## CLINICAL SCIENCE

# PREVALENCE OF METHICILLIN-RESISTANT AND METHICILLIN-SUSCEPTIBLE *S. AUREUS* IN THE SALIVA OF HEALTH PROFESSIONALS

**Milton Jorge de Carvalho,[I] Fabiana Cristina Pimenta,[II,IV] Miyeko Hayashida,[III] Elucir Gir,[III] Adriana Maria da Silva,[III] Caio Parente Barbosa,[I] Silvia Rita Marin da Silva Canini,[III] Silvana Santiago[IV]**

**doi: 10.1590/S1807-59322009000400005**

de Carvalho MJ, Pimenta FC, Hayashida M, Gir E, da Silva AM, Barbosa CP et al. Prevalence of methicillin-resistant and methicillin-susceptible *S. aureus* in the saliva of health professionals. Clinics. 64(4):295-302.

**INTRODUCTION:** *S. aureus* is one of the main agents of nosocomial infection and is sometimes difficult to treat with currently available active antimicrobials.
**PURPOSE:** To analyze the prevalence of methicillin-susceptible *S.aureus* (MSSA) and methicillin-resistant *S. aureus* (MRSA) as well as the MRSA antimicrobial susceptibility profile isolated in the saliva of health professionals at a large public education hospital.
**MATERIALS AND METHODS:** The project was approved by the research and ethics committee of the institution under study. Three samples of saliva from 340 health professionals were collected. The saliva analysis used to identify *S. aureus* was based on mannitol fermentation tests, catalase production, coagulase, DNAse, and lecithinase. In order to detect MRSA, samples were submitted to the disk diffusion test and the oxacillin agar screening test . In order to identify the minimum inhibitory concentration, the Etest® technique was used.
**RESULTS:** The prevalence of MSSA was 43.5% (148/340), and MRSA was 4.1% (14/340). MRSA detected by the diffusion disk test, was 100% resistant to penicillin and oxacillin, 92.9% resistant to erythromycin, 57.1% resistant to clindamycin, 42.9% resistant to ciprofloxacin and 57.1% resistant to cefoxetin.
**CONCLUSION:** This subject is important for both the education of health professionals and for preventative measures. Standard and contact-precautions should be employed in professional practice.

**KEYWORDS:** *S. aureus;* Methicillin resistance; Occupational risk; Hospital infection. Exposure to biological agents.

## INTRODUCTION

*S. aureus* is one of the main agents responsible for infections. Its virulence and ability to acquire resistance to antimicrobial agents mean results in a serious worldwide problem for hospitals and health professionals.

[I] Department of Gynecology and Obstetrics, College of Medicine of the ABC - Santo Andre/SP, Brazil.
[II] Centers for Disease Control and Prevention - Atlanta, GA, USA.
[III] Ribeirão Preto College of Nursing, University of São Paulo - Ribeirão Preto/SP, Brazil.
[IV] Federal University of Goiás - Goiás, Brazil.
Email: egir@eerp.usp.br
Phone: 55 16 3602.3414
Received for publication on October 13, 2008
Accepted for publication on December 23, 2008

About 20% of the human population carries at least one type of *S. aureus*. Studies show that higher rates of colonization by this organism are found in health professionals, intravenous drug users, and insulin-dependent diabetic patients with skin diseases or with venous catheter use for long periods.[1]

MRSA is found endemically in many hospitals. The severity of resulting diseases and high costs of health care justify an investment in prevention and control guidelines. It is therefore imperative for health services to carry out systematic MRSA surveillance and disseminate the findings to health professionals.[2]

The resistance of *S. aureus* to antimicrobial agents can be encoded by both chromosomes and plasmids. There are three distinct mechanisms of methicillin resistance: beta-lactamase hyperproduction, the presence of a penicillin-binding protein (PBP) called PBP 2a, and altered ability to bind to PBP.[3] Thus, a single specimen can use these different mechanisms for methicillin resistance, and the mechanisms can even interact among themselves.[4]

Since 1990, MRSA, which was exclusively considered a hospital pathogen (HA-MRSA), has been isolated from individuals in the community with no identified risk factors and no epidemiological relation to the community-associated MRSA (CA-MRSA.).[5]

The management of hospital and community infections has become increasingly difficult because both HA-MRSA and the CA-MRSA have been isolated in both locations.

Most colonized health professionals are transient carriers but may become persistent carriers, especially when they have skin lesions. Thus, the identification and treatment of colonized health professionals can reduce the incidence of MRSA, as unidentified colonized patients can act as a reservoir in endemic situations.[6]

## OBJECTIVE

To determine the prevalence of MSSA and MRSA, as well as the MRSA antimicrobial susceptibility profile isolated in the saliva of health professionals at a large public education hospital.

## MATERIALS AND METHODS

This was a cross-sectional study conducted at a large public hospital, in Santo Andre, São Paulo, Brazil, from August 2006 to June 2008. The hospital served as the site for the collection of material (saliva) at three different time points and for the distribution of questionnaires.

The following inclusion criteria were used: physicians, registered nurses, nursing technicians or nursing assistants who were full-time professionals during the data collection period, were not using antimicrobials for 30 days prior to the collection, gave their consent to participate, provided three samples of saliva collected at established times, and worked in the intensive care units, medical clinic, surgery, gynecology-obstetrics, surgery centers, day hospital or emergency rooms.

From a sample of 374 nursing and gynecology professionals, 34 were excluded due to partition or removal from the institution. Of the remaining 340 participants, 22 were gynecologists and obstetricians, and 318 were professionals from the nursing staff (42 registered nurses, 99 nursing technicians, 177 nursing assistants).

In order to carry out this investigation, the Resolution of the National Council of Ethics in Research (CONEP) No. 196, of 1996, and No. 251, of 1997 were followed.[7] This project was approved by the ethics and research committee of the Ethics and Research Committee of the College of Medicine of ABC, according to CEP/ FMABC protocol, No 242/2006.

The subjects were informed about the research objectives as well as the anonymity and confidentiality of the information provided. Those who agreed to participate in the investigation signed the free and informed consent form.

### Data Collection

The saliva was collected in 12 ml sterile tapered plastic tubes, capped, packaged in a styrofoam box and sent to the Bacteriology Laboratory (IPTSP / UFG). The collection of the second and third samples was conducted similarly, at time points of two and four months.

A semi-structured questionnaire testing the following areas was used: occupational category, gender, age, sector and working shift, time of work in the institution and employment at another institution.

### Laboratory procedures: isolation and identification of *S. aureus*

The identification of *S. aureus* was based on mannitol fermentation tests, catalase, coagulase, DNAse and lecithinase production.[8] The *S. aureus* identified were submitted to the diffusion disk test.[9]

Oxoid disks (Basingstoke, England) were used with the following antimicrobials: oxacillin, cefoxitin, erythromycin, clindamycin, tetracycline, rifampin, ciprofloxacin, gentamicin, sulfamethoxazole-trimetoprin, vancomycin, penicillin, linezolid, and mupirocin. The susceptibility and resistance were compared with the standardized halo table by CLSI. Isolates with intermediate susceptivity were considered resistant. Quality control was performed with the ATCC standard strains of *S. aureus* 25923 and 29213.[9]

In order to detect the resistance of *S. aureus* to methicillin, the oxacillin agar screening test was performed in Petri dishes containing Mueller-Hinton agar supplemented with 4% NaCl and oxacillin 6 µg/ml. The growth of a colony was indicative of resistance to methicillin.[9]

The strains of *Staphylococcus* that were resistant to oxacillin on the disk diffusion test were then tested in the minimum inhibitory concentration (MIC) by Etest®. The bacteria were cultured on blood agar (Muller Hinton Agar plus 5% sheep blood) and incubated at 37ºC for 24 hours. After this incubation period, a bacterial suspension was prepared in sterile saline solution, equivalent to 0.5 on the McFarland scale ($1x10^8$ CFU/ml). This suspension was poured on a plate containing Mueller-Hinton agar plus 2% NaCl. After drying the inoculum on the surface of the agar, the Etest tape was placed using forceps, as per manufacturer recommendation (AB Biodisk, Solna, Switzerland). The plate was subsequently incubated at 35°C. Readings were performed after 24 hours.[10] The standard lineage used for quality control was *S. aureus* ATCC 29213. The MIC by Etest shows the concentration of antibiotics as indicated in the tape at the intersection of the ellipse and bacterial growth inhibition. Results were interpreted according to the CLSI.[10]

### Organization and data analysis

The database was structured and analyzed using the *Statistical Package Social Science* program, version 15.0 for Windows.

## RESULTS

Of 340 professional participants in the study, 22 (6.5%) were gynecologists and obstetricians, 42 (12.3%) registered nurses, 99 (29.1%) nursing technicians and 177 (52.1%) nursing assistants. Of these, 256 (75.3%) were female and 84 (24.7%) male. The age of participants ranged from 19 to 60 years, with an average of 34.6 years.

With regard to the workplace, surgical clinic admittance units (18.5%), intensive care units (13.8%) and nursery and neonatal intensive care units (11.5%) comprised the largest number of work places followed by the surgery center (10.3%), clinical medicine units for carriers of infectious diseases (9.7%) and emergency unit/day hospital (9.7%). Other sites were represented by a smaller number of professionals: obstetrics clinic and center (8.8%), pediatric and coronary intensive care unit (7.6%), obstetrics and gynecology (6.5%) and pediatrics (3.5%).

The working time in the institution ranged from one to 60 months, with an average of 26 months. Regarding the working hours, it is notable that nursing professionals worked 36 hours per week and physicians worked in shifts ranging from 12 to 24 hours per week. Regarding the work shift, the highest number of professionals work on a fixed scale, with 164 (48.2%) individuals working the day

**Table 1 -** Distribution of participants according to professional category and colonization by *S. aureus,* 2007-2008

| Professional category | Not colonized | | Colonized | | TOTAL | |
|---|---|---|---|---|---|---|
| | F | % | f | % | f | % |
| Nursing Assistant | 89 | 50.0 (42.4-57.6) | 88 | 54.3 (46.3-62.2) | 177 | 52.1 (46.6-57.5) |
| Nursing Technician | 54 | 30.3 (23.7-37.7) | 45 | 27.8 (21.0-35.3) | 99 | 29.1 (24.4-34.3) |
| Registered nurse | 25 | 14.0 (9.3-20.0) | 17 | 10.5 (6.2-16.3) | 42 | 12.3 (9.1-16.4) |
| Physician | 10 | 5.7 (2.7-10.1) | 12 | 7.4 (3.9-16.9) | 22 | 6.5 (4.2-9.8) |
| Total | 178 | 100 | 162 | 100 | 340 | 100 |

(95% confidence limits)

**Table 2 -** Distribution of participants according to working sector and colonization by *S. aureus,* 2007-2008

| Working Sector | Not colonized | | Colonized | | TOTAL | |
|---|---|---|---|---|---|---|
| | f | % | f | % | f | % |
| Surgery | 32 | 18.0 (12.6-24.4) | 31 | 19.1 (13.4-26.0) | 63 | 18.5 (14.6-23.2) |
| ICU | 28 | 15.8 (10.7-21.9) | 19 | 11.7 (7.2-17.7) | 47 | 13.8 (10.4-18.1) |
| Nursery and neonatal ICU | 18 | 10.1 (6.1-15.5) | 21 | 13.0 (8.2-19.1) | 39 | 11.5 (8.4-15.5) |
| Surgical center/PAR | 16 | 9.0 (5.2-14.2) | 19 | 11.7 (7.2-17.7) | 35 | 10.3 (7.4-14.1) |
| Medical clinic | 18 | 10.1 (6.1-15.5) | 15 | 9.3 (5.3-14.8) | 33 | 9.7 (6.9-13.5) |
| Day hospital and emergency room | 14 | 7.9 (4.4-12.8) | 19 | 11.7 (7.2-17.7) | 33 | 9.7 (6.9-13.5) |
| Obstetrics clinic and center | 17 | 9.5 (5.7-14.9) | 13 | 8.0 (4.3-13.3) | 30 | 8.8 (6.1-12.5) |
| Coronary + pediatric ICU | 17 | 9.5 (5.7-14.9) | 09 | 5.6 (2.6-10.3) | 26 | 7.6 (5.2-11.1) |
| Gynecology and obstetrics | 10 | 5.6 (2.7-10.1) | 12 | 7.4 (3.9-12.6) | 22 | 6.5 (4.2-9.8) |
| Pediatrics | 08 | 4.5 (2.0-8.7) | 04 | 2.5 (0.7-6.2) | 12 | 3.5 (1.9-6.2) |
| Total | 178 | 100 | 162 | 100 | 340 | 100 |

Label – ICU: Intensive care unit; PAR: Post-anesthesia recovery, (95% confidence limits)

**Table 3 -** Distribution of participants according to professional and personal characterization and colonization by *S. aureus,* 2007-2008

| Variables | Not colonized (n = 178) | | Colonized (n = 162) | | TOTAL (n = 340) | |
|---|---|---|---|---|---|---|
| | F | % | f | % | f | % |
| **Gender** | | | | | | |
| Female | 139 | 78.1 (71.3-83.9) | 117 | 72.2 (64.7-79.0) | 256 | 75.3 (70.4-79.8) |
| Male | 39 | 21.9 (16.1-28.7) | 45 | 27.8 (21.0-35.3) | 84 | 24.7 (20.3-29.7) |
| **Age (years)** | | | | | | |
| 19 to 29 | 50 | 28.1 (21.6-35.3) | 59 | 36.4 (29.0-44.3) | 109 | 32.1 (27.2-37.3) |
| 30 to 39 | 76 | 42.7 (35.3-50.3) | 54 | 33.3 (26.1-41.2) | 130 | 38.2 (33.1-43.7) |
| 40 to 49 | 44 | 24.7 (18.6-31.7) | 44 | 27.2 (20.5-34.7) | 88 | 25.9 (21.4-30.9) |
| 50 to 59 | 08 | 4.5 (2.0-8.7) | 05 | 3.1 (1.0-7.1) | 13 | 3.8 (2.1-6.6) |
| **Length of employment in the institution (months)** | | | | | | |
| 01 to 11 | 38 | 21.3 (15.6-28.1) | 37 | 22.8 (16.6-30.1) | 75 | 22.1 (17.8-26.9) |
| 12 to 23 | 33 | 18.5 (13.1-25.0) | 29 | 17.9 (12.3-24.7) | 62 | 18.2 (14.4-22.8) |
| 24 to 35 | 36 | 20.2 (14.6-26.9) | 25 | 15.4 (10.2-21.9) | 61 | 17.9 (14.1-22.5) |
| 36 to 47 | 47 | 26.4 (20.1-33.5) | 41 | 25.3 (18.8-32.7) | 88 | 25.9 (21.4-30.9) |
| 48 to 60 | 13 | 7.3 (3.9-12.2) | 12 | 7.4 (3.9-12.6) | 25 | 7.4 (4.9-10.8) |
| No answer | 11 | 6.2 (3.1-10.8) | 18 | 11.1 (6.7-17.0) | 29 | 8.5 (5.9-12.1) |
| **Work shift** | | | | | | |
| Day | 89 | 50.0 (42.4-57.6) | 75 | 46.3 (38.4-54.3) | 164 | 48.2 (42.8-53.7) |
| Night | 81 | 45.5 (38.0-53.1) | 74 | 45.7 (37.8-53.7) | 155 | 45.6 (40.2-51.0) |
| Rotating schedule | 02 | 1.1 (0.1-4.0) | 04 | 2.5 (0.7-6.2) | 06 | 1.8 (0.7-4.0) |
| No answer | 06 | 3.4 (1.2-7.2) | 09 | 5.6 (2.6-10.3) | 15 | 4.4 (2.6-7.3) |
| **Multiple Employment** | | | | | | |
| Yes | 61 | 34.3 (27.3-41.7) | 52 | 32.1 (25.0-39.9) | 113 | 33.2 (28.3-38.6) |
| No | 112 | 62.9 (55.4-70.0) | 101 | 62.3 (54.4-69.8) | 213 | 62.6 (57.3-67.8) |
| No answer | 05 | 2.8 (0.9-6.4) | 09 | 5.6 (2.6-10.3) | 14 | 4.1 (2.4-7.0) |

(95% confidence limits)

shift, 155 (45.6%) the night shift, and 6 (1.8%) a rotational schedule. Fifteen individuals (4.4%) did not answer this question.

A total of 113 (33.2%) respondents maintained ties with other health institutions and have an additional work load ranging from six to 48 hours per week.

### Health professionals and *S. aureus* colonization

Of the 340 professionals from whom three saliva samples were collected, *S. aureus* was isolated from at least one sample in 162 individuals (47.6%.) Therefore, the prevalence of *S. aureus* was 47.6% (162/340.)

The demographic and professional characterization of subjects, ranked according to colonization, is presented in Tables 1-3. Regarding the professional category of the colonized subjects, 88 (54.3%) were nursing auxiliaries, 45 (27.8%) were nursing technicians, 17 (10.5%) were registered nurses and 12 (7.4%) were physicians. Females (72.2%) between the ages of 19 and 39 years (69.7%) prevailed among colonized professionals.

The following work sectors stand out in terms of the proportion of colonized subjects: surgical clinics (19.1%), nursery and neonatal intensive care unit (13.0%), intensive care unit (11.7%), surgical center (11.7%) day-hospital and emergency (11.7%).

Regarding the working shift, 46.3% of workers who were carriers of *S. aureus* were from the day shift and 45.7% from the night shift. Of the 113 with secondary employment, 52 (32.1%) were colonized.

### Health professionals and colonization by MRSA

Table 4 highlights the characteristics of professionals colonized by MRSA according to their professional category, gender, sector of employment, length of employment at the

**Table 4 -** Characterization of health professionals from a public education hospital who were colonized by MRSA (n=14), 2007-2008

| Subject | Professional category | Gender | Working Sector | Working time (months) | Working at other institution |
|---|---|---|---|---|---|
| 009 | nursing assistant | Female | Surgery | 02 | No |
| 026 | nursing assistant | Female | Obstetric clinic/center | 21 | No |
| 029 | nursing assistant | Female | Obstetric clinic/center | 10 | No |
| 073 | nursing technician | Female | Nursery/neonatal ICU | 05 | Yes |
| 118 | nursing assistant | Female | Surgery | 12 | No |
| 132 | nursing assistant | Female | Surgical center/PAR | 31 | No |
| 155 | nursing assistant | Female | Obstetric clinic/center | 45 | Yes |
| 173 | nursing technician | Female | Nursery/neonatal ICU | 50 | No |
| 188 | nursing technician | Male | ICU I and II | 45 | Yes |
| 189 | nursing assistant | Male | Surgery | 44 | No |
| 198 | nursing assistant | Female | Obstetric clinic/center | 22 | Yes |
| 213 | nursing assistant | Male | Surgery | 04 | Yes |
| 221 | nursing technician | Female | ICU I and II | 04 | No |
| 276 | nursing technician | Female | Pediatric and coronary ICU | 04 | Yes |

Label – ICU: Intensive Care Unit; PAR: Post-Anesthesia Recovery

investigated hospital and other institutional bonds. In terms of category, the following were colonized by MRSA: nine nursing assistants and five nursing technicians. In terms of gender, 11 were female and three were males between the ages of 25 and 49 years, with the majority (42.9%) between 25 and 29 years. Regarding the labor sector, four participants worked in the surgical clinic, four in the obstetrics clinic and center, three in the intensive care unit, two in the nursery and neonatal intensive care unit, and one in the surgical center. No professional working in the pediatrics unit or in the medical clinic and day hospital/emergency room was identified to be colonized by MRSA. The prevalence of MRSA was 4.1% (14/340).

The number of colony-forming units (CFU) of MRSA ranged from 50 to 10,500.

Of the 14 professionals colonized by MRSA, 7 had been working at the institution less than 12 months. Four individuals were working between 37 and 60 months; nine individuals worked in the institution during the day shift and six had a second employment.

## Antimicrobial susceptibility of MRSA

For the disc diffusion test, MRSA was cultured in agar-screening oxacillin (6 µg) supplemented with sodium chloride at 4.0%. MRSA grown under these conditions were subjected to the Etest® technique, and 14 colonies showed a minimum inhibitory concentration greater than 256 µg/ml. The MRSA susceptibility profile of the saliva of health professionals is presented in Table 5. This table indicates resistance to oxacillin as well as penicillin (100%). A total of 92.9% presented resistance to erythromycin, 57.1% to clindamycin, 57.1% to cefoxitin, 42.9% to ciprofloxacin, 7.1% to gentamicin and 7.1% to trimethoprim-sulfamethoxazole. All MRSA (100%) presented susceptibility to tetracycline, rifampin, vancomycin, linezolid and mupirocin.

## DISCUSSION

It is necessary to detect MRSA in healthy individuals. These individuals can act as carriers and thus as a potential source of microorganisms, which are important for the epidemiology and pathogenesis of hospital infections.[1,11]

The prevalence of *S. aureus* in this study was 47.6% (162/340). The isolation of *S. aureus* from health professionals varied according to the professional category, working sector and levels of adherence to specific precautions against multi-resistant microorganisms.

Studies in different countries have indicated the prevalence of individuals colonized by *S.aureus*; in these studies, the micorganisms were isolated from the nostrils. The prevalence of *S. aureus* in the anterior nostril of 975 health professionals was 33.4%, where 262 (27.2%) had MSSA and 60 (6.2%) had MRSA.[12] In another study, the isolation rate of *S. aureus* in health professionals was 33.8%.[13]

The prevalence of MRSA varies between institutions and geographic areas. Most hospitals face the challenge of controlling MRSA. The increasing incidence of MRSA has been well documented among health professionals.[14]

**Table 5 -** Antimicrobial susceptibility profile detected by disk diffusion test for 14 MRSA-identified health professionals from a public education hospital, 2007-2008

| ID | Oxa | Pen | Eri | Cli | Cip | Cef | Gen | Sul | Oxa 6µg |
|---|---|---|---|---|---|---|---|---|---|
| 9 | **R** | **R** | **R** | **R** | **R** | **R** | S | S | + |
| 26 | **R** | **R** | **R** | **R** | **R** | S | S | S | + |
| 29 | **R** | **R** | **R** | S | S | **R** | S | S | + |
| 73 | **R** | **R** | **R** | **R** | **R** | **R** | S | S | + |
| 118 | **R** | **R** | **R** | **R** | **R** | **R** | **R** | **R** | + |
| 132 | **R** | **R** | S | S | S | **R** | S | S | + |
| 155 | **R** | **R** | **R** | **R** | **R** | S | S | S | + |
| 173 | **R** | **R** | **R** | S | S | S | S | S | + |
| 188 | **R** | **R** | **R** | **R** | S | S | S | S | + |
| 189 | **R** | **R** | **R** | S | S | S | S | S | + |
| 198 | **R** | **R** | **R** | S | S | **R** | S | S | + |
| 213 | **R** | **R** | **R** | S | S | **R** | S | S | + |
| 221 | **R** | **R** | **R** | **R** | **R** | **R** | S | S | + |
| 276 | **R** | **R** | **R** | **R** | S | S | S | S | + |
| **% R** | **100.0** | **100.0** | **92.9** | **57.1** | **42.9** | **57.1** | **7.1** | **7.1** | **100.0** |

Label: ID: identification of the subject; R: resistant, S: susceptible; oxa: oxacillin, Pen: penicillin, Eri: erythromycin, Cli: clindamycin, Cip: ciprofloxacin, Cef: Cefoxitin, Gen: gentamicin, Sul: trimethoprim-sulfamethoxazole

An investigation in the Netherlands found 35% of health professionals to be carriers of MSSA and less than 5% to be colonized by MRSA[15]. In Berlin, Germany a rate of 1.6%[13] was identified. In a German trauma center with 750 beds, samples were collected from the oropharynx of 324 physicians and registered nurses, and the prevalence of MRSA was identified to be 5.3% and 36.4% of the identified *S. aureus.*[16]

In the United States, the prevalence of MRSA was found to be 15% among employees of an emergency department[17]. Another investigation with 255 professional (physicians, registered nurses, social service) found that the prevalence of *S. aureus* was 31.8% and 13.6% for MRSA. MRSA was identified in the nursing staff.[18] The prevalence of *S. aureus* was 28%, and MRSA 2%, in the nostrils of 200 former health employees of an American tertiary hospital.[19] Among professionals who care for burn patients, a rate of 4.5% was detected in Rhode Island.[6]

In Brazil, the data are still not enough. The estimated frequency of MRSA varies from 25% to 50%.[14] A study in Goiânia found that 26.9% of health professionals were carriers of MRSA.[20] In Curitiba-PR, the prevalence was 60.9% (296/486,) with 12.7% (62/486) for MRSA and 48.1% (234/486) for MSSA.[21]

In the present study, 4.1% of health professionals were found to be MRSA carriers. A study that investigated an outbreak of MRSA found that 80.6% of cases were associated with strains from colonized health care professionals.[22]

Another study, however, found an incidence of 50% colonization by *S. aureus* among professionals (296/592), where 38.7% were resistant to methicillin. The overall incidence of colonization ranged from 12.4% in the intensive care unit to 36.7% in clinical surgery.[23]

Regarding the colonization of professionals by MRSA, various indices have been recorded, ranging from 2.6% to 38.7%.[20,23-28] In a systematic review[29] of 127 articles on colonization from January 1980 to March 2006, it was noted that although studies have differed in terms of methodology and the body site investigated, the average prevalence of MRSA was 4.6% among the 33,318 health professionals assessed, with 5.1% having an infection. Regarding the professional category, the prevalence of MRSA among the nursing staff was between 7.4% and 8.0%.

In this study, MRSA was found exclusively in the nursing staff, including nursing technicians and assistants. No registered nurse or physician was infected or found to be a healthy carrier.

The lack identification of MRSA among workers in the medical clinic, a location where infectious diseases (isolation) often occur, can be explained by the routine use of precautions. Another factor that should be considered is the increased risk of transmission for workers in the surgical center, obstetric clinics, neonatal intensive care unit and nursery, given the specific procedures and the patient conditions.

In Goiania, 26.9% of professionals with MRSA were identified to work in the medical intensive care unit, 19.2% in medical clinics, 15.4% in surgical intensive care units, 15.4% in the surgical clinic, 15.4% in the gynecology-obstetrics clinic, and 7.7% in surgery[20].

The identification of MRSA is considered to be a preventative strategy that allows the reduction of incidence. Several researchers have proposed laboratory methods aimed at optimizing the time of analysis in order to obtain sure results of the state of colonization by MRSA.[11,30]

Of the 14 MRSA isolates, 100% presented resistance to penicillin and oxacillin, 92.9% to erythromycin, 57.1% to clindamycin, 57.1% to cefoxitin and 42.9% to ciprofloxacin. In terms of resistance to different groups of antimicrobials, six MRSA isolates that demonstrated resistance to oxacillin also showed resistance to three other groups of antibiotics: erythromycin (macrolid), clindamycin (lincosamides) and ciprofloxacin (quinolone). This suggests resistance to macrolides, lincosamides and streptogramins (MLS), which are widely used for the treatment of staphylococcus infections. These antibiotics are chemically different, but share the same mechanism of action: inhibition of bacterial protein synthesis. The profile of multi-resistance is representative of MRSA clones from hospitals.

Two MRSA isolates were resistant to erythromycin and clindamycin. Their phenotype of susceptibility suggested origination from the community. These eight (57.1%) staphylococci can be classified as multi drug-resistant.

Analysis of the profile of 14 strains of MRSA isolated from the vaginal secretions of pregnant women revealed five isolates phenotypes associated with the community; these phenotypes comprised susceptibility to ciprofloxacin, gentamicin, trimethoprim-sulfamethoxazole and clindamycin. Meanwhile, three MRSA isolates with hospital features that were resistant to gentamicin, ciprofloxacin and clindamycin were identified; four isolated were suggestive of the MLS[31] profile.

There was a high rate (92.9%) of resistance to erythromycin in MRSA isolated from saliva.

Among the lincosamides (lincomycin and clindamycin), clindamycin is the drug of choice for staphylococcus infections resistant to erythromycin, especially for skin and soft tissue infections. This further represents a safe alternative for patients allergic to penicillin. However, the inducible MLS resistance phenotype has led to clinical failure during treatment. In the present study, 61.16% of MRSA isolates were resistant to clindamycin, which limits therapeutic options. Of the 14 MRSA isolates tested, 44.4% were resistant to both erythromycin and clindamycin, which leads us to infer a resistance profile.[32]

Three related determinants, *erm*A, *erm*B and ermC, have been identified and thought to be responsible for the $MLS^B$ phenotype in staphylococci. The expression of this phenotype may be constitutive or inducible. When expression of the MBS phenotype it is constitutive, isolates are resistant to all macrolides, lincosamides and type B streptogramins. When the phenotype is induced, the isolates are resistant to macrolides with 14 and 15 atoms in the lactone ring. Macrolides with 16 atoms, lincosamides and streptogramins remain active. This resistance occurs due to the differences in MLS antibiotic inducing abilities. Thus, 14 and 15 atoms in the macrolide are effective for inducing synthesis of metilases.[33] It was found in this study that six (33.3%) MRSA isolates were resistant to erythromycin and susceptible to clindamycin; this may represent induced resistance to clindamycin. The 14 MRSA isolates were susceptible to tetracyclin, rifampin, vancomycin, linezolid and mupirocin. This may represent a favorable quality, as the antibiotics of choice for treatment of infections by MRSA are vancomycin and linezolid. Also, it should be emphasized that mupirocin is used to stop colonization.[34]

In a previous analysis of 13 MRSA isolates with infections acquired in the community, all presented SCC*mec* type IV.[35] These isolates demonstrated a profile of susceptivity to gentamicin, linezolid, mupirocin, trimethoprim-sulfamethoxazole, vancomycin, and beta-lactam. These findings are similar to those found in this study.

Several preventive measures have been recommended for the control of MRSA, such as prospective microbiological surveillance, contact precautions for colonized or infected patients, hand hygiene, cleaning of the environment, control of microbes, and the stoppage of colonization in colonized patients and professionals.[34]

## CONCLUSIONS

The prevalence of *S. aureus* among health professionals was 47.6% (162/340) and the prevalence of MRSA was 4.1% (14/340).

MRSA identified in 14 health professionals was 100% resistant to penicillin and oxacillin. Moreover, there were large degrees of resistance to erythromycin (92.9%), clindamycin (57.1%), ciprofloxacin (42.9%) and cefoxetin (57.1%).

*S. aureus* was classified in this study to be multi-resistant (57.1%) when it was resistant to two or three different groups of antimicrobials: erythromycin, clindamycin and ciprofloxacin.

To assess the prevalence of MRSA among health professionals it is important to determine preventive measures in hospital infection and even morbidity. There is a need for a greater awareness among health professionals regarding standard precaution measures aimed at the prevention of acquisition of pathogens, especially when considering multidrug resistance and the potential for infection from health professionals colonized by MRSA.

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