Chapter-V

DISCUSSION
5. DISCUSSION

*Staphylococcus aureus* is a well known pyogenic coccus responsible for various pus forming diseases. It has a wide distribution and carriage rate among the community, hospital personnel as well as the patients (Chambers, 2001; Mathur et al., 1994). Despite the introduction of effective antimicrobial agents and improvement in hygiene, staphylococci have persisted as important hospital and community pathogens (Chambers, 1997; Sutherland and Ryffel et al., 1994). It has overcome most of the therapeutic agents that have been developed in the recent years and hence the antimicrobial chemotherapy for this species has always been empirical (Jun et al., 2004). The increasing number of MRSA coupled with multiple drug resistance has complicated the treatment process (Kowalski, 2005), thus emphasizing the prevention of staphylococcal infections as the immediate need of the hour.

There has been a steady increase in the prevalence of MRSA in hospitals all over the world including India over the years such that now approximately 50% of nosocomial isolates of *S. aureus* are methicillin resistant (Shopsin et al 2001; Kowalski, 2005; Graham, 2006). Due to the widespread use of antibiotics, especially in developing countries, the resistance profile of microorganisms is changing, evidenced by increasing occurrences of antibiotic resistance among bacterial populations (Ako-nai et al., 1995; Farrar, 1994; O'Brien., 1986) Additionally resistance rates are typically higher (more than 50% upto 95%) in developing countries (Lamikanret al 1989; Orrett and Shurland, 1996; Young et al., 1986) as compared to developed countries (where rates are 20 to 50%) (Lacey, 1987; Thompson et al., 1994; Graham., 2006; Laverdiere.,
Various hospital-based studies have described the incidence of MRSA causing such infections (Layton et al., 1995; Saravolatz et al., 1982; Salaria and Singh, 2001; Anupurba et al., 2003; Brown and Ngeno, 2007).

Low level of resistance even to vancomycin is emerging at present (Assadullah et al., 2003; CDC, 2002 & 2004). Thus only a few antimicrobial agents are available for treatment of infections caused by S. aureus and none of these possess ideal characteristics. Hence accurate and rapid identification of MRSA in a clinical specimen is essential for timely decisions on isolation procedures and effective antimicrobial therapy (Geha et al., 1994; Kohner et al., 1999; Murakami et al., 1991; Sakoulas et al., 2001; Unal et al., 1994).

Infected and colonized patients provide the primary reservoir for S. aureus. Serious endemic and epidemic MRSA infections occur globally as infected and colonized patients in hospitals mediate the dissemination of these isolates and hospital staff assists further transmission. The root causes of serious endemic and epidemic MRSA infections is the dissemination of the strain from infected patients and hospital staff. (McDonald, 1997). It is well known that colonization precedes infection (Perl and Golub, 1998). Anterior nares constitute the most common site of colonization of S. aureus and also is responsible for the dissemination of this organism.

In the hospital, inpatients and hospital personnel are the potential reservoir for this organism. However, studies regarding the prevalence of this organism in communities beyond the hospital have been few (Moreno et al., 1995, O'Brien et al., 1999).
Community-acquired methicillin resistant Staphylococcus aureus (CA-MRSA) infections have been increasing. The most common of these infections present as skin abscesses. The objectives were formulated to obtain insights into the CA-MRSA infection, exhibiting antibiotic sensitivity patterns and the description with reference to the abscesses in pediatric emergency population (David et al 2008).

S. aureus is found in nasal carriages as well as in defined patient groups and healthcare workers. (Thompson et al., 1982, Layton et al., 1995). Few studies also suggest the MRSA infections in individuals with little or no direct contact with primary sources like hospitals and healthcare centers. (Hollis et al., 1995, Pate et al., 1995).

Reports of increasing community acquired MRSA from U.S., Canada and Australia are evidence of the changing epidemiology of MRSA. Because of such changes it is important to assess the carriage rate of MRSA in the community amongst healthy individuals who have not been hospitalized, nor had antibiotic therapy in the past. In this study we demonstrated the nasal carriage rate of S. aureus in a general population with no previous exposure to hospital or antibiotic usage.

It is not always clear whether the S. aureus strains have arisen in the community or are hospital strains that have spread to the community (Saxena et al., 2003). During the past few years extensive research is undertaken across the world in SCCmec typing and has been found to be a more advantageous tool (Enright et al., 2002; Olivira et al., 2002; Huang et al., 2004; O'Brien et al., 2004; Jann-Tay et al., 2007; Arakere et al., 2003; Ito et al., 2004; Nadig et al., 2006).
*Staphylococcus aureus* is a bacterial species of medical significance, only approximately 30% of all humans carry staphylococcal cells persistently but asymptptomatically in their nasopharynx and/or other body sites (Alex van Belkum et al 2008)

Epidemiological and clinical reports (Vandenesch *et al*., 2003 and Berglund *et al*., 2005) provide strong evidence that the high virulence potential of community acquired MRSA is due to the presence of a putative virulence factor called PVL. Thus, in our study PVL was used as a marker to differentiate community acquired MRSA isolates of *S. aureus* from hospital acquired MRSA.

This study was designed to determine the prevalence of *S. aureus* in hospitals and community and characterize the isolates phenotypically and genotypically. The results obtained in our study are discussed as follows:

**5.1. ISOLATION RATE OF *S. AUREUS* IN HOSPITALS AND COMMUNITY**

In this study, the prevalence of *S. aureus* and MRSA isolates were determined from the hospitals (clinical samples and hospital personnel) and healthy individuals (school children and adults) from community.

In 1997, the MRSA Surveillance Study Group conducted a pilot programme of MRSA surveillance in India and observed that there was an increasing trend in the resistance to methicillin (45.7%) among the *S. aureus* (MRSA–SSG, 1997). Methicillin resistance among *S. aureus* isolates has reached phenomenal proportions in Indian
hospitals, with some cities reporting that up to 70% of the strains resistant to methicillin (Anupurbha et al., 2003).

Overall rate of isolation of S. aureus strains from all types of samples was 50.86%. Not much difference was observed in the isolation rate of S. aureus from clinical samples and community samples. However, very high rate of (82.14%) isolation was observed in the nasal samples of hospital personnel. Among the clinical samples highest percentage (66.6%) of incidence of S. aureus was seen in the CSF samples, while incidence of S. aureus from other clinical samples in this study is agreeable with the earlier research reports (Nadig et al., 2006). Reports on incidence of S. aureus from CSF may be high in this study since we included only few cases and also samples were obtained from defined cases. Majority of reports are mainly available on the pus, urine and throat. The highest numbers of S. aureus were obtained from pus followed by urine and catheter tips. Similarly Nadig et al. (2006) reported that majority of the S. aureus isolates in their study were isolated from pus. Among 57 S. aureus isolates recovered from pus samples 26 (45.61%) isolates belonged to burns ward. Our finding is similar to the findings of Krishnan et al. (2002) who reported about 40-50% of S. aureus strains from pus samples of burn and trauma wards. The problem is compounded in the burns unit as patients are severely immuno-compromised and receive numerous antibiotics.

A significant number (18) of S. aureus isolates were also recovered from urine. The isolation rate of S. aureus from urine samples was 43% which is almost double than that reported by Brown and Charles (2007) and Dar et al., (2006) who reported the
incidence of *S. aureus* in the urine samples to be (14.8%). *S. aureus* is a rare cause of urinary tract infections, accounting for only 0.5% to 6% of all the urine cultures (Muder *et al.*, 2006 and Sheth and Dinubile, 1997), their finding is increasingly being recognized as significant especially in patients with urinary tract catheterization or delayed treatment could lead to the development of staphylococcal bacteremia (Jensen *et al.*, 2002 and Weems, 2001). In the present study lowest incidence of *S. aureus* was observed in blood samples compared to earlier reports, of Dar *et al.* (2006) where *S. aureus* isolation rate was 11.3% in blood.

Staphylococcus aureus can infect skin, hair follicles, abscesses, tissues and also major organs like heart, lungs, bones and blood which makes this pathogen a major cause for the multiple types of infections (Mohamed *et al.* 2008).

Among the hospital personnel highest carriage rate (82.14%) of *S. aureus* was observed. The colonizing rate was highest (91%) in the anterior nares of nursing assistants compared to doctors and nurses. However, Preetha *et al.* (2000) reported similar observation with lower percent of incidence among hospital personnel. Methicillin-resistant *S. aureus* (MRSA) confinement was previously prevalent to hospitals and other health care environments where patients frequently visit. (2010). This study to identify and characterize the *S. aureus* isolates from healthy individuals, hospital personnel and clinical samples by applying both conventional and molecular methods. Our results suggest that CA-MRSA and HA-MRSA evolved independently and have different SCCmec types and CA-MRSA also possessed PVL toxin (prabha 2010).
Prevalence of *S. aureus* in the healthy individuals of community was 45.45% and was slightly higher in children than adults. Reports from Indian studies revealed that prevalence of *S. aureus* in the community was ranging from 10% to 40%. The prevalence of *S. aureus* is slightly higher in our study. Many studies on nasal carriage rate of *S. aureus* in children is higher than the adults in the community and also it differs with geographical area (Brown and Charles, 2007 and Saxena *et al.*, 2003). High frequency of isolation of *S. aureus* was observed in the age group of ≤ 18 years and older age group of ≥ 50 years (73.07% and 51.78% respectively). 2

### 5.2. PHENOTYPIC DETECTION OF MRSA

The conventional MRSA detection assays are simple and relatively cheap methods for detecting methicillin resistance. The conventional methods to detect MRSA included oxacillin agar screen test, disk diffusion using 1 µg microgram oxacillin disk, cefoxitin disc (30 µg) test as well as oxacillin MIC by broth dilution methods. All the 177 isolates of *S. aureus* in our study were tested for methicillin resistance by disc diffusion method. Off the 177 *S. aureus* isolates, 88 isolates tested positive for oxacillin agar screen, oxacillin disc test and cefoxitin disc test. The results obtained revealed 100% concordance. The specificity of conventional methods in our study is 100%, which is similar to the findings of (Montesinos et al 2002) who reported 100% concordance in their results with oxacillin disc test, oxacillin agar test and oxacillin MIC. (Alex et al 2009) also reported 100% concordance in their results with oxacillin, methicillin and cefoxitin. Oxacillin MIC values were high for the MRSA strains isolated from the clinical samples compared to the isolates from the hospital personnel and
healthy individuals. Accurate and rapid detection of Methicillin Resistant Staphylococcus aureus (MRSA) is an important diagnostic tool of clinical microbiology laboratories to avoid treatment failure (Somayeh Karami et al 2011). Working in the same direction, the aim of this study was formulated to compare conventional methods and the E-test minimum inhibitory concentration (MIC) method to determine the best ones.

5.3. ANTIMICROBIAL SUSCEPTIBILITY TEST

Widespread use of antibiotics especially in the developing countries leads to change in the resistance profile of microorganisms.

Acquiring resistance to antimicrobial agents is one of the major microbial threats in the 21st century (Smolinski et al., 2003). S. aureus always acquires resistance to the newly introduced antimicrobial agents (Kim et al., 2004; Hiramatsu et al., 2001). And it is therefore important to study the antimicrobial resistance patterns of S. aureus which will lead to better understanding of the emerging patterns of its resistance.

Our study provides important data on current antimicrobial resistance, including methicillin resistance for a collection of S. aureus obtained from clinical samples (104), hospital personnel (23) and from healthy individuals from community (50) in Bangalore.

Indian literature shows the incidence of MRSA to be on the rise; the value ranges from 5 to 50 percent in different institutional studies (Mathur et al., 1994). The incidence of hospital acquired MRSA infections in Indian hospitals has been recorded at between 30 to 80% (Manoharan et al., 1997; Anupurba et al., 2003). The MRSA incidence was as low as 6.9% in 1988 and reached to 24 and 32.8%, in Vellore
(Pulimood et al., 1996) and Lucknow (Mathur et al., 1994) in 1994, respectively and was of the same order in Mumbai, Delhi and Bangalore in 1996 and in Rohtak and Mangalore in 1999 (Verma et al., 2000).

Susceptibility test profile revealed a high level of resistance amongst the \textit{S. aureus} to most of the commonly used antibiotics. The results were comparable to those in previous studies (Pulimood et al., 1996 and Manoharan and Lalitha, 1997). As expected, highest resistance was observed towards penicillin-G (92.31%), which is slightly higher than 90.6% as reported by Rajaduraipandi et al. (1997). But the significant observation of this study is the resistance shown by MRSA to different antibiotics and none of the isolates were resistant to vancomycin. The MRSA showed a high level of resistance to all antimicrobials in general in comparison to the MSSA. Also most of the MRSA in this study were actually resistant to many classes of antimicrobials at the same time and thus qualify as multiple drug resistant \textit{S. aureus} (MDR-MRSA).

The overall isolation rate of MRSA among \textit{S. aureus} isolates was found to be 66.34% which is higher than the findings of Majumdar et al. (2001) from Assam who reported 23.2% of the MRSA from the clinical samples. The distribution rate of MRSA was highest in pus (77.19%) which is higher than the isolation rate of 33% from pus reported by Mehta (1998). However, Qureshi (2004) from Pakistan reported a high isolation rate of upto 83% MRSA from pus which is comparable with our results. However the incidence of MRSA among the collected clinical samples was found to be 32.86%.
Vidhani et al. (2001) from Delhi reported as 87.3% of MRSA. In North America it was 20 to 50% and 80% in Turkey (Orret, 1996), but in Africa only 23% of MRSA was observed (Brown and Charles, 2007). Majority of reports from Indian studies on the incidence of MRSA from hospital isolates was in the range of 50 to 80% (Anupurba et al., 2003).

Various studies have postulated that MRSA carriage by health care workers contributes to the occurrence of MRSA infections in clinical situations (Preetha et al., 2000). In this study highest isolation rate of *S. aureus* was seen among nursing assistants (90%) followed by nurses (76.9%) and doctors (75%). Highest MRSA isolation rate was seen among nursing assistants (60%) followed by nurses (50%) and doctors (33.3%). Opal et al. (1990) reported a higher isolation rate of 65% of MRSA among nurses in comparison to our study. However the total carriage rate of MRSA among the hospital personnel was 42.85% which is higher than the findings of Vardhan (Saxena et al., 2003) who reported the nasal carriage rate of 39% among health care workers. This may be one of the predisposing factor for high incidence of nosocomial infections of *S. aureus*.

In this study we demonstrated the nasal carriage rate of *S. aureus* in the healthy individuals from the community with no previous exposure to hospital or antibiotic usage. We screened the school children and adults from the community. Literature survey showed 0% to 29% carrier rate (Mehta et al., 1998; Sachdev et al., 2003; Pulimood et al., 1996). The nasal carriage of *S. aureus* was 45.5% in our study which is comparatively higher. The nasal carriage of *S. aureus* was highest in school children (46.5%) below 18 years followed by adults (41.6%). The isolation rate of *S. aureus* was
45.5% which is slightly higher than 29.4% reported by Saxena et al. (2003). Whereas overall MRSA carriage rate in the population was 6.3% (7/110), which is also slightly higher than 5% reported by Saxena et al. (2003). The colonization rate ranged from 10% to more than 40% in normal adult population of community (Klutymans, 1997). Our result on the S. aureus colonization rate (41.6%) in adult population is well within the colonization range reported earlier. On the other hand nasal colonization rate of S. aureus in children was reported to be 36.4% by Creech et al. (2005) which is near to our finding (46.5%) where as MRSA incidence in the children was reported to be 9.2% which in slightly higher than our report (5.8%). However Lo et al. (2007) and children od the below 5 years age 70% had ≥1 chronic health condition, and 88.2% received oseltamivir (5.8% started before PICU admission). Most patients had respiratory failure with 564 (67.3%) receiving mechanical ventilation; 162 (19.3%) received vasopressors, and 75 (8.9%) died. Overall, 71 (8.5%) of the patients had a presumed diagnosis of early (within 72 hours after PICU admission) Staphylococcus aureus coinfection of the lung with 48% methicillin-resistant S aureus ( Adreinne et al 2011) from Taiwan reported 13.2% MRSA and 25% S. aureus carriage rate in school children which differs from our study. This clearly suggests that prevalence of nasal carriage rate of S. aureus is different, not only in age, but also geographical areas. 3

Antimicrobial susceptibility testing was performed for all the S. aureus strains isolated in this study. We observed highest percent of resistance to penicillin (78.53%) followed by 59.88% to cloxacillin and ampicillin. However, only 50% of isolates were resistant to methicillin, on the other hand all S. aureus strains isolated in this study were susceptible to vancomycin. Over all more the 50% of isolates were also resistant
to aminoglycosides and macrolides. Majority of MRSA strains were isolated from the clinical samples and more than 80% of them also showed resistance to all β-lactam antibiotics tested with highest of 98.86% against penicillin-G and lowest to cefotaxime (50.72%). Over all 50% MRSA from clinical isolates were resistant to all antibiotics except vancomycin. Comparatively the incidence of antibiotics resistance observed in *S. aureus* strains isolated from the various sources is in concordance with the earlier reports made by Dar *et al.*, 2006. However, all MRSA were susceptible to vancomycin while the highest degree of resistance was observed for penicillin-G (98.86%) followed by ampicillin (85.22%). Less frequency of resistance to various antibiotics was observed in the *S. aureus* strains isolated from the healthy individuals from community compared to clinical and carriers of hospital personnel. However, 100% resistance to penicillin-G was observed in the MRSA strains isolated from the healthy individuals and hospital personnel but not in the isolates from the clinical samples (98.55%).

Thus, anterior nares as the main carrier site for *S. aureus* colonization has been confirmed by many reports (Noble *et al.*, 1964; Jayaraj *et al.*, 1990; Klutymans *et al.*, 1997; Paul *et al.*, 2003). Surveillance studies of *S. aureus* infection and carriage suggested a consistent increase in both hospital and community. Such increase in the population is an alarming situation for public health management department and physicians.

The rate of methicillin resistance among *S. aureus* strains was low in the community (14%) compared to that in the hospital personnel (52.17%) and clinical samples (66.34%) which is very high. However, our study has shown that MRSA is not
only a problem of hospitalized patients but also a problem of people within the community.

Qureshi et al. (2004) and Pulimod et al. (1996) had reported ciprofloxacin resistance as high as 98.9%, among MRSA isolates from clinical samples. In contrast, we have 69.57% of the MRSA strains resistant to ciprofloxacin. The studies from Pulimood et al. (1996) revealed that only 8% resistance of MRSA to gentamicin as against 69.57% in our study. Gentamicin resistance is on the rise since 1996 which reached to 80% from 0% just after 1996. (Price et al., 1998). The reports from Qureshi et al. (2004) suggested the gentamicin resistance of 97.8% which is higher than our obtained results.

Although MRSA from clinical samples showed higher susceptibility to individual antibiotics when compared with others, we obtained high percentage of multi-drug resistant MRSA in our samples. Majumdar (2001) from Assam had reported 23.2% of the MRSA isolated from clinical samples to be multi-drug resistant MRSA.

5.4. MOLECULAR TYPING

Conventional MRSA detection is simple and relatively economic. For detecting methicillin resistance few difficulties occur when organisms have their MICs near the breakpoint. It is in such instances that detection of \textit{mecA} gene is useful by molecular techniques. Now MRSA are being isolated not only from clinical, hospital personnel but also from the community. So, it is also necessary to know the origin of the MRSA. The phenotypic methods available till date cannot efficiently discriminate and produce ambiguous results at times (Ip et al., 2003). A large number of molecular
methods have been developed for typing MRSA strains. DNA fingerprinting by pulsed-field gel electrophoresis (PFGE) is the most reliable, discriminatory and reproducible technique used for the detection of high degree DNA polymorphism (Ryffel, et al., 1991; Struelens et al., 1991, 1992; Maslow et al., 1994; Nada et al., 1996), but it is technically demanding, time consuming, and expensive. The PCR based detection method which are presented can help in the investigation and guide infection control measures very quickly. And by these results we can also reach to a conclusion that PCR based methods can to some extent complement PFGE for MRSA typing.

Possible other methods for typing the S. aureus isolates included multilocus enzyme electrophoresis, bacterial restriction endonuclease digest analysis, multilocus sequence typing (MLST) (Enright et al., 2000), spa typing (Shopsin et al., 1999), multiplex PCR for SCCmec typing (Oliviera et al., 2002) and random amplification of polymorphic DNA (RAPD) (Wang et al., 1993).

The need of the hour for the diagnosis of MRSA is a typing system that is reliable, sensitive and reproducible. Genotypic typing is based on the analysis of a chromosome or extra-chromosomal DNA, allowing direct comparisons of genotypes between strains.

The SCCmec typing provides strong evidence for the independent deviation of HA-MRSA and CA-MRSA clones (Okuma et al., 2002). The SCCmec types I, II and III are predominantly found in HA-MRSA strains, whereas the SCCmec types IV and V are mainly associated with CA-MRSA throughout the world (Gonzalez et al.,
2005). It is essential to differentiate strains causing infections occurring in the community and hospitals.

First discovered in 1932, PVL is a biocomponent synergohymenotropic toxin that is present in the majority of community acquired MRSA carrying SCCmec IV (Francis et al., 2005). It is one of the pore forming toxins most consistently present as transferable toxin locus among CA-MRSA strains.

Recently, there has been much interest in PVL, due to its involvement in severe disease among children and young adults with no known exposure to health care establishment. More recently, cases of community acquired pneumonia due to PVL positive S. aureus have been reported in France (Boussaud et al., 2003), Sweden (Osterlund et al., 2002), the Netherlands (van der Flier et al., 2003), the United Kingdom (Klein et al., 2003). In addition, PVL genes have been identified as a stable marker of community acquired MRSA strains worldwide. Thus in our study, PVL was used as a marker to distinguish the isolates from hospitals and community.

We are reporting the SCCmec types and PVL occurrence in MRSA isolates from hospitals and community in Bangalore. 38 MRSA isolates were randomly selected from clinical specimens, hospital personnel and healthy individuals for SCCmec and PVL characterization. Majority of isolates were derived from pus, although the percentage of isolates from various other sites varied amongst hospitals. Off these 38 isolates, 26 belonged to clinical isolates, 6 belonged to nasal carriage of hospital personnel and 4 isolates were from the healthy individuals of community. The results of multiplex PCR for SCCmec typing revealed that of the 38 isolates, 19 isolates had SCCmec type III
(PCR products showing four bands of 209-, 243-, 303- and 414-bp bands) and 6 had IIIA showing (209-, 243- and 414-bp bands and devoid of 303-bp band). 8 isolates had type IIIB (both 414-, 303-bp bands were absent), 4 isolates belonged to type IV (only 342-bp band present). However, in our study only 1 isolate was not typeable (variant). All the clinical isolates showed either SCCmec type III, IIIA or IIIB. Except one clinical isolate from catheter tips which was a variant. SCCmec type IV isolates were recovered from healthy individuals. Highest percentage of the isolates had SCCmec type III (50%) followed by IIIA (15.78%) and IIIB (21.05%).

We strongly believe that we are reporting for the first time SCCmec typing and PVL analysis of MRSA isolates from both hospitals and community in Bangalore. Our results are similar to Arakere et al. (2005) who genotyped 82 strains belonging to clinical samples from two Bangalore hospitals and reported that 75 isolates were type III or III A (35%). Nadig et al. (2006) collected 186 clinical strains from eight hospitals in different cities of India (excluding Bangalore) and performed molecular characterization. 46 isolates out of 104 had SCCmec III (76%) or IIIA (24%). These findings are slightly higher than our results, wherein we obtained 50% of type III and 15.78% of type IIIA, however our reports indicate similar proportionality with earlier reports. 4

Aires de Sousa et al., 2003 reported that recovery of predominantly type III and IIIA isolates from two hospitals in Taiwan and China, which is similar to our reports. In the past years several reports on the genotypes of MRSA prevalent in Asian countries have been published (Kwan, et al., 2005; Ip et al., 2005; Aires et al., 2004). In the past, several reports on the genotypes of MRSA prevalent in Asian countries have been published. Kwan Soo Ko et al. (2005) collected five or more S. aureus isolates
from the following Asian countries– Korea, Japan, China, India, Indonesia, Philippines, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand and Vietnam and genotyped them. They reported that Korea and Japan showed exclusively SCCmec type II containing isolates and the remaining countries had isolates with type III or IIIA cassettes, IIIA being the majority. Among the Indian isolates, 65-75% comprised of type III and the rest IIIA. This finding is similar to our reports which reveals 65.7% of the isolates (25/38) belonging to type III and IIIA. A more recent publication from Kwan Soo Ko et al. (2005) from a survey of samples collected from different hospitals in Korea reported that type III and IIIA containing isolates are surfacing in Korea although the dominant type is still type II.

All type III and IIIA isolates were resistant to penicillin-G, methicillin, oxacillin, gentamicin and erythromycin and all the strains were sensitive to vancomycin. In contrast to the multi-drug resistance usually seen in hospital acquired MRSA, antibiotic resistance in community acquired MRSA strains is often limited to β-lactams (Deresinski, 2005). In our study, the SCCmec typing correlated well with major antimicrobial susceptibility results in MRSA strains. SCCmec type III isolates possessed significantly greater resistance than SCCmec IV isolates to several commonly used antibiotics. Meticillin-resistant Staphylococcus aureus (MRSA) is endemic in many hospitals worldwide.

MRSA strains are beginning to emerge as a cause of community infections unlike previously associated with hospital or healthcare units. (Jonathan 2010).
Isolates from clinical specimens and hospital personnel had higher oxacillin MIC ranging from 32-512 µg/ml, where as community isolates had lower oxacillin MIC ranging from 2-64 µg/ml.

Our results on the PVL analysis revealed that all MRSA isolates identified as SCCmec type IV were positive for the presence of PVL gene. Our results on PVL study clearly suggest that it is present only in SCCmec type IV. Among 38 isolates, 10.5% (4) of MRSA isolates were positive for PVL. Off 4 isolates having SCCmec type IV, all were positive for PVL gene. This finding of our study is slightly higher than the reports of Wannet et al. (2004) who reported 65% of the PVL-MRSA belonging to SCCmec type IV.

Our results strongly support that SCCmec typing and PVL analysis are valuable adjunctive tools for evaluating and distinguishing the MRSA strains isolated within the hospital from the clinical samples and hospital strains and S. aureus circulating in the community.