The Antibiotic Susceptibilities of Methicillin-Resistant Staphylococcus aureus Strains Isolated From Various Clinical Samples

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Research

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Abstract

Background and Objective:

In this study, it was aimed to determine the in vitro susceptibilities of Methicillin-Resistant Staphylococcus aureus (MRSA) strains to fluoroquinolone, linezolid, tigecycline, and quinupristin/dalfopristin as well as the macrolide-lincosamide-streptogramin B (MLSB) resistance phenotype.

Materials and Methods

A total of 94 MRSA strains isolated from various clinical samples in our hospital laboratory between January 2020 and September 2020 were included. The in-vitro susceptibilities of MRSA strains against fluoroquinolone, linezolid, tigecycline, and quinupristin/dalfopristin were determined by Kirby-Bauer disc diffusion assay according to The European Committee on Antimicrobial Susceptibility Testing (EUCAST). The E test assay was used for evaluation of tigecycline susceptibility. The D-zone test was performed with erythromycin (15 µg) and clindamycin (2 µg) discs to determine the MLSB resistance. Besides, bacterial identification, antibiotic susceptibility tests including methicillin resistance and MLSB phenotype determination were performed by using VITEK 2 Gram-positive diagnostic kits (Bio-Mérieux/France).

Results

Results: Among 94 MRSA strains included, resistance rates to ciprofloxacin, moxifloxacin, tigecycline, and quinupristin/dalfopristin were found as 71% (67 isolates) 64% (60 isolates), 17% (16 isolates), and 2% (2 isolates), respectively.. Resistance was not detected for linezolid. A total of 36 (49%) isolates showed cMLSB resistance phenotype while 18 (19%) had iMLSB resistance. The MS phenotype – strains resistant to erythromycin and susceptible to clindamycin- was not detected.

Conclusion

Very little or no resistance was found to linezolid, quinupristin/dalfopristin and tigecycline. Therefore, these antibiotics may be beneficial for the proper treatment of infections caused by MLSB-resistant isolates.

Introduction

Methicillin-resistant Staphylococcus aureus (MRSA) is one of the most important causes of infections caused by multiple resistant microorganisms, which makes treatment difficult and reduces treatment options. Resistance to beta-lactam group and fluoroquinolones leads to the use of last-option drugs such as vancomycin and teicoplanin, thus increases the resistance rates of these drugs. Therefore, the
need for new antimicrobial drugs has come to the fore and various antibiotics have been developed for the treatment of infections caused by this bacterial group\textsuperscript{3,4}.

Tigecycline (GAR-936), is a semi-synthetic analogue of classical tetracyclines which has activity against both Gram-positive and Gram-negative bacteria\textsuperscript{5}. Tigecycline prevents the aminoacyl tRNA from entering its target by binding to the 30S ribosomal subunit. This prevents the bacteria's protein synthesis and stops its growth\textsuperscript{6,7,8}. Linezolid from the oxazolidinone group is another antimicrobial agent used in the treatment of MRSA infections. Linezolid prevents the formation of the initial complex in protein synthesis by binding to the 50S subunit in ribosomes. The absence of intrinsic resistance gene against linezolid is an advantage for Gram-positive bacteria\textsuperscript{9,10}. Quinupristin / dalfopristin is a combination of semisynthetic streptogramins containing 30:70 ratio of quinupristin and dalfopristin. This macrolide-lincosamide-streptogramin B (MLSB) group antibiotic is effective against Gram-positive bacteria. The drug acts by binding to the 50S ribosomal subunit and inhibits protein synthesis\textsuperscript{11,12}. Frequent use of MLSB group antibiotics in MRSA infections is important in terms of leading to the increase of the number of resistant strains. Methylase enzymes encoded by methylase genes (erm), which is associated with the development of resistance to erythromycin, play a role in the development of resistance\textsuperscript{13}. MLSB resistance phenotypes are of two types, structural (cMLSB) and inducible (iMLSB). Strains with inducible MLSB resistance are crucial as erythromycin treatment causes enzyme induction in the bacterium, leading to resistance to macrolides and lincosamides\textsuperscript{14}.

This study aims to investigate in-vitro susceptibilities of MRSA strains isolated from various clinical samples to fluoroquinolone, linezolid, tigecycline, and quinupristin /dalfopristin and to determine the MLSB resistance phenotype.

**Materials And Methods**

This study is a retrospective study and it was conducted in accordance with ethical principles for medical research with the Declaration of Helsinki. A total of 94 MRSA strains isolated from various clinical samples in the laboratory of our hospital between January 2020 and September 2020 were included.

**Identification**

*Staphylococcus aureus* strains were identified by conventional methods - colony morphology, hemolysis type, Gram stain, catalase, and coagulase tests- and VITEK 2 automated system (Bio-Mérieux / France).

**Detection of antibiotic susceptibilities**

Methicillin resistance and antibiotics susceptibility testing (AST) were investigated by the Kirby-Bauer disk diffusion method according to the recommendations of The European Committee on Antimicrobial Susceptibility Testing (EUCAST)\textsuperscript{15}. Cefoxitin (30 µg) (Oxoid, England) disc was tested for methicillin resistance. Isolates with a cefoxitin inhibition zone diameter of less than 21 mm were defined as methicillin resistant. The MRSA isolates were subjected to the antibiotic susceptibility test with
ciprofloxacin (5µg), moxifloxacin (5µg), linezolid (30µg), quinupristin/dalfopristin (15µg) discs (Oxoid, UK) and tigecycline E test strips (Bio-Mérieux / France). A suspension of 0.5 McFarland fresh bacterial culture in sterile physiological saline was prepared and spread on two separate Mueller Hinton agar (Oxoid, England) plates. Ciprofloxacin (5µg), moxifloxacin (5µg), linezolid (30µg), quinupristin / dalfopristin (15µg) discs (Oxoid, UK) were placed on one plate, and tigecycline on the other one. After incubation at 35 ± 2oC for 18–24 hours, the minimal inhibitor concentration (MIC) of tigecycline and the inhibition zone diameters of other antibiotics were measured and the results were evaluated according to EUCAST criteria. In addition, D-test was performed with erythromycin (15 µg) and clindamycin (2 µg) discs adjacent to each other in order to detect MLSB resistance. The flattening of the clindamycin inhibition zone - defined as the (D) zone- facing the erythromycin disc was evaluated as inducible clindamycin resistance (iMLSB). Strains without an inhibition zone around the clindamycin and erythromycin discs were defined as constitutive clindamycin resistant (cMLSB). AST was also performed by VITEK 2 Gram-positive diagnostic kits (Bio-Mérieux / France) automatically.

Quality control

*S. aureus* ATCC 25923 and *S. aureus* ATCC 29213 and 43300 were used as quality control strains in the study.

Statistical methods

The results were evaluated in terms of frequency and percentage, in line with the purpose of the study.

Results

Out of 94 MRSA strains included in the study, 67 (71%) were resistant to ciprofloxacin, 60 (64%) to moxifloxacin, 16 (17%) to tigecycline, 2 (2%) to quinupristin / dalfopristin. There was no resistance to linezolid. The sensitivity of MRSA strains to antibiotics is shown in Table-1.

Of all the MRSA strains examined, 46 (49%) had cMLSB resistance, 18 (19%) had iMLSB resistance, and 30 (32%) had no resistance. In the strains included in the study, inducible resistance was found in all strains resistant to erythromycin and susceptible to clindamycin (Table-2).

VITEK 2 (Bio-Mérieux / France) results were concordant with classical microbiological identification tests and antibiotic susceptibility test results.

Discussion

In recent years, infections caused by multi-drug resistant MRSA have increased all over the world. MRSA strains resistance to various antimicrobials such as fluoroquinolones have led to use of glycopeptide antibiotics as the first and sometimes the only option. With the reporting of glycopeptide resistance in
MRSA infections, it has brought the use of antimicrobials such as linezolid, tigecycline and quinopristin / dalfopristin in treatment\textsuperscript{16,17}.

In this study, a very high rate of fluoroquinolone resistance was found. 71% of 94 MRSA strains were resistant to ciprofloxacin and 64% to moxifloxacin. The fluoroquinolone resistance rate reported for MRSA strains in our country is between 33% and 85.9%; in other countries it ranges from 9.2–85%. Similar to this study, in a study in which Dündar et al.; investigated the antimicrobial susceptibility of S. aureus strains in a 3-year period (2005–2007) and reported ciprofloxacin resistance rates as 87%, 90% and 92%, respectively\textsuperscript{18}.

Linezolid and tigecycline are reported to be highly effective in MRSA strains. Linezolid resistance has been reported to be less than 0.1% in various surveillance programs since linezolid resistance, which was first published in 2001\textsuperscript{19–22}. In this study, no resistance to linezolid was found among the MRSA strains. Similar results have been obtained in various studies, too. In a study conducted by Dizbay et al. in 2005 on 120 MRSA strains isolated from various clinical samples, all strains were found to be susceptible to linezolid\textsuperscript{23}. In another study conducted with 1707 MRSA strains between 1997–1999, again, linezolid sensitivity was found to be 100\%\textsuperscript{23}. A study conducted in Korea retrospectively examined antibiotic susceptibility tests of a total of 22,067 MRSA isolates over 4 years, and only 110 (0.5\%) were found to be resistant to linezolid\textsuperscript{24}.

In various studies, MRSA strains were found to be highly susceptible to tigecycline and resistance was not reported. For example; Arslan et al. investigated tigecycline in 100 MRSA strains isolated from various clinical specimens and linezolid in 80 of them and found all strains susceptible to linezolid and tigecycline\textsuperscript{4}. Similarly, Goff et al. found all strains susceptible to tigecycline and linezolid in a study they conducted between January 2004 and September 2005 on 879 MRSA strains\textsuperscript{26}. Behera et al. found 21 MRSA strains isolated from a hospital in India to be 100\% susceptible to tigecycline\textsuperscript{27}. In a study conducted in Malesia, five isolates (5.6\%) were found, tigecycline-resistant but they were not linezolid resistance in 90 MRSA\textsuperscript{28}. In this study, 16 (17\%) of the MRSA strains were found to be resistant to tigecycline. Similar to this study, in a study by Kaya et al. investigating the in-vitro activity of tigecycline and linezolid in 60 MRSA strains; while they found all strains susceptible to linezolid, they found resistance against tigecycline in 1 strain\textsuperscript{29}. Hoban et al. reported tigecycline sensitivity as 98.9\% in a study they conducted with 5348 MRSA strains in 2004\textsuperscript{30}. The lower rate of tigecycline resistance in various studies conducted in the past years may be attributed to the resistance of MRSA strains to this antibiotic over time.

In a review article published in 2020, quinupristin/dalfopristin resistance was found as 0.7\% (0.3-1\%) in MRSA strains\textsuperscript{31}. Additionally, in some studies investigating the susceptibility of MRSA to quinupristin/dalfopristin abroad, the rate of resistance was reported to be between 0–31\%\textsuperscript{13,32,33}. Kim et al. did not find resistance to quinopristin/dalfopristin in any of 439 MRSA strains in Korea\textsuperscript{13}. Baddour et al. found that all 512 MRSA strains in Saudi Arabia were susceptible to quinopristin/dalfopristin\textsuperscript{34}. Luh
et al. determined this rate as 31% in Taiwan\textsuperscript{32}. In our country, Baysallar et al. and Yavuz et al. found the quinopristin/dalfopristin resistance to be 1% for MRSA strains and it was found as 2.3% by Tünger et al.\textsuperscript{35,36,37}. Kılıç et al. found no resistance in MRSA strains in the study they conducted in 2001 and 2002 while they reported that they found 2% resistance in 2003\textsuperscript{2}. In this study, similar to various studies conducted in our country, quinopristin / dalfopristin resistance was found to be 2%.

Although macrolides and lincosamides are used effectively in MRSA infections, they cause problems in treatment due to MLSB resistance detected recently. Among 94 MRSA isolates included in this study, MLSB resistance was determined as 49% and iMLSB as 19%; no resistance was found in 30 MRSA strains (32%). These rates are similar to various studies conducted in our country. For example, in the study conducted by Doğruman et al. on 63 MRSA strains isolated from various clinical samples in Ankara between 2005 and 2006; 32 (50.8%) had cMLSB resistance, 13 (20.6%) had iMLSB resistance and 18 (28.6%) had no resistance\textsuperscript{14}. In the strains included in the study, no strains resistant to erythromycin, susceptible to clindamycin but not inducible resistance (MS phenotype) were detected. In the study conducted by Azap et al. in Ankara, similar to the results of this study, cMLSB resistance was found as 45% and iMLSB resistance was found as 37\textsuperscript{38}.

Different resistance rates were found in the studies abroad examining MLSB resistance in MRSA infections. Otsuka et al. in Japan, reported that they found iMLSB resistance is 38.7%, cMLSB resistance is 61.3%; Fiebelkorn et al. reported that they found iMLSB resistance as 29.8% and cMLSB resistance as 34.2% in the USA\textsuperscript{39,40}.

**Conclusion**

Determining the resistance against MLSB group antibiotics will be useful in providing appropriate and effective treatment in MRSA infections. Thus, selection of appropriate and effective drugs before treatment will both prevent the increase in resistance and increase the chance of treatment. Lack of resistance or low rate of resistance to antimicrobial agents such as quinupristin / dalfopristin, linezolid and tigecycline in MLSB-resistant MRSA infections will positively affect the success of the treatment.

**Significance Statement**

Aims of antimicrobial susceptibility tests are contributing to prescribed appropriate antibiotics and monitoring resistant pathogens. Researches of Antibiotic susceptibility, conducted with genotypic or phenotypic methods, contribute to provide epidemiological data, as well as regulation of correct antibacterial treatment regimens. In addition, by collecting data on regional antibiotic susceptibility test results, the types of resistance detected can guide empirical treatment selection.

Results of this study is shown that there is widespread resistance to other antibiotics besides methicillin resistance in \textit{S. aureus} strains and it emphasized that to importance of antibiotic susceptibility tests.
Declarations

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

References

1. Padmanabhan RA, Fraser TG. The emergence of methicillin-resistant Staphylococcus aureus in the community. Cleve Clin J Med. 2005;72:235–41.

2. Kılıc A, Baysallar M, Kuçukkaraaslan A, Aydogan H, Doganci L. In vitro susceptibility of methicillin-resistant Staphylococcus aureus strains to quinupristin/dalfopristine. Turkish Journal of Infection. 2004;18(4):453–6.

3. Azap A, Özkan S, Aygun H, Gul S, Yagci D, Memikoglu O, et al. In Vitro Activity of Moxifloxacin and Ciprofloxacin Against Staphylococcus Aureus Isolates. Turkish Journal of Infection. 2005;19(1):97–100.

4. Arslan U, Yukselkaya S, Işık F, Tuncer I. 2006. In Vitro Susceptibility of Methicillin-Resistant Staphylococcus aureus Strains to Linezolid and Tigecycline ANKEM Derg., 20(4):210–213.

5. Bouchillon SK, Hoban DJ, Johnson BM, Johnson JL, Hsiung A, Dowzicky MJ. 2005. In vitro activity of tigecycline against 3989 Gram-negative and Gram-positive clinical isolates from the United States Tigecycline Evaluation and Surveillance Trial (T.E.S.T. Program; 2004). Diagn Microbiol Infect Dis., 52:173–179.

6. Betriu C, Rodríguez-Avial I, Sanchez BA, Gómez M, Álvarez J, Picazzo JJ, et al., 2002 In vitro activities of tigecycline (GAR-936) against recently isolated clinical bacteria in Spain, Antimicrob Agents Chemother 2002;46(3):892–895.

7. Milatovic D, Schmitz FJ, Verhoef J, Fluit AC. Activities of the glycylcycline tigecycline (GAR-936) against 1,924 recent European clinical bacterial isolates. Antimicrob Agents Chemother. 2003;47(1):400–4.

8. Petersen PJ, Jacobus NV, Weiss WJ, Sum PE, Testa RT. In vitro and in vivo antibacterial activities of novel glycylcycline, the 9-t-butylglycylamido derivate of minocycline (GAR-936). Antimicrob Agents Chemother. 1999;43(4):738–44.

9. Jr. RC, Moellering. Linezolid: the first oxazolidinone antimicrobial. Ann Intern Med. 2003;138(2):135–42.

10. Marchese A, Schito GC. The oxazolidinones as a new family of antimicrobial agent. Clinical Microbiology Infection. 2001;7(4):66–74.

11. Allen GP, Cha R, Rybak MJ. In vitro activities of quinupristin-dalfopristin and cefepime, alone and in combination with various antimicrobials, against multidrug-resistant staphylococci and enterococci in an in vitro pharmacodynamic model. Antimicrob Agents Chemother. 2002;46:2606–12.
12. R. Fekefy In: Mandell GL, Bennett JE, Dolin R. Mandell 2000. Douglas and Bennett’s Principles and Practice of Infectious Diseases. 5th ed. Vancomycin, teicoplanin, and streptogramins: Quinupristin and dalfopristin. Philadelphia: Churchill Livingstone, 382–391.

13. Kim HB, Lee B, Jang HC, Kim SH, Kang CI, Choi YJ, et al. A high frequency of macrolide-lincosamide-streptogramin resistance determinants in Staphylococcus aureus isolated in South Korea. Microbiol Drug Resist. 2004;10:248–54.

14. Dogruman Al F, Akca G, Aykan B, Sipahi AB, Caglar K. The Susceptibility To Quinupristin/Dalfopristin And Linesolid And Resistance To Macrolide-Lincosamide-Streptogramin B In Methicilline Resistant Staphylococcus Aureus Strains. Turkish Journal of Infection. 2008;22(3):153–63.

15. European Committee on Antimicrobial Susceptibility Testing. 2020. Breakpoint tables for interpretation of MICs and zone diameters, version 10. https://eucast.org/clinical_breakpoints/.

16. Bozdoğan B, Esel D, Whitener C, Browne FA, Appelbaum PC. Antibacterial susceptibility of a vancomycin-resistant Staphylococcus aureus strain isolated at the Hershey Medical Center. J Antimicrob Chemother. 2003;52:864–8.

17. Chang S, Sievert DM, Hageman JC, Boulton ML, Tenover FC, Downes FP, et al. Infection with vancomycin-resistant Staphylococcus aureus containing the vanA resistance gene. N Engl J Med. 2003;348:1342–7.

18. Dundar D, Sonmez TG. Antimicrobial susceptibilities of staphylococcus aureus strains isolated from clinical samples: Three years evaluation. ANKEM Derg. 2009;23(1):8–12.

19. Tsiodras S, Gold HS, Sakoulas G, Wennersten C, Venkataraman L, Moellering RC, et al. Linezolid resistance in a Staphylococcus aureus isolate. Lancet. 2001;358(9277):207–8.

20. Anderegg TR, Sader HS, Fritsche TR, Ross JE, Jones RN. Trends in linezolid susceptibility patterns: report from the 2002–2003 worldwide Zyvox Annual Appraisal of Potency and Spectrum (ZAAPS) Program. Int J Antimicrob Agents. 2005;26(1):13–21.

21. Mutnick AH, Enne V, Jones RN. 2003 Linezolid resistance since 2001: SENTRY Antimicrobial Surveillance Program. Ann Pharmacother., 37(6):769–774.

22. Styers D, Sheehan DJ, Hogan P, Sahm DF. Laboratory-based surveillance of current antimicrobial resistance patterns and trends among Staphylococcus aureus: 2005 status in the United States. Ann Clin Microbiol Antimicrob. 2006;5:2.

23. Dizbay M, Sipahi AB, Günal O, Kirca F, Sanal L, Caglar K. Investigation of Glycopeptid and Linezolid Resistance among Methicillin-Resistant Staphylococcus aureus Isolates. ANKEM Derg. 2007;21(1):23–6.

24. Yoo IY, Kang OK, Shim HJ, Huh HJ, Lee NY. Linezolid Resistance in Methicillin-Resistant Staphylococcus aureus in Korea: High Rate of False Resistance to Linezolid by the VITEK 2 System. Ann Lab Med. 2020;40(1):57–62.

25. Facklam RR, Sahm DF, Teixeira LM, Murray PR, Baron EJ, Pfaller MA, Tenover FC, Yolken RH. 2007. Enterococcus. Manual of Clinical Microbiology. 9th ed. Washington DC: ASM Press., p. 430.
26. Goff DA and M.J. Dowzicky. Prevalence and regional variation in meticillin resistant Staphylococcus aureus (MRSA) in the USA and comparative in vitro activity of tigecycline, a glycyclycline antimicrobial. Journal of Medical Microbiology. 2007;56:1189–95.

27. Behera B, Das A, Mathur P, Kapil A, Gadepalli R, Dhawan B. Tigecycline susceptibility report from an Indian tertiary care hospital. Indian J Med Res. 2009;129(4):446–50.

28. Che Hamzah AM, Yeo CC, Puah SM, Chua KH, Rahman NIA, Abdullah FH, et al. Tigecycline and inducible clindamycin resistance in clinical isolates of methicillin-resistant Staphylococcus aureus from Terengganu, Malaysia. Journal of Medical Microbiology. 2019;68:1299–305.

29. Kaya O, Akcam FZ, Temel EN. In vitro activities of linezolid and tigecycline against methicillin-resistant Staphylococcus aureus strains. Microb Drug Resist. 2008;14(2):151–3.

30. Hoban DJ, Bouchillon SK, Johnson BM, Johnson JL, Dowzicky MJ, 2005. In vitro activity of tigecycline against 6792 Gram-negative and Gram-positive clinical isolates from the global Tigecycline Evaluation and Surveillance Trial (T.E.S.T. Program, 2004). Diagn Microbiol Infect Dis., 52, 215–227.

31. Shariati A, Dadashi M, Chegini Z, vanBelkum A, Mirzaai M, Khoramrooz SS, et al. The global prevalence of Daptomycin, Tigecycline, Quinupristin/Dalfopristin, and Linezolid-resistant Staphylococcus aureus and coagulase–negative staphylococci strains: a systematic review and metaanalysis. Antimicrobial Resistance Infection Control. 2020;9:56.

32. Luh KT, Hsueh PR, Teng LJ, Pan HJ, Chen YC, Lu JJ, et al. Quinupristin-dalfopristin resistance among gram positive bacteria in Taiwan. Antimicrob Agents Chemother. 2000;44:3374–80.

33. Millan L, Cerda P, Rubio MC, Goñi P, Canales M, Capilla S, et al. In vitro activity of telithromycine, quinupristin/dalfopristin, linezolid and comparator antimicrobial agents againts Staphylococcus aureus clinical isolates. J Chemother. 2004;16:230–7.

34. Baddour MM, Abuelkeir MM, and A.J. Fatani. Trends in antibiotic susceptibility patterns and epidemiology of MRSA isolates from several hospitals in Riyadh, Saudi Arabia. Ann Clin Microbiol Antimicrob. 2006;5:30.

35. Baysallar M, Kilic A, Aydogan H, Cilli F, Doganci L. Linezolid and quinupristin/dalfopristin resistance in vancomycin-resistant enterococci and methicillin-resistant Staphylococcus aureus prior to clinical use in Turkey. Int J Antimicrobial Agents. 2004;23:510–2.

36. Yavuz MT, Behcet M, Ozturk CE, Ozaydin C, Kaya D. 2006. Staphylococcus aureus süğlarının kuinuprisin/dalfopristin’e duyarlılıklarını. Türk Mikrobiyol Cem Derg, 36: 190–4.

37. Tunger A, Aydemir S, Uluer S, Cilli F. In vitro activity of linezolid & quinupristin/dalfopristin against Gram-positive cocci. Indian J Med Res. 2004;120:546–52.

38. Azap A, Yuksel O, Ozkan S, Aygun H, Bozkurt YG, Memikoglu O, et al. 2005 Investigation of inducible clindamycin resistance in Staphylococcus aureus strains. Turkish Journal of Infection., 19:335–338.

39. Otsuka T, Zaraket H, Takano T, Saito K, Dohmae S, Higuchi W, et al. Macrolide-lincosamide-streptogramin B resistance phenotypes and genotypes among Staphylococcus aureus clinical isolates in Japan. Clin Microbiol Infect. 2007;13:325–7.
40. Fiebelkorn KR, Crawford SA, McElmeel ML, Jorgensen JH. 2003. Practical disk diffusion method for detection of inducible clindamycin resistance in *Staphylococcus aureus* and coagulase-negative staphylococci. J Clin Microbiol., 2003; 41: 4740–4744.

**Tables**

Table 1. Antibiotic Sensitivity of MRSA Strains

|             | CIP | MXF | TGC | QD | LZD |
|-------------|-----|-----|-----|----|-----|
|             | n   | %   | n   | %  | n   | %  | n   | %  | n   | %  |
| Sensitive (S)| 27  | 29  | 34  | 36 | 78  | 83 | 92  | 98 | 94  | 100|
| Resistant (R)| 67  | 71  | 60  | 64 | 16  | 17 | 2   | 2  | -   | -  |

CIP: Ciprofloxacin, MXF: Moxifloxacin, TGC: Tigecycline, LZD: Linezolid, QD: Quinupristin / Dalfopristin

Table 2. Distribution of MLSB Resistance in MRSA Strains

| MLSB Resistance                        | n | % |
|----------------------------------------|---|---|
| Number of strains with cMLSB resistance| 46| 49|
| Number of strains with iMLSB resistance| 18| 19|

cMLS$_B$: Constitutive macrolide-lincosamide-streptogramin B

iMLS$_B$: Inducible macrolide-lincosamide-streptogramin B