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Coagulase-Negative Staphylococci: Comparison of Phenotypic and Genotypic Oxacillin Susceptibility Tests and Evaluation of the Agar Screening Test by Using Different Concentrations of Oxacillin

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This study evaluated the oxacillin susceptibilities of 152 coagulase-negative staphylococcal (CoNS) strains of 12 species by disk diffusion; agar dilution; E-test; the slide latex agglutination test (Slidex MRSA Detection test; bioMérieux S/A, Paris, France); the agar screening test with 1, 2, 4, or 6 μg of oxacillin per ml and incubation for 24 or 48 h; and detection of the *mecA* gene by PCR. The results revealed that the agar screening test with 4 μg of oxacillin per ml and incubation for 48 h was superior to any single phenotype-based susceptibility assay, presenting a sensitivity and a specificity of 100% each. For the different methods evaluated, the sensitivities and specificities were as follows: for disk diffusion, 94.2 and 91.8%, respectively; for the agar dilution test 100 and 73.5%, respectively; for E-test, 100 and 71.4%, respectively; and for the slide latex agglutination test, 97.1 and 98%, respectively. A good correlation was observed between oxacillin susceptibility testing results and PCR results for *Staphylococcus epidermidis*, *S. haemolyticus*, *S. hominis* subsp. *hominis*, and all *mecA*-positive strains. However, at least 60% of the *mecA*-negative isolates of the species *S. saprophyticus*, *S. cohnii* subsp. *urealyticum*, *S. lugdunensis*, and *S. sciuri* were erroneously classified as oxacillin resistant by the agar dilution test. Conversely, the slide latex agglutination test presented a high sensitivity (97.1%) and a high specificity (98%) for all CoNS species. Our results demonstrated the accuracy of the agar screening test with 4 μg of oxacillin per ml and incubation for 48 h and the slide latex agglutination test for the appropriate detection of the oxacillin susceptibilities of CoNS isolates. Both assays are technically simple and can be easier to perform in routine laboratories than PCR.

Coagulase-negative staphylococcal (CoNS) isolates have become a common cause of nosocomial infections, particularly bloodstream infections (26) and infections related to prostheses (28). They account for about 9% of hospital-acquired infections (15). A substantial increase in the frequency of oxacillin resistance in CoNS isolates has occurred over the last decades. At present, more than 70% of the CoNS isolates worldwide are resistant to oxacillin (4). In addition, those CoNS strains acquired in the hospital have become resistant to various other antimicrobial agents. Reports on this issue from Brazil are scarce. Sader and colleagues (29) reported an oxacillin resistance frequency of 80% among CoNS isolates involved in bloodstream infections. In a recent study, Ferreira and coworkers (5) found an oxacillin resistance frequency of 64% among CoNS strains isolated from different clinical sites. The treatment of choice for infections caused by these microorganisms is often vancomycin. Due to the emergence of vancomycin-resistant enterococci (1) and vancomycin-resistant staphylococci (9, 31), the recommendation is to reduce the use of this drug (10). Therefore, it is important for clinical laboratories to distinguish between oxacillin-susceptible and oxacillin-resistant CoNS strains to control the unnecessary use of vancomycin in hospitals.

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The main mechanism of oxacillin resistance in staphylococci is mediated by the production of a nonnative penicillin-binding protein (PBP 2a) that has a low affinity for β-lactam antibiotics and that is encoded by the *mecA* gene (3). In 1999, the National Committee for Clinical Laboratory Standards (NCCLS) (20) lowered the oxacillin breakpoints for CoNS strains in an attempt to improve the correlation between oxacillin resistance detection and the presence of the *mecA* gene among these microorganisms. In addition, the use of the agar screening method was no longer recommended for this group of organisms, although some investigators found the test to be a sensitive method for the detection of oxacillin resistance in CoNS strains (2, 17).

Despite these new standardized recommendations, several studies have been unable to classify many *mecA*-negative CoNS strains as oxacillin susceptible (7, 12, 18). The NCCLS (23) has therefore recommended the detection of PBP 2a for these pathogens. Moreover, a slide latex agglutination test (Slidex MRSA Detection test; bioMérieux S/A, Paris, France) for the detection of this protein has recently been developed. It is a simple 15-min test that uses latex particles sensitized with a monoclonal antibody against PBP 2a (2), and its accuracy for the detection of oxacillin resistance in CoNS strains has been assessed in some studies (14, 18).

Studies evaluating the performance of methods focusing on the phenotypic detection of oxacillin susceptibility in Brazilian CoNS isolates are scarce (5, 27). Furthermore, a slide latex agglutination test for the detection of susceptibility had not

previously been evaluated in Brazil. The aim of this study was to evaluate the oxacillin susceptibilities of CoNS clinical isolates by comparing the results obtained by the disk diffusion, agar dilution, agar screening, E-test, and the slide latex agglutination phenotypic methods with those obtained by *mecA* gene detection by PCR. We also evaluated the accuracy of the agar screening test by using four different oxacillin concentrations and two incubation periods.

MATERIALS AND METHODS

Clinical isolates. We tested 152 CoNS clinical isolates obtained from different clinical specimens (blood, $n = 72$; nostrils, $n = 24$; surgical wounds, $n = 16$; urine, $n = 12$; catheter tips, $n = 4$ and other sites, $n = 24$) from patients at 10 Brazilian hospitals between 1994 and 2000. Only one strain from each patient was analyzed. Identification of the staphylococcal strains to the species level was carried out by Gram staining; the oxidation-fermentation test; detection of enzyme production (coagulase, catalase, phosphatase, ornithine, and urease); L-pyrrolidonyl-β-naphthylamide hydrolysis; hemolytic properties on sheep blood agar; acid production from mannitol, mannose, and trehalose; and resistance to novobiocin, polymyxin B, and desferrioxamine (16, 19). Isolates were kept frozen at −20°C in tryptic soy broth containing 20% glycerol (vol/vol).

Disk diffusion test. The susceptibilities of the isolates to 12 antimicrobial agents, including oxacillin, was determined by the disk diffusion method with Mueller-Hinton agar plates (Difco Laboratories, Detroit, Mich.), according to the guidelines of the NCCLS (21, 23). Disks contained the following antibiotics (CECON, São Paulo, Brazil) at the specific absolute concentrations indicated in parentheses: ciprofloxacin (5 μg), clindamycin (2 μg), chloramphenicol (30 μg), erythromycin (15 μg), gentamicin (10 μg), oxacillin (1 μg), penicillin G (10 IU), rifampin (5 μg), trimethoprim-sulfamethoxazole (1.25/23.75 μg), teicoplanin (30 μg), tetracycline (30 μg), and vancomycin (30 μg). *Staphylococcus aureus* ATCC 25923 was used as a control.

Oxacillin agar screening test. All isolates were plated on Mueller-Hinton agar (Difco) supplemented with 4% (wt/vol) NaCl containing oxacillin (Bristol-Myers Squibb, São Paulo, Brazil) at a concentration of 1, 2, 4, or 6 μg/ml. The plates were inoculated with a cotton swab dipped into a 0.5 McFarland standard suspension of each isolate, according to the procedures outlined in the NCCLS guidelines for *S. aureus* (22). Oxacillin resistance was confirmed by bacterial growth after 24 and 48 h of incubation at 35°C. *S. aureus* ATCC 29213 (oxacillin susceptible) and *S. aureus* ATCC 33591 (oxacillin resistant) were included as control organisms.

Agar dilution test. The MICs of oxacillin (Bristol-Myers Squibb) were determined by the agar dilution method, according to the guidelines of the NCCLS (22, 23). Briefly, for each strain, colonies isolated from an overnight growth were transferred to sterile saline. The suspensions were adjusted to a 0.5 McFarland standard, diluted 1:10, and inoculated on Mueller-Hinton agar (Difco) plates supplemented with 2% (wt/vol) NaCl by using a replicator, which delivered approximately 10^4 CFU in each spot. The plates were incubated at 35°C for 24 h. *S. aureus* ATCC 29213 was included in each test as the control organism.

E-test. The MICs of oxacillin were also determined by the E-test (AB Biodisk, Solna, Sweden), according to the instructions of the manufacturer. The plates were inoculated by swabbing the surfaces with a 0.5 McFarland standard bacterial suspension on Mueller-Hinton agar medium (Difco) supplemented with 2% (wt/vol) NaCl. The E-test strips were placed on the medium, and the plates were then incubated at 35°C for 24 h. The results were analyzed on the basis of NCCLS guidelines (23). *S. aureus* ATCC 29213 was included as the control organism.

Slide latex agglutination test. The slide latex agglutination test (Slidex MRSA Detection test; bioMérieux S/A) was performed according to the instructions of the manufacturer. For each isolate, a 1-μl loopful of colonies obtained from a blood agar plate was suspended in 4 drops (200 μl) of extraction reagent no. 1 (0.1 M NaOH) and boiled for 3 min. After that, 1 drop (50 μl) of extraction reagent no. 2 (0.5 M KH_2PO_4) was added to the suspension, and the components were mixed well. This mixture was centrifuged at 1,500 × *g* for 5 min, and 50 μl of the supernatant was placed in both circles of the test slide. One drop (50 μl) of anti-PBP 2a monoclonal antibody-sensitized latex was added to one of the circles and the contents were mixed well. As a negative control, 50 μl of negative control latex was added to the supernatant in the other circle. After the contents of the slide were mixed for 3 min, the presence of agglutination was evaluated visually. The influence of the induction of the *mecA* gene on the performance of the slide agglutination test was also analyzed among 20 CoNS isolates, including those that presented discordant results by the susceptibility tests. It was performed by the disk diffusion test with the bacterial growth around the 1-μg oxacillin disk after 24 h of incubation. *S. aureus* ATCC 33591 and *S. aureus* ATCC 25923 were included as positive and negative controls of the test, respectively.

Detection of *mecA* gene. The *mecA* gene was detected by PCR with specific primers MRS_1 (5′-TAGAAATGACTGAACGTCCG-3′) and MRS_2 (5′-TTGC GATCAATGTTACCGTAG-3′) (Life Technologies, Gaithersburg, Md.), as described previously (30). Staphylococcal DNA was extracted by boiling as described by Nunes and colleagues (24). Subsequently, 10 μl of the bacterial DNA was added to the PCR tube. PCR was performed with a 50-μl mixture containing 250 μM each deoxynucleoside triphosphate (Life Technologies), 1.5 U of *Taq* DNA polymerase (Life Technologies), 20 mM Tris-HCl (pH 8.4), 50 mM KCl, and 2 mM $MgCl_2$. The PCR tests were run in a programmable thermal controller (PTC-100; MJ Research, Inc.). After an initial denaturation step for 15 s at 94°C, 30 cycles of amplification were performed as follows: denaturation at 94°C for 15 s, annealing at 55°C for 15 s, and DNA extension at 72°C for 5 s. A positive result was indicated by the presence of a 154-bp amplified DNA fragment, which was revealed by electrophoresis on a 2% agarose gel at 100 V for 1 h and 30 min. In order to ensure the accuracy of the PCR, each isolate was analyzed at least twice. The strains *S. aureus* ATCC 25923 (*mecA* negative) and *S. aureus* ATCC 33591 (*mecA* positive) were used as controls.

RESULTS

A total of 152 CoNS strains belonging to 12 species were identified, including *S. epidermidis* (78 strains), *S. haemolyticus* (35 strains), *S. hominis* subsp. *hominis* (9 strains), *S. saprophyticus* (8 strains), *S. lugdunensis* (5 strains), *S. warneri* (4 strains), *S. sciuri* (4 strains), *S. cohnii* subsp. *urealyticum* (3 strains), *S. schleiferi* subsp. *schleiferi* (2 strains), *S. capitis* subsp. *capitis* (2 strains), *S. caprae* (1 strain), and *S. simulans* (1 strain). One hundred three (67.8%) strains were *mecA* positive and 49 (32.2%) were *mecA* negative by PCR. Multiresistance was observed among the *mecA*-positive isolates, while *mecA*-negative strains showed higher levels of susceptibility to all antimicrobial agents tested except penicillin. All the strains presented susceptibility to vancomycin, but one strain each of *S. haemolyticus* and *S. hominis* subsp. *hominis* presented intermediate resistance to teicoplanin. All *mecA*-positive isolates were detected by the agar screening test with 4 μg of oxacillin per ml and an incubation period of 48 h. Furthermore, none of the *mecA*-negative strains grew under these conditions (100% sensitivity and 100% specificity) (Table 1). The other three concentrations of oxacillin (1, 2, and 6 μg/ml) used in the agar screening test showed lower sensitivity and/or specificity values. The sensitivities, specificities, and positive and negative predictive values of the assays evaluated are presented in Table 1. The slide latex agglutination method (Slidex MRSA Detection test) showed a high sensitivity (97.1%) and a high specificity (98%) for the detection of oxacillin resistance in the CoNS isolates. Oxacillin resistance was not detected in three isolates, while one strain presented a false-positive reaction. After retesting of the method by inoculating the bacteria around the oxacillin disk, the sensitivity and specificity of the slide latex test were 99 and 98%, respectively. Agar dilution and E-test were equally reliable in the detection of oxacillin resistance in *mecA*-positive strains (100% sensitivity). However, both tests proved to be less accurate in discerning strains lacking the *mecA* gene (specificities, 73.5 and 71.4%, respectively). The disk diffusion test failed to detect six *mecA*-positive strains and four *mecA*-negative strains, showing 94.2% sensitivity and 91.8% specificity.

TABLE 1. Sensitivities, specificities, and positive and negative predictive values for phenotypic methods in comparison with the results of PCR for detection of oxacillin susceptibility among 152 CoNS isolates

Method	No. of strains				Sensitivity (%)[b]	Specificity (%)[c]	PPV (%)[d]	NPV (%)[e]
	mecA[a] positive (total n = 103)		*mecA* negative (total n = 49)					
	True positive	False negative	True negative	False positive				
Disk diffusion	97	6	45	4	94.2	91.8	96	88.2
Agar dilution	103		36	13	100	73.5	88.8	100
E-test	103		35	14	100	71.4	88	100
Slide latex agglutination	100	3	48	1	97.1	98	99	94.1
Agar screen								
1 μg/ml								
24 h[f]	93	10	41	8	90.3	83.7	92.1	80.4
48 h[f]	103		37	12	100	75.5	89.6	100
2 μg/ml								
24 h	88	15	49		85.4	100	100	76.6
48 h	103		48	1	100	98	99	100
4 μg/ml								
24 h	80	23	49		77.7	100	100	68
48 h	103		49		100	100	100	100
6 μg/ml								
24 h	78	25	49		75.7	100	100	66.2
48 h	97	6	49		94.2	100	100	89.1

[a] The *mecA* status of the strains was determined by PCR.
[b] Sensitivity was calculated as the number of strains with true-positive results/number of *mecA*-positive strains.
[c] Specificity was calculated as the number of strains with true-negative results/number of *mecA*-negative strains.
[d] PPV, positive predictive value, which was calculated as the number of strains with true-positive results by the test/number of strains with positive results by the test.
[e] NPV, negative predictive value, which was calculated as the number of strains with true-negative results by the test/number of strains with negative results by the test.
[f] Incubation period.

Table 2 shows the correlation between the oxacillin MICs determined by the agar dilution test and the presence of the *mecA* gene in 12 species of CoNS. The oxacilling MICs for all *mecA*-positive strains were ≥0.5 μg/ml. A total of 13 of 49 *mecA*-negative isolates, including 7 *S. saprophyticus* strains, 3 *S. cohnii* subsp. *urealyticum* strains, 1 *S. lugdunensis* strain, 1 *S. sciuri* strain, and 1 *S. epidermidis* strain, were classified as oxacillin resistant according to NCCLS guidelines (23), with MICs ranging from 0.5 to 1 μg/ml. None of the *S. saprophyticus*, *S. cohnii* subsp. *urealyticum*, *S. lugdunensis*, *S. capitis* subsp. *capitis*, *S. caprae*, or *S. simulans* isolates had the *mecA* gene.

The susceptibilities to oxacillin of all 27 isolates that showed discrepant results by one or more phenotypic tests are given in Table 3. Ten strains of *S. epidermidis* and one strain each of *S. hominis* subsp. *hominis* and *S. warneri* that contained the *mecA* gene showed false-negative results by at least one of the oxacillin susceptibility tests evaluated. On the other hand, *mecA*-negative *S. saprophyticus* (8 strains), *S. cohnii* subsp. *urealyticum* (3 strains), *S. lugdunensis* (2 strains), *S. epidermidis* (1 strain), and *S. sciuri* (1 strain) isolates presented false-positive results by at least one of the phenotypic methods analyzed.

DISCUSSION

In this study we compared six different phenotyping methods (conventional and commercial) and genotyping methods to evaluate the oxacillin susceptibilities of CoNS strains. The distribution of CoNS species in our collection was similar to that in other studies (12, 25), as was the percentage of oxacillin-resistant *mecA*-positive CoNS strains found (67.8%) (8, 25).

Detection of oxacillin resistance among CoNS isolates is difficult, mainly because it is often heterogeneous (3). To overcome this problem, different methods have been used. In this study, the disk diffusion method showed the lowest sensitivity (94.2%) for the detection of oxacillin resistance in CoNS strains. This result agrees with those obtained in other studies (5, 18). Six *S. epidermidis* isolates that contained the *mecA* gene were found to be susceptible to oxacillin by this method. This finding has already been reported and can be associated with the heteroresistance of the strains to oxacillin, as well as the absence of *mecA* gene expression in these isolates (6). The MICs for four *mecA*-negative CoNS isolates that presented false resistance to oxacillin by the disk diffusion test also indicated resistance (MICs, 1 μg/ml), according to NCCLS guide-

TABLE 2. Correlation between oxacillin MICs determined by the agar dilution test and the presence of *mecA* gene in 12 species of 152 CoNS isolates

CoNS species	Presence of *mecA* gene[a]	No. of strains	No. of strains for which the oxacillin MIC (μg/ml) was as follows:							
			≤0.25	0.5	1	2	4	8	16	≥32
S. epidermidis	+	62		6	4	13	5	5	3	26
	−	16	15		1					
S. haemolyticus	+	34		2	2	4				26
	−	1	1							
S. hominis subsp. *hominis*	+	2								2
	−	7	7							
S. saprophyticus	−	8	1	5	2					
S. lugdunensis	−	5	4	1						
S. warneri	+	1							1	
	−	3	3							
S. sciuri	+	3								3
	−	1			1					
S. cohnii subsp. *urealyticum*	−	3		1	2					
S. schleiferi subsp. *schleiferi*	+	1							1	
	−	1	1							
S. capitis subsp. *capitis*	−	2	2							
S. caprae	−	1	1							
S. simulans	−	1	1							

[a] Determined by PCR.

lines (23). Such results might be explained by the overproduction of β-lactamases (3) by these isolates.

According to the present oxacillin breakpoints, our MIC results correctly classified all CoNS strains with the *mecA* gene as oxacillin resistant and correctly classified *mecA*-negative *S. epidermidis*, *S. haemolyticus*, *S. hominis* subsp. *hominis*, *S. warneri*, *S. schleiferi* subsp. *schleiferi*, *S. capitis* subsp. *capitis*, *S. caprae*, and *S. simulans* isolates as oxacillin susceptible. How-

TABLE 3. Susceptibilities to oxacillin of 27 CoNS isolates that presented discrepancies by one or more phenotypic methods

CoNS species (no. of strains)	Presence of *mecA* gene[a]	Slide latex agglutination result	Agar screen result (6 μg/ml)[b]	Disk diffusion result[c]	MIC (μg/ml)[d]	
					Agar dilution	E-test
S. epidermidis (3)	+	+	−	R	0.5–4 (R)	0.5–2 (R)
S. epidermidis (3)	+	+	+	S	0.5–2 (R)	2–4 (R)
S. epidermidis (2)	+	+	−	S	0.5 (R)	0.5–0.75 (R)
S. epidermidis (1)	+	−	+	S	2 (R)	1 (R)
S. epidermidis (1)	+	−	+	R	2 (R)	8 (R)
S. hominis subsp. *hominis* (1)	+	+	−	R	4 (R)	2 (R)
S. warneri (1)	+	−	+	R	16 (R)	8 (R)
S. saprophyticus (6)	−	−	−	S	0.5–1 (R)	0.75–1 (R)
S. saprophyticus (1)	−	−	−	R	1 (R)	0.5 (R)
S. saprophyticus (1)	−	−	−	S	0.25 (S)	1 (R)
S. cohnii subsp. *urealyticum* (2)	−	−	−	R	1 (R)	0.75 (R)
S. cohnii subsp. *urealyticum* (1)	−	−	−	S	0.5 (R)	0.75 (R)
S. lugdunensis (1)	−	−	−	S	0.5 (R)	0.25 (S)
S. lugdunensis (1)	−	−	−	S	0.25 (S)	0.75 (R)
S. epidermidis (1)	−	+	−	S	1 (R)	2 (R)
S. sciuri (1)	−	−	−	R	1 (R)	0.75 (R)

[a] Determined by PCR.
[b] Incubation for 48 h.
[c] R, resistant; S, susceptible.
[d] Items in parentheses are NCCLS interpretation categories (S, susceptible; R, resistant).

ever, agar dilution and E-test showed very low specificities, mainly by consideration of the results obtained with the isolates of the species *S. saprophyticus*, *S. cohnii* subsp. *urealyticum*, *S. lugdunensis*, and *S. sciuri*. These findings were similar to those from other studies (7, 12) for the species *S. saprophyticus*, *S. cohnii* subsp. *urealyticum*, and *S. lugdunensis*. On the other hand, *mecA*-negative *S. warneri* strains did not present false-positive results, as shown previously (7, 12). At present, the NCCLS guidelines (23) do not recommend use of the agar dilution test with *S. saprophyticus* and *S. lugdunensis* isolates, although this test is still recommended for use with *S. cohnii* subsp. *urealyticum* and other more uncommon species. Studies that analyze a higher number of CoNS species are necessary to establish a more reliable breakpoint.

Since the breakpoints for oxacillin resistance among CoNS strains were lowered (20), use of the agar screening test with 6 μg of oxacillin per ml and 48 h of incubation is no longer recommended by the NCCLS. However, several studies observed that this technique is sensitive and can be used as an additional test to confirm the results obtained by the disk diffusion test (2, 6, 11, 18). In our hands, the results obtained by this method showed a good correlation with those obtained by PCR (94.2% sensitivity and 100% specificity). Kohner and colleagues (17) proposed the use of 0.6 μg of oxacillin per ml in the agar screening test on the basis of the 10-fold decrease in resistance breakpoints for CoNS isolates. A recent study (27) evaluated use of this concentration of oxacillin in the test. The investigators reported a poor correlation of the agar screening test results and *mecA* gene detection for all CoNS strains tested except those of *S. epidermidis.* In order to raise the sensitivity of this method, we evaluated four concentrations of oxacillin (1, 2, 4, and 6 μg/ml) and different periods of incubation (24 and 48 h). Our results showed that the agar screening test with 4 μg of oxacillin per ml and 48 h of incubation presented 100% sensitivity and 100% specificity, being the most accurate method for the detection of oxacillin resistance among the CoNS isolates tested. Besides that, this test was easy to perform and cheap, allowing it to be used as a good alternative to the PCR technique.

The slide latex agglutination (Slidex MRSA Detection test) was initially developed for the rapid detection of PBP 2a in oxacillin-resistant *S. aureus* isolates (2). However, several studies have also observed that this method has good accuracy for the detection of PBP 2a in CoNS isolates (13, 14, 18). In our study, the latex agglutination test showed a high sensitivity (97.1%) and a high specificity (98%). Two *mecA*-positive *S. epidermidis* strains and one *mecA*-positive *S. warneri* strain did not present visible agglutination in the test, and one *mecA*-negative *S. epidermidis* strain was classified as resistant. Hussain and colleagues (14) tested the influence of induction of resistance in the slide latex agglutination test and observed an increase in sensitivity from 50 to 100%. However, they showed that two *mecA*-negative *S. warneri* strains presented positive results after induction. In our study, an increase in sensitivity from 97.1 to 99% was observed after induction. One *mecA*-positive *S. epidermidis* strain and one *mecA*-positive *S. warneri* strain showed positive results after the induction of oxacillin resistance. The MICs for these two strains were also higher by the agar dilution and/or the E-test methods. The use of oxacillin disks in the induction of resistance could improve oxacillin resistance detection without a delay in the test time, once the disk diffusion test is generally performed in a routine laboratory. Another advantage is the stronger agglutination reaction observed after induction, which makes the interpretation of the test results easier (14).

In conclusion, the agar screening test with 4 μg of oxacillin per ml and 48 h of incubation, as described here, allowed the reliable detection of *mecA*-positive and *mecA*-negative CoNS clinical isolates and therefore can help to control the unnecessary use of vancomycin in hospitals. To our knowledge, this is the first study to have analyzed different concentrations of oxacillin in the agar screening test. The slide latex agglutination test was also accurate for the detection of oxacillin resistance, and the use of both methods could be recommended for the detection of the oxacillin resistance in CoNS isolates. These methods are technically simple, and in routine laboratories it may be easier perform these methods than PCR.

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