In Vitro Testing of Bacterial Trapping in a Silicone Foam Wound Dressing

Braunwarth Horst, Coloplast GmbH (Germany), Christiansen Cecilie, Coloplast A/S (Denmark)

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Introduction

Wound exudate contains a wide variety of components and microorganisms. Presence of microorganisms does not necessarily imply an ongoing infection but can affect the wound healing negatively. Some modern absorbent wound dressings can trap and retain bacteria by absorbing the wound exudate. However, this ability varies according to the nature of the dressing structure and material. Removing exudate containing bacteria from the wound bed and preventing re-entry under pressure may support the wound healing in wounds with substantial bacterial load.

Some silicone foam dressings are designed to absorb bacteria-containing exudate by capillary action. Bacteria are then further absorbed into the foam matrix and absorbent layers containing superabsorbent particles. In this study, we compared the bacterial trapping capability of three silicone foam dressings and a conventional gauze in vitro.

Methodology

Materials: Dressing A, Dressing B and Dressing C were included in this study. Dressing D has minimal fluid handling capacity and was included as a control. Staphylococcus aureus ATCC 6538 was used as the test strain. Simulated wound fluid was a solution of 50% fetal calf serum and 50% peptone diluent.

Experimental Method[1]: A schematic illustration is provided in **Figure 1**.

1. Add Inoculum: Staphylococcus aureus culture prepared to $1x10^5 \pm 5x10^4$ CFU/ml in simulated wound fluid was applied into the centre of the absorption pad. The volume corresponds to one third of the absorption capacity of each dressing (**Figure 2**). Dressings were incubated at room temperature (18-24˚C) for 30 minutes to allow the inoculum to be absorbed.

2. Incubate under Pressure: Filters from an STR Strainer bag were prepared to 7.5cm x 7.5cm aseptically. Dressings were placed, wound contact layer down, on top of a filter inside a 400ml Stomacher® bag and incubated at 35 ± 2°C and 90% relative humidity for one hour under a weight proportional to the size of each dressing tested (**Table 1**).

Table 1. Size of dressings and weight applied during incubation.

Dressing	Size (cm^2)	Weight Applied (kg)
Dressing A	20.25	1.23
Dressing B	16.00	0.79
Dressing C	20.25	1.00
Dressing D	25.00	1.23

Figure 1. Illustration of the experimental method.

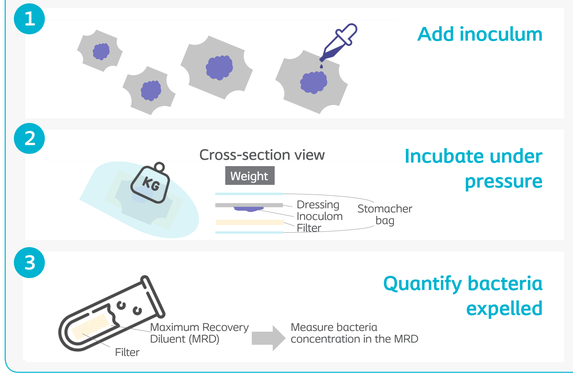
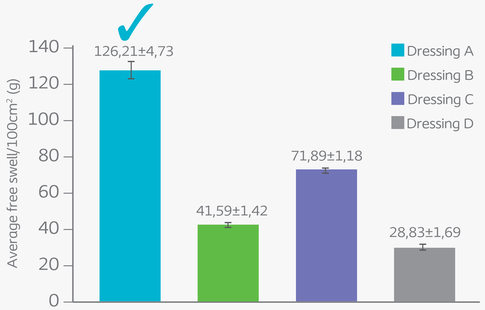
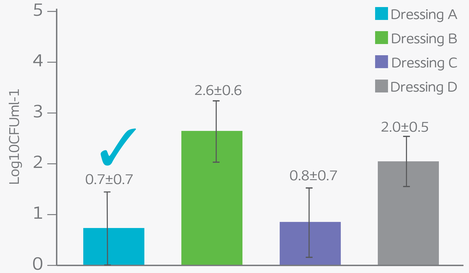


*Figure 2. Dressing A **has the highest free swell capacity**.*



Volume of inoculum added equals 1/3 of the free swell capacity for each dressing

*Figure 3. Dressing A **expelled the least amount of bacteria** despite the larger quantity of initial bacteria load.*



3. Quantifying Bacteria Expelled: Following incubation, dressings were removed, and filters were placed into 10ml maximum recovery diluent (MRD) with 0.1% Tween and vortexed for 5 seconds. Microorganisms were enumerated by performing 10-fold dilutions of the resultant suspension and plated out onto tryptone soya agar (TSA).

Data Analysis: A test was done with five samples of each test dressing in each run and repeated a further two times by the same operator on separate occasions. The bacterial retention capability of dressings was measured by the concentration of bacteria contained in the MRD. Lower bacteria count (expressed in $Log_{10}CFUml^{-1}$) indicates fewer bacteria expelled from a dressing under pressure, which indicates stronger bacterial trapping capability.

Results

Mean Free Swell/100cm2 was significantly higher for Dressing A compared to all 3 comparator products (all three p-values <0.0001) (**Figure 2**).

Dressing A was loaded with the highest volume of inoculum because of its superior free swell absorptive capacity (Figure 2).

Despite the large quantity of initial bacteria load, Dressing A dressings expelled the least amount of bacteria following incubation under pressure (**Figure 3**). The average $Log_{10}CFUml^{-1} \pm$ SD of bacteria recovered from filters following contact with the test dressings was: 0.7±0.7 (Dressing A), 2.6±0.6 (Dressing B), 0.8±0.7 (Dressing C), and 2.0±0.5 (Dressing D).

Results (continuing)

Mean $Log_{10}CFU$ was significantly lower (p-value<0.0001) for Dressing A compared to Dressing B and Dressing D whereas there was no significant difference in mean $Log_{10}CFU$ for Dressing A compared to Dressing C (p-value=0.9906).

Discussion

As a result of its strong absorptive capacity and minimal quantity of bacteria expelled, Dressing A is able to trap and retain exudate containing bacteria. Trapping bacteria contained in exudate in the dressing may provide an additional mechanism of antimicrobial control without active substances.

Dressing B and the control showed a comparable absorbance capacity. The absorptive capacity is a characteristic of the dressing material and a similar result was found for extraction of absorbed bacterial endotoxins from Dressing B and cotton gauze in a study from 2014[3].

The results from this test method indicate that different dressing show significant different absorbance and retention capacities. A better absorbance and retention capacity maybe used as a indicator for dressing selection depending on the bacterial load of the wound.

Conclusion

Bacteria can be retained and trapped in some modern silicone wound dressings even under pressure. However, the effect depends on the dressing design[2]. Dressing A is shown to expel the least amount of bacteria among four different wound care products tested in the study despite the larger quantity of initial bacteria load.

Dressing A: Biatain Silicone
Dressing B: Cutimed Siltec Sorbact
Dressing C: Mepilex Border Flex
Dressing D: Mölnlycke gauze

References

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3. Braunwarth H, Becher D, Brill FHH. In vitro study on endotoxin release of gram-negative bacteria after contact with silver releasing compared to DACC coated wound dressings. Wound Medicine 7 (2014) 14–17.

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