or blood of patients during January 1993 to November 1994 from Christian Medical College, Vellore, India. Antimicrobial susceptibility of isolates was tested using Kirby-Bauer disk diffusion technique. Among 1382 isolates of Staphylococcus aureus, 332 (24%) were reported to be MRSA.

Gupta et al, (1999) carried out surveillance study for MRSA in the surgical ward and operation theatre of Maulana Azad Medical College, New Delhi. The source of this outbreak was traced to an outdoor patient with community acquired MRSA infection. A total of 320 clinical and environmental samples were screened for MRSA. Seventy (21.8%) Staphylococcus aureus were isolated, of which 12.8% were resistant to methicillin. Fourteen percent of the MRSA infections were from the community. Nasal carriage rates of MRSA in the screened hospital staff admitted patients
were also studied and were found to be 5.8% and 4.3% respectively. None of the environmental sample yielded MRSA. The study indicated the increasing prevalence of MRSA in the community.

Surveillance study was conducted by Mehta et al, (1996) simultaneously at three centers across India. A total of 13,610 test samples from various sites were obtained. Microbiological methods employed were similar at the three centers. Identification of *S. aureus* was based on the recognition of the production of coagulase with positive isolates being recorded as *S. aureus*. Both tube coagulase tests and slide coagulase test were performed. Antimicrobial susceptibility testing of the isolated strains of *Staphylococcus aureus* and *Staphylococcus epidermidis* to various oxacillin disk was carried out according to standardized disk diffusion method recommended by NCCLS. Of the total 739 cultures of *S. aureus*, 235 (32%) were found to be resistant with the individual figures for resistance being 27% (Bombay), 42.5% (Delhi) and 47% (Bangalore). MRSA is emerging to be a significant problem pathogen in the surgical setting with vancomycin probably the only reliable choice for these infections.
Methicillin resistant *Staphylococcus aureus* as a hospital pathogen has presented many clinical problems in the University Hospital Kuala Lumpur, Malaysia. Hanifah et al, (1992) reported that incidence of MRSA among *Staphylococcus aureus* isolated from hospital inpatients had increased from 11.5% in 1979 to 18.8% in 1985. The characteristics of 50 MRSA isolates associated with nosocomial infections in the hospital were described. The predominant strains produced type IV coagulase and 84% of isolates showed moderate to high resistance to methicillin with MIC values of 25µg/ml or higher. Between August 1990 to November 1991, Cheong et al, (1994) reported 905 of 2583 (35.4%) of *Staphylococcus aureus* were found to be methicillin-resistant in a general hospital in Malaysia. A detailed study of 539 of these isolates showed a high prevalence of methicillin resistant *Staphylococcus aureus* in surgical/orthopaedic wards, paediatric wards and the critical care unit. The yield of MRSA was highest from wounds, ulcers, and skin swabs accounting for 64.2% followed by 6.9% in blood cultures.
Durmaz et al, (1997) conducted a study with the purpose to determine the prevalence of Turkish isolates of methicillin resistant *Staphylococcus aureus* in nosocomial and community infections and their resistance patterns. A total of 383 *Staphylococcus aureus* strains were identified from different patients. The prevalence of methicillin resistance among *Staphylococcus aureus* strains was 31.3% (120/383). The proportions of MRSA isolated from nosocomial and community infections were 26.4% (46/174) and 35.4% (74/209), respectively.

A three-month surveillance study of methicillin resistant *Staphylococcus aureus* was carried out by Thevanesam et al, (1994) in the male surgical unit of General hospital, Peradeniya, Sri Lanka. Nose, throat, axillary, perineal and wound swabs were taken from 251 patients and 35 staff members. Among 305 isolates of *Staphylococcus aureus* from patients, 84 (27.5%) were MRSA. Staff carriage was only 6%. No casualties were reported due to MRSA.

Voss et al, (1994) collected data on methicillin resistant *Staphylococcus aureus* from Europe. Forty-three laboratories
from ten European countries were screened for MRSA. Only one isolate per patient was permitted. Of the 7,333 *Staphylococcus aureus* strains screened, 936 (12.8%) were methicillin resistant. The proportion of MRSA in the various European countries ranged from <1% in Scandinavia to >30% in Spain, France and Italy. Sixty percent of the methicillin resistant strains originated from patients in surgical and medical departments with wounds being the most common isolation source followed by ICUs.

Takahashi *et al*, (1990) from Department of surgery, Akita university school of medicine, Japan observed an increase in MRSA infections in their ward including general, pediatric and neurosurgery. They investigated following items for analyzing a prevalence of the infections; 1) the frequency of MRSA in *Staphylococcus aureus* isolates from clinical materials, 2) the monthly number of patients with MRSA infectious diseases, and 3) the biologic types and the toxigenicity of MRSA isolates from clinical materials, nasal carriers and an environmental material in the ward. The results were as follows, 1) Methicillin resistance was determined in 204 of 247 *Staphylococcus aureus* isolates (83%), 2) Monthly registration showed an increased number of patients in one unit were followed by an increase in other units.
and 3) Most of the MRSA isolates were classified into type II
coagulase. Most of MRSA isolates had capabilities of producing
type C enterotoxin and toxic shock syndrome toxin-1 (TSST-1).
The results suggested that the frequent MRSA infectious
diseases attributed to hospital infection. The surveillance of
MRSA in 11 hospitals of greater Dusseldorf area of Germany was
performed by Schimtz et al (1997) for 3 years. From a total of
7,814 *Staphylococcus aureus* isolates, 489 (6.3%) were
methicillin resistant. Methicillin resistance among all
*Staphylococcus aureus* isolates from 11 hospitals ranged from
0.5% to 7.8% depending upon the size of the hospital. The
highest incidence (7.8%) was found in a 1,500-bed hospital and
the lowest incidence in a smaller 200-bed hospital (0.5%). With
respect to the distribution of clinical departments the highest
incidence of MRSA isolates was found in ICUs and surgical wards,
25.5% and 13% respectively. The commonest specimen from
which the MRSA isolates were cultured, were respiratory
secretions (17.6%) followed by central venous catheter tips
(12.8%).

Swanson (1999) determined the prevalence of methicillin
resistant *Staphylococcus aureus* at the general hospital, Port -of-
Spain between June 1995 and May 1996. The MRSA prevalence rate was 4.6% of all *Staphylococcus aureus* isolates. Fifteen isolates were associated with infections, and three were colonizing strains. Seventeen of the 18 patients with MRSA had received antibiotics previously, including 13 who had received multiple antibiotics. Skin and soft tissue were the sites of infection and colonization in 12 cases; surgical wards and the intensive care unit accounted for 16 MRSA isolates. One of the two deaths was attributable to MRSA.

Biedenbach *et al,* (2004) studied occurrence of antimicrobial resistance and compared the antimicrobial resistance pattern from the SENTRY antimicrobial surveillance program (1997-2002). The SENTRY antimicrobial surveillance program has monitored BSI from patients in medical centers worldwide since 1997. During 1997-2002, a total of 81,213 BSI pathogens from North America, Latin America and Europe were tested for antimicrobial susceptibility. *S. aureus,* Coagulase negative *Staphylococci* and *E.coli* were the three most common BSI pathogen in all three regions each year. Geographically, Oxacillin-resistant *Staphylococcus aureus* (39.1%, 2002) were highest in North America. Patient age analysis showed the most
common BSI pathogen among neonates and elderly patients was coagulase negative *Staphylococci*.

### 2.8 Worldwide Prevalance of MRCoNS

Jain *et al.* (2004) from King George’s Medical University, Lucknow, India studied the prevalence of methicillin resistant Coagulase-negative *Staphylococci* in neonatal intensive care units with particular reference to the phenotypic expression of methicillin resistance. Antimicrobial resistance pattern of coagulase negative Staphylococcal species isolated from the blood and skin of neonates with clinical suspicion of late onset septicemia was determined. Antibiotic sensitivity of all CoNS isolates was determined according to NCCLS recommendations. *Staphylococcus haemolyticus* was the commonest species (34%) followed by *Staphylococcus epidermidis* (24%) amongst blood isolates. Resistance to penicillin and methicillin was 94 and 66% respectively. Similar antimicrobial resistance pattern were observed in skin isolates.

A study of 192 strains of Coagulase negative staphylococcus (CoNS) by Mohan *et al.* (2002) showed that *Staphylococcus epidermidis* was the most common species, 158 (82.29%)
isolated from all clinical specimens followed by *S. saprophyticus* (30, 15.62%) isolated mainly from urine. Only two other species of *CONS* were identified *S. cohnii* (1) and *S. haemolyticus* (3). Resistance towards penicillin and cephalaxin was found to be 90.6% and 54.6% respectively. All the isolates were sensitive to vancomycin.

Pal & Ayyagari, (1989) isolated 75 strains of coagulase negative staphylococci in pure culture from different specimens. These strains were identified as *S.epidermidis, S.cohnii, S.hominis, S.capitis, S.haemolyticus, S.simulans, S.warneri and S.saprophyticus*. Methicillin resistant strains (14.6%) were isolated mainly from patients of meningitis, urinary tract infections and endocarditis.

Nosocomial bloodstream infections are important causes of morbidity and mortality. In a study Edmond et al, (1999) conducted concurrent surveillance for nosocomial bloodstream infections at 49 hospitals over a 3-year period and detected >10,000 infections. Gram-positive organisms accounted for 64% of cases. Coagulase-negative staphylococci were the most
common pathogens and methicillin resistance was detected in 80% of coagulase-negative staphylococci.

Akiyama et al, (1998) isolated 162 coagulase-negative staphylococci from various skin diseases between January, 1995, and January, 1998. From eighteen infected cysts, 10 \textit{Staphylococcus epidermidis} strains, 3 \textit{S.capitis} strains, 2 \textit{S.hominis} strains, 2 \textit{S.auricularis} strains, and one \textit{S. saprophyticus} strain were individually detected. \textit{Staphylococcus hominis} strains and \textit{S.capitis} strains were suggested to be potential pathogens in the initiation of suppuration in various purulent skin lesions. Among the 28 \textit{S.epidermidis} strains, 13 (46.4%) were methicillin-resistant (oxacillin, minimum inhibitory concentration \( \geq 4 \, \mu\text{g/ml} \)). Twelve (29.3%) out of the other 41 coagulase-negative staphylococci were methicillin-resistant.

The antimicrobial susceptibility of 239 coagulase-negative staphylococci (CNS) isolates consecutively collected from blood culture in patients admitted in a 600-bed teaching hospital was evaluated by Del’ Alcamo et al, (1999). The isolates were identified to the species level by conventional methods and their susceptibility to oxacillin was tested by agar dilution, disk diffusion. The species distribution was found to be \textit{S.epidermidis}.
120 (50.2%), *S. hominis* 29 (12.1%), *S. haemolyticus* 24 (10.0%), *S. cohnii* 14 (5.9%) and isolates from other CoNS species 52 (21.8%). The percentage of resistance to oxacillin was 74.5% by agar dilution. The highest percentages of oxacillin resistance were found among *S. haemolyticus* (95.8%) and *S. epidermidis* (80.8%).

Gill *et al.*, (1983) carried out identification of potentially significant coagulase-negative staphylococci isolated from clinical specimens and performed antibiotic susceptibility determinations. *S. epidermidis* accounted for 75% of these isolates, with *S. haemolyticus* and *S. hominis* being the second and third most frequently encountered species, respectively. Antibiotic susceptibility profiles demonstrated that *S. haemolyticus* and *S. epidermidis* were frequently multiple antibiotic resistant. *S. haemolyticus* had a higher percentage of isolates that were oxacillin resistant than *S. epidermidis*.

Gaikwad & Deodhar (1983) isolated 1352 strains of staphylococci from various specimens of which 1300 (96.37%) were coagulase positive staphylococci and 52 (3.7%) were coagulase negative staphylococci. Drainage from wounds was the most frequent source of coagulase negative staphylococci
(40 strains, 76.92%) followed by blood (6 strains, 11.54%), tissue fluids (5 strains, 9.62%) and urine (one strain, 1.92%). Among coagulase negative staphylococci, 29 (55.75%) were identified as *S.epidermidis* and 23 (44.25%) as *S.saprophyticus*. Of the 52 strains, 25 strains were β-lactamase producers and penicillin resistance was associated with β-lactamase activity. One strain identified as *S.epidermidis* was sensitive to penicillin in the antibiotic disc susceptibility test, had low MIC level (0.25 units/ml) and yet showed the presence of β-lactamase enzyme.