Investigation of the Residual Activity of Chlorhexidine Gluconate Using a Novel Method to Simulate Real-world Conditions

Joseph D. Rutter, B.S
GOJO Industries, Inc., Akron, Ohio

David R. Macinga, PhD
GOJO Industries, Inc., Akron, Ohio

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ABSTRACT

Background

Chlorhexidine gluconate (CHG) is used routinely to disinfect skin in a variety of product types in healthcare settings. CHG is known to adhere to and remain on skin even after rinsing with water (substantivity). When used in pre-operative skin preps and pre-surgical hand disinfectants, CHG slows repopulation of the resident flora for hours after the initial use (persistence). It has been suggested that residual CHG can kill transient organisms contaminating the skin long after product application (residual activity). However data to support this phenomenon has typically been generated using liquid suspensions of bacterial to contaminate the skin. The purpose of this study was to investigate the residual activity of CHG using a dry contact contamination method, designed to more closely reflect skin contamination in typical healthcare situations.

Methods

CHG was 'loaded' onto to the hands of eight test subjects by rubbing 4 ml of a 1% CHG solution in 70% ethanol over all surfaces of the hands until completely dried. Four fingers on one hand were then contaminated by spotting 5 µl of a liquid suspension of *Staphylococcus aureus* (ATCC 6538) onto the fingerpads. The four fingers of the opposite hand were contaminated by pressing the fingerpads onto 1 cm diameter stainless steel discs onto which a liquid suspension of *S. aureus* had been previously dried. At specific time points following contamination, individual fingers were sampled by kneading in 10 ml of neutralizer for 30 seconds and dilutions were plated to quantify surviving bacteria.

Results

Consistent with previous studies, significant residual activity was observed when fingers were directly contaminated using liquid suspension, achieving a 2.86±1.07 log reduction within the first 5 minutes and a 3.02±1.18 log reduction after 15 minutes. However when hands were contaminated by dry contact, no significant residual activity was observed out to fifteen minutes (0.03±0.05 log reduction).

Conclusions

The results demonstrate that CHG exhibits residual activity only when the contaminating bacteria is applied in a liquid suspension and suggest that the CHG must be re-solubilized to exhibit activity. Previous studies using liquid suspensions of bacteria have likely overestimated residual kill by CHG. Under conditions which more closely simulate a typical contamination scenario in healthcare settings (i.e. through touching a dry surface), CHG does not possess significant residual activity. Healthcare workers must therefore not have a false sense of security when using CHG containing products and should disinfect hands whenever hand contamination is suspected.

INTRODUCTION

Chlorhexidine gluconate (CHG) is used routinely in a variety of product types to disinfect skin in healthcare settings. Following the use of these products, CHG adheres to skin and has been shown to ***slow the regrowth*** of resident skin flora. It has been suggested that this residual CHG can ***kill*** microorganisms which contaminate the skin long after product application (1-6).

However, the methods used to measure "residual kill" are unrealistic. Specifically, the use of liquid bacterial suspensions to contaminate the skin may re-solubilize residual CHG and allow it to become active. In the real world, hands are typically contaminated by touching dry objects. Therefore, excessive moisture is not introduced to the skin.

The purpose of this study was to investigate the residual kill of CHG using a ***dry contact contamination method***, designed to more closely reflect skin contamination in typical healthcare situations.

DEFINITIONS

Substantivity – the ability of antimicrobials to adhere to and remain on skin even after rinsing with water

Cumulative effect – a progressive increase in product efficacy following repeated applications

Persistence – slowing the regrowth of the resident flora for hours after the initial use

Residual kill – killing transient organisms contaminating the skin long after product application

Can CHG kill bacteria on the skin long after product use?

RESULTS

Consistent with previous studies, significant residual kill was observed when fingers were contaminated using liquid suspension, achieving a 3.02±1.18 log reduction after 15 minutes.

When hands were contaminated by dry contact, no residual kill was observed out to fifteen minutes (0.03±0.05 log reduction).

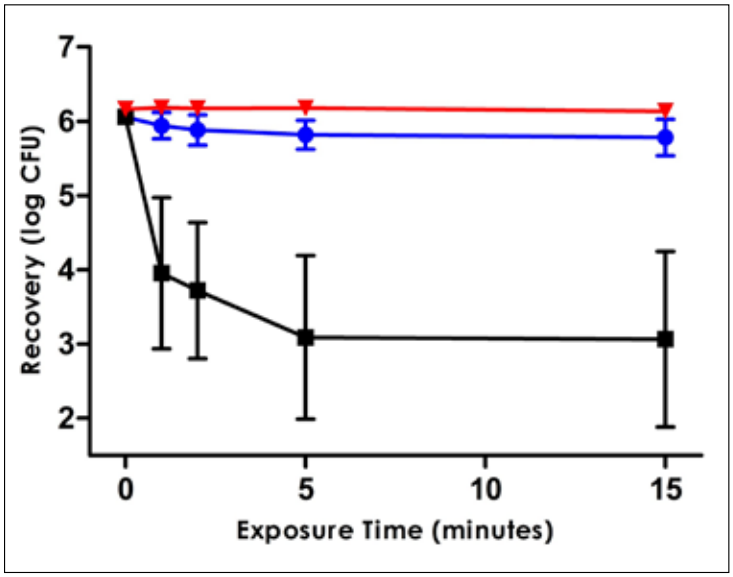


Figure: Effect of Contamination Method on Residual Kill

Average recovery per finger with standard deviation shown (8 subjects)

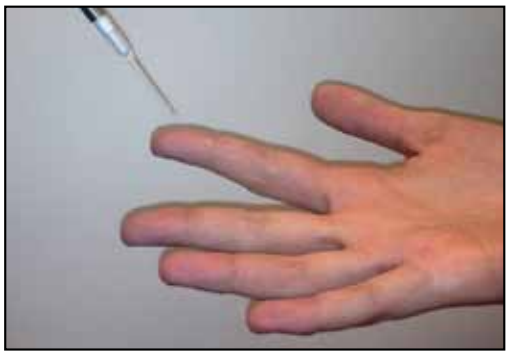
- ▼ Pretreat hands with CHG and contaminate by dry contact
- ● Pretreat hands with ethanol and contaminate with liquid suspension
- ■ Pretreat hands with CHG and contaminate with liquid suspension

When tested under realistic conditions, CHG does not continue to kill bacteria after product use

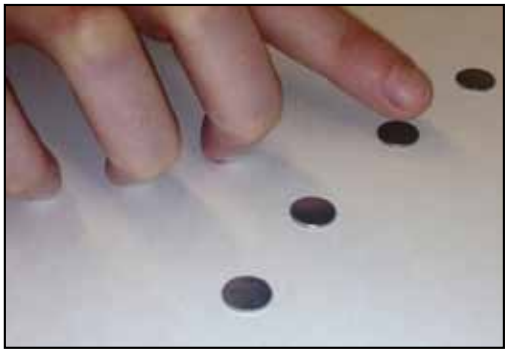
MATERIALS AND METHODS

Challenge suspensions were prepared by suspending overnight colonies of *Staphylococcus aureus ATCC 6538* in tryptic soy broth to 8-8.5 log CFU/ml. Stainless steel discs 1 cm in diameter were spotted with 10 µl challenge suspension and allowed to dry overnight or approximately 24 hours. Ethical approval for this study was provided by the Gallatin Institutional Review Board and performed as follows:

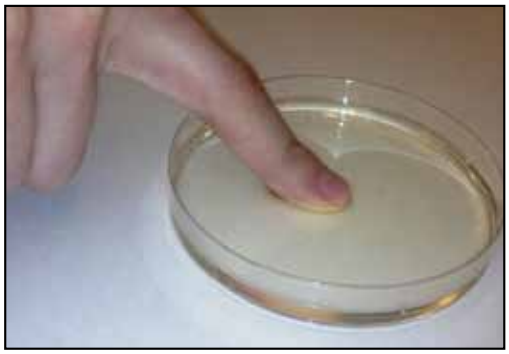
'Load' hands with CHG
by rubbing 4 ml of 1% CHG in 70% w/w ethanol over all surfaces of both hands until completely dry



Contaminate one hand with liquid suspension
by applying 5 µl of bacterial challenge suspension directly to the fingerpads



Contaminate other hand by dry contact
by firmly pressing the fingerpads onto contaminated discs for 2 seconds



Recover surviving bacteria
by kneading individual fingers In 10 ml of neutralizer for 30 seconds 0, 1, 2, 5, and 15 minutes after contamination

CONCLUSIONS

- The results demonstrate that CHG only exhibits residual kill when the bacteria is applied in a liquid suspension and suggest that the CHG must be re-solubilized to exhibit activity.
- While residual CHG may be able to suppress growth of resident microorganisms, it does not kill transient microorganisms introduced to the skin after product use.
- Residual kill appears to be an artifact of methods which do not reflect reality.
- Healthcare workers are cautioned not to have a false sense of security when using CHG containing products and should disinfect hands according to established guidelines whenever hand contamination is suspected.

References

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For more information, contact:
Joseph Rutter
GOJO Industries, Inc.
330-255-6506
rutterj@GOJO.com

GOJO Industries, Inc.
330-255-6000
www.GOJO.com