Official Journal of the Brazilian Association of Infection Control and Hospital Epidemiology

Journal of INFECTION CONTROL
ISSN 2316-5324 | Ano VIII . Volume 8 . Número 2 . Abr/Jun . 2019

> ACESSE AQUI A REVISTA ONLINE

ORIGINAL ARTICLE

In vitro effect of chlorhexidine gluconate and polyvinylpyrrolidone iodine on *Staphylococcus aureus*: ensuring the skin preparation process

Efeito in vitro do gluconato de chlorhexidine e polyvinylpyrrolidone iodine em Staphylococcus aureus: assegurando o processo do preparo de pele

Efecto in vitro del gluconato de clorhexidina y el polivinilpirrolidona yodada sobre Staphylococcus aureus: asegurando el proceso de preparación de la piel

Bruna Toillier,[1] Gabriela Baierle,[1] Lia Gonçalves Possuelo,[1,2] Jane Dagmar Pollo Renner,[1,2] Luciana de Souza Nunes,[3] Marcelo Carneiro.[1,2,4]

[1]Centro de Pesquisa e Treinamento em Biotecnologia (TECNOUNISC), Santa Cruz do Sul, RS, Brasil.
[2]Professor do Departamento de Biologia e Farmácia e do Programa de Pós Graduação em Promoção da Saúde, Universidade de Santa Cruz do Sul, Santa Cruz do Sul, RS, Brasil.
[3]Professor da Universidade Federal do Pampa, RS, Brasil.
[4]Chefe da Comissão de Controle de Infecção e Epidemiologia Hospitalar, Hospital Santa Cruz, Santa Cruz do Sul, RS, Brasil.

Recieved: *15/09/2019*
Accept: *02/10/2019*
Available online: *10/11/2019*

Corresponding author's address:
Marcelo Carneiro
Rua Gaspar Silveira Martins, 2210
Centro, Santa Cruz do Sul, RS, Brasil.
marceloc@unisc.br

RESUMO

Os antissépticos são uma estratégia para a prevenção de infecções cirúrgicas e relacionadas a dispositivos invasivos. A segurança deste processo contra bactérias resistentes a antimicrobianos e antissépticos é essencial para os bundles de prevenção. Este estudo *in vitro* analisou a ação do *chlorhexidine gluconate* (0.5% e 2%) e do *polyvinylpyrrolidone iodine* em cepas sensíveis e resistentes de *Staphylococcus aureus* e demonstrou melhores resultados com o uso de gluconato de chlorhexidine 2%.

Palavras Chave: *Gluconato de chlorhexidine; polyvinylpyrrolidone iodine; antiséptico; bactéria; Staphylococcus aureus.*

SUMMARY

Antiseptics constitute a strategy for the prevention of surgical and invasive device-related infections. The safety of this process against antimicrobial- and antiseptic-resistant bacteria is essential for prevention bundles. This *in vitro* study analyzed the effect of chlorhexidine gluconate (0.5% and 2%) and polyvinylpyrrolidone iodine on sensitive and resistant strains of *Staphylococcus aureus* and showed better results with the use of 2% chlorhexidine gluconate.

Descriptors: *Chlorhexidine gluconate; polyvinylpyrrolidone iodine; antiseptic; bacteria; Staphylococcus aureus.*

RESUMEN

Los antisépticos son una estrategia para prevenir infecciones quirúrgicas e invasivas relacionadas con dispositivos. La seguridad de este proceso contra las bacterias antimicrobianas y resistentes a los antisépticos es esencial para los paquetes de prevención. Este estudio *in vitro* analizó la acción del gluconato de clorhexidina (0.5% y 2%) y el polivinilpirrolidona yodada en cepas sensibles y resistentes de *Staphylococcus aureus* y demostró mejores resultados con el uso de gluconato de clorhexidina al 2%.

Palabras Clave: *Gluconato de chlorhexidine; polyvinylpyrrolidone iodine; antiséptico; bacterias; Staphylococcus aureus.*

INTRODUCTION

Staphylococcus aureus is part of the skin microbiota and is a pathogen of concern in clinical and surgical practice, especially due to its resistance to antimicrobials. Methicillin-resistant *S. aureus* accounted for 58% of healthcare-associated infections (HAIs) in Brazil in 2016.[1] These infections have a major financial, morbidity and mortality impact when associated with surgical implants,[2] bacteremias, skin and soft tissue infections, and in Burn units.[3]

All efforts made to reduce bacterial count are of utmost importance for the prevention of HAIs; however, ensuring the efficiency of the entire prevention process is based on the susceptibility testing of antiseptic agents used for skin preparation and prophylactic decolonization. Previous studies reported that 86-92% of the skin microbiota may decrease with the use of chlorhexidine gluconate (CHG).[4]

Polyvinylpyrrolidone iodine (PI) has a fast bactericidal activity when the iodine anion is released; however, it is inactivated in the presence of organic matter, unlike CHG, which also has residual antimicrobial activity. Both antiseptics improve their activities in alcoholic solutions, accelerating the rapid onset of action after drying on the skin.[5]

A study comparing products used as antiseptic agents, by analyzing the reduction in infection rates, showed superior results of alcoholic-based CHG (RR 0.70; 95% CI: 0.52–0.92) with positive results related to rapid action onset, bacterial damage, favorable safety profile due to residual activity, broad antimicrobial spectrum and low interaction with body fluids.[6] Low concentrations are bacteriostatic, whereas higher concentrations have prolonged bactericidal activity, inducing cytolysis.[7]

This study evaluated the minimum inhibitory capacity (MIC), minimum bactericidal capacity (MBC) for 0.5 and 2% CHG and PI for antibiotic-sensitive and -resistant *S. aureus*.

METHODS

Laboratorial aspects:

MIC and MBC tests were performed for *S. aureus*. The strains used in the study were named as follows: (A) *S. aureus* ATCC 43300 *mecA* positive and SCCmec Type II positive; (B) *S. aureus* ATCC BAA-1708, *mecA* positive, *SCCmec* Type II positive, *mupA* positive, high level resistance control to mupirocin; (C) *S. aureus* subsp. *aureus* ATCC 700698 *mecA* positive, *SCCmec* type II positive and heterogeneous susceptibility to vancomycin and (D) *S. aureus* ATCC 29213, *mecA* negative, weak β-lactamase-producing strain, sensitive to oxacillin, quality control for MIC determination.[8,9] The preparation of antimicrobial and antiseptic agents, CHG (0.5% and 2%) and PI (10%), were in accordance with document M7A6.[8] The inocula of *S. aureus* strains A, B, C and D, MIC and MBC were performed as described by M100.[8]

RESULTS AND DISCUSSION

The MIC results of the *S. aureus* strains are described in table 1. The mean MIC for PI was 3584 µg / mL, whereas it was 0.7 µg / mL for 0.5% CHG and 0.03 µg / mL for 2% CHG it. There was no change in MIC results for 2% CHG regardless of the phenotypic profile of strain resistance, being more effective than 0.5% CHG. The MBC showed better results with 2% CHG in strains B and C. The MIC and MBC results for PI did not show satisfactory results when compared with CHG, regardless of the concentration, for strains A, B and C.

Regarding the type of analyzed antiseptic, it was observed that the CHG, regardless of the concentration used, showed higher MIC and MBC results. The 0.5 and 2% CHG did not differ regarding the bactericidal capacity for oxacillin-sensitive *S. aureus* (mecA negative). Regarding strains with some type of resistance, 2% CHG showed to be superior, with greater certainty in inhibiting growth, demonstrating that the increase in concentration offers superior bactericidal activity. It is important to note that *S. aureus* strains resistant to mupirocin and hetero-resistant to vancomycin also showed growth inhibition with increased safety in the presence of 2% CHG solutions.

This evidence is important, as the use of antiseptics for skin preparation before and after invasive procedures (catheter insertion and maintenance and surgical incisions), baths, hand hygiene and decolonization are of relevant necessity for the practice of HAI prevention, especially in patients colonized / infected with oxacillin-resistant *S. aureus*.

The reduction in CHG sensitivity or tolerance, typically defined by CHG MIC ≥ 4 µg/mL, is related to the presence of the *qacA/B* gene.[10] In this study, none of the samples showed a phenotype compatible with this resistance.

On the other hand, we stress the concern regarding the abuse and non-judicious use of CHG. Such attitudes may result in selective pressure and accelerate the emergence of resistance or tolerance to CHG. Therefore, surveillance is mandatory, so these prevention strategies will continue to be successful and the catastrophic history of antimicrobial resistance will not be repeated with antiseptic agents.

CONCLUSION

This study confirmed the *in vitro* superiority of CHG. It is important to emphasize that *S. aureus* strains resistant to mupirocin and hetero-resistant to vancomycin also showed

Table 1. Results of MIC and MBC (µg/mL) for *S. aureus*.

Cepas	PEN			OXA			CLI			VAN			PI		CHG 0.5%		CHG 2%	
	MIC	MBC	CLSI	MIC	MBC	CLSI	MIC	MBC	CLSI	MIC	MBC	CLSI	MIC	MBC	MIC	PI	MIC	PI
A	8	8	R	8	16	R	>16	R	R	0.5	0.5	S	4096	4096	0.12	0.12	<0.03	0.12
B	32	32	R	8	>100	R	>16	R	R	0.5	0.5	S	4096	4096	0.5	1	<0.03	0.06
C	16	64	R	>16	*	R	>16	R	R	1	2	S	4096	4096	2	2	<0.03	0.03
D	0.06	0.06	S	0.12	0.25	S	0.06	0.25	S	0.5	0.5	S	2048	2048	<0.03	0.03	<0.03	0.03

Legend: *MIC – Minimum Inhibitory Concentration; MBC – Minimum Bactericidal Concentration; PEN – Penicilin; OXA – Oxacilin; CLI – Clindamicin; VAN –Vancomicin; PI – Polyvinylpyrrolidone Iodine; CHG 0.5% - Chlorhexidine gluconate 0.5%; CHG 2% - Chlorhexidine gluconate 2%; S – susceptible; R – resistence; * - not performed MBC for not presenting MIC. Strain A - S. aureus ATCC 43300; Strain B - S. aureus ATCC BAA 1708; Strain C - S. aureus subsp. aureus ATCC 700698;*