

Effectiveness of a New Antimicrobial Gauze Dressing as a Bacterial Barrier

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ABSTRACT

BACKGROUND: Gauze dressing continues to be the most commonly used wound dressing. However, because of its porous structure it is not a barrier to bacterial penetration. Binding an antimicrobial agent to the gauze fibers may prevent bacterial migration through the gauze and thus allow gauze to become a bacterial barrier. The purpose of this study was to evaluate the effectiveness of gauze treated with an antimicrobial agent to prevent external contamination from reaching the skin of normal volunteers.

METHODS: 3 types of gauze were evaluated: gauze containing 0.2% polyhexamethylene biguanide (PHMB); gauze treated with iodophor solution (IG); and untreated gauze control (control). Twenty-four subjects were tested in 4 groups: PHMB vs. Control, PHMB vs. IG, PHMB vs. IG (1:10 in saline), and PHMB vs. IG (1:10 in broth). Each volunteer received 6 gauze sites on their back that were contaminated with 10^6 *S. epidermidis* and occluded for 24 hours before the gauze and underlying skin were quantitated for the challenge organism.

RESULTS: No bacteria were detected in any of the PHMB gauze samples. Either no bacteria or only a few bacteria were detected on the skin beneath the PHMB gauze samples. In contrast, high numbers of challenge organisms were found in 92% of the control gauze samples and 100% of the underlying skin sites. Iodophor solution was effective in eradicating the challenge organisms unless the iodophor was exposed to protein in which case the antimicrobial activity of the iodophor was neutralized.

CONCLUSIONS: Treating gauze with 0.2% PHMB prevented the migration of 10^6 bacteria through the gauze and kept underlying skin relatively free of bacteria. Binding PHMB to the gauze fiber was more effective than adding iodophor solution to the gauze in a protein-rich environment. These results indicate that binding 0.2% PHMB to gauze provides an effective barrier to bacterial penetration.

INTRODUCTION

Gauze dressing continues to be the most commonly used wound dressing. However, because of its porous structure, gauze is not a barrier to external bacterial penetration. Binding an antimicrobial agent to the gauze fibers may make the gauze an effective bacterial barrier since the bacteria would be killed on contact.

Biguanides are an important class of antimicrobial agents with a long history of use in healthcare. The most commonly used biguanide in healthcare is chlorhexidine. Although chlorhexidine is a very effective antimicrobial, it is too cytotoxic for use in wounds. A modified biguanide that is more biocompatible is polyhexamethylene biguanide (PHMB). FDA has cleared the use of PHMB as an antimicrobial component in wound dressings under the pre-market notification (510k) process.

The purpose of this study on human volunteers was to evaluate the ability of gauze treated with PHMB in the prevention of bacterial penetration.

MATERIAL AND METHODS

Dressing material:

Standard gauze dressing was impregnated with PHMB so that the final bound antimicrobial agent was 0.2% by weight¹. Since the antimicrobial agent is bound to the gauze, the wound tissue is not exposed to the agent.

In this study the control dressing was the same gauze that had not been treated with any PHMB².

Human volunteers:

The study was conducted on healthy human volunteers who signed Informed Consent. The study was reviewed and approved by the Human Investigations Committee of the University of Virginia Health System. Volunteers had to be 18 years or older, and have dorsal skin that was intact, free of lesions or inflammation, and had minimal hair growth. Prior to enrollment, the dorsal skin of each volunteer was assessed by a scrubbing technique for the presence of penicillin-resistant microorganisms. Since the challenge organism in the study was a penicillin-resistant strain, any volunteer having a penicillin-resistant organism already on their skin was excluded.

Test procedure:

The dorsal skin of each volunteer was scrubbed with iodophor antiseptic solution and subsequently rinsed with sterile saline, 1% neutralizer (thiosulfate solution), and finally 70% isopropyl alcohol. Six test sites were identified (3 experimental and 3 control). Using sterile technique each test site received a 1" X 1" gauze sample which was taped to the skin by 1/2" wide, waterproof tape³. Each gauze sample first received 0.45 ml of wetting solution, then the surface of the saturated gauze was contaminated uniformly by adding dropwise 0.05 ml of saline containing 10^6 , penicillin-resistant, *Staphylococcus epidermidis* (ATCC # 27626). After 10 minutes the gauze was occluded with an impermeable plastic film⁴ and held in place with an adhesive transparent film dressing⁵. Each site was independent and self-contained. Twenty-four hours later the presence of the contaminating organism was quantitated in the gauze and on the skin surface below the gauze.

Bacterial Quantitation

Gauze

Using aseptic technique, the gauze was exposed. With sterile scissors and forceps the gauze sample was cut along the tape edges and removed. The gauze sample (0.5" X 0.5") was immersed in 25 ml of sterile neutralizer solution and agitated with a mechanical shaker for 5 minutes. The number of challenge organisms remaining in the gauze was quantitated by standard serial dilution and plating techniques using selective trypticase soy agar containing 25 mcg/ml penicillin G. Results were reported as \log_{10} of colony forming units (CFU) per cm^2 . The minimum detectable level of CFU in the gauze sample was 156 ($\log=2.19$).

Skin

The number of challenge organisms on the skin beneath the gauze was quantitated using a modified Kligman cup scrub technique. A sterile glass cylinder (1" inside diameter) was placed on the skin and 2 ml of sterile neutralizer solution was added. The skin was scrubbed with a sterile glass rod for 2 minutes before the neutralized solution was aspirated. The number of challenge organisms present in the scrub was quantitated by standard serial dilution and plating techniques using selective trypticase soy agar containing 25 mcg/ml penicillin G. Results were reported as log₁₀ of colony forming units (CFU) per cm². The minimum detectable level of CFU on the skin sample was 4 (log=0.60).

Experimental Design

Twenty-four human volunteers were equally divided into 4 study groups.

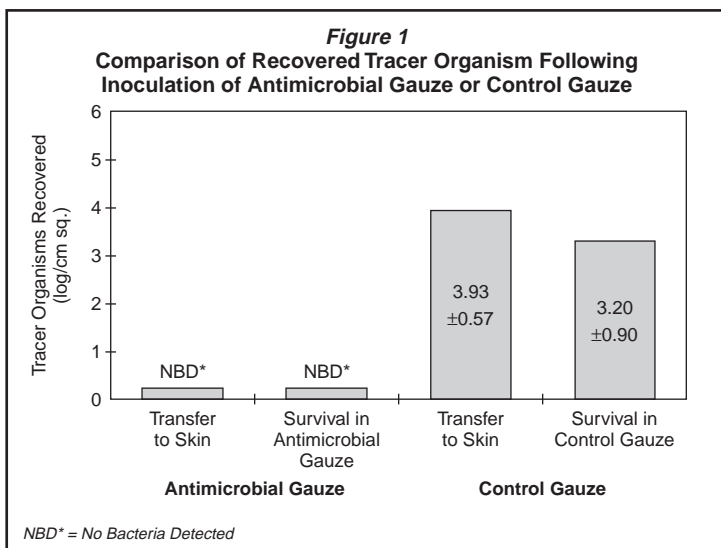
1. PHMB gauze vs. control gauze
2. PHMB gauze vs. control gauze + iodophor solution⁶
3. PHMB gauze vs. control gauze + diluted iodophor solution (1:10 in saline)
4. PHMB gauze vs. control gauze + diluted iodophor solution (1:10 in broth)

RESULTS

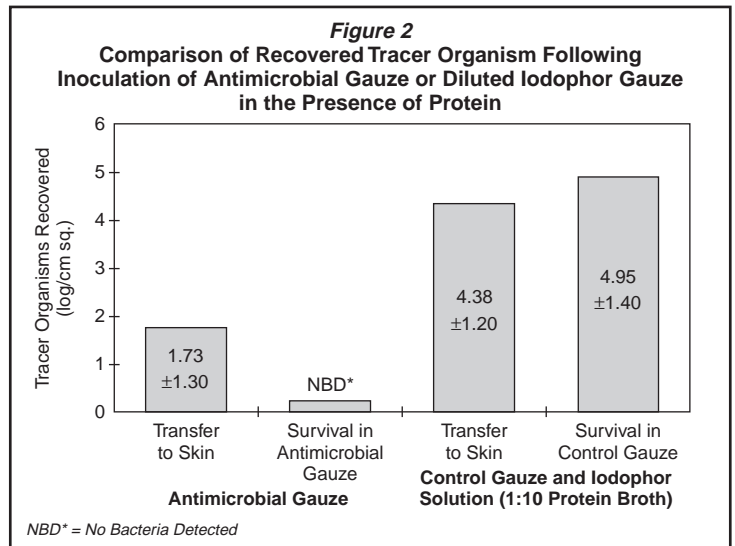
Antimicrobial PHMB gauze was an effective bacterial barrier that prevented 10⁶ challenge organisms from reaching the skin beneath the dressing (Figure 1). In addition, no bacteria could be detected in the gauze dressing. In contrast, control gauze contained a mean of 10^{3.20} challenge organisms and the skin beneath the control gauze a mean of 10^{3.93} challenge organisms.

When full-strength iodophor solution was used to saturate control gauze the challenge bacteria were eliminated. Similar results were obtained with the gauze containing PHMB.

When the iodophor solution was diluted 1:10 with saline, it maintained its antimicrobial activity. PHMB gauze was again documented to eliminate the challenge organisms.



In the presence of protein the iodophor solution was inactivated and the challenge organisms were recovered in high numbers from both gauze (10^{4.95}) and skin (10^{4.38}) (Figure 2). In contrast, PHMB maintained activity in the presence of protein and prevented bacteria from surviving in the gauze. Some of the challenge organisms were detected on the skin beneath the PHMB gauze (mean=10^{1.73}). In half of the test sites (9/18), no challenge organisms were detected on the skin beneath the PHMB gauze.



DISCUSSION

Gauze is the most commonly used wound dressing. It is utilized primarily because of its low cost and high absorptive capacity. However, when gauze is wetted it promotes the migration of bacteria. Binding an antimicrobial agent to the gauze surface should prevent bacterial migration.

The results of this study documented that gauze containing 0.2% PHMB was an effective barrier to bacterial penetration when the surface of the saturated gauze was contaminated with 10⁶ bacteria. Saturated control gauze with iodophor solution was also an effective method of making gauze a barrier dressing. However, the activity of iodophor solution decreases with time and in the presence of protein. As shown in this study, when iodophor solution was exposed to protein its antimicrobial activity was neutralized. As a result, the challenge bacteria survived in the iodophor-inhibited gauze and were able to contaminate the skin beneath the gauze. PHMB gauze was still an effective bacteria barrier in the presence of protein.

CONCLUSIONS

Binding 0.2% of polyhexamethylene biguanide (PHMB) to gauze provides an effective barrier to bacterial penetration even in the presence of protein.

Agents used in this study:

¹Kerlix® A.M.D. gauze (Kendall, Mansfield, MA)

²Kerlix® gauze (Kendall, Mansfield, MA)

³Wet-Pruf® (Kendall, Mansfield, MA)

⁴Blisterfilm™ (Kendall, Mansfield, MA)

⁵Saran™ (S.C. Johnson & Son, Inc, Racine, WI)

⁶Betadine® (The Purdue Frederick Co., Norwalk, CT)

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