Non-antibiotic antimicrobial technology: wound dressings exerting an antibacterial effect on Pseudomonas Aeruginosa and a Staphylococcus Aureus biofilm in vitro

C. Wiegand1, M. Abel2, S. deLange2, P. Ruth2, U.-C. Hipler1

1Department of Dermatology, University Medical Center Jena, Germany 2Lohmann & Rauscher GmbH & Co. KG, Rengsdorf, Germany

Introduction
An increased bacterial load on the surface of a wound amplifies and/or perpetuates a pro-inflammatory environment. It has been suggested, that a lower probability of healing is seen when four or more pathogens are present, based on their synergistic relationship [1]. It is now widely accepted that them forming biofilms, complex structures consisting of bacteria cells embedded in an extracellular matrix consisting of hydrated extrapolymeric substances (EPS), further lowers the probability of healing [2,3]. Hence, it was postulated that it is necessary to create conditions that are unfavorable to micro-organisms and favorable for the host repair mechanisms. Wound dressings featuring active antimicrobial agents or a passive antimicrobial mechanism may help in the treatment of chronic wounds.

Material & Methods
The dressings CS, VS, VA Ag, and SX + PHMB were investigated. According to the JIS L 1902:2002, samples of 400mg of the dressings were used for testing. The samples were incubated up to 24h at 37°C under aerobic conditions with P. aeruginosa growth. Furthermore, a S. aureus biofilm was cultivated on glass plates, covered with the dressings, and incubated for 24h at 37°C. Then, dressings were removed and glass plates further incubated for 48h. Biofilm on the glass plates was evaluated directly after dressing removal and following 48h regrowth period using the fluorescent alamar blue assay.

Figure 1: Growth of Paeuerginosa under the influence of the dressings* over 24h (A) and the reduction of bacterial growth achieved in [log cfu] (B). The antibacterial activity was rated according to the JIS L 1902:2002.

Figure 2: Decrease of S. aureus biomass on the glass plates during incubation with the wound dressings for 24 hours at 37°C

Figure 3: Regrowth of biomass is significantly inhibited after 48 hours by the dressing Suprasorb® X+PHMB.

Results
The dressings CS, VS, VA Ag and SX+PHMB displayed a complete inhibition of Pseudomonas aeruginosa growth (figure 1). The antibacterial effect achieved against Pseudomonas aeruginosa could be rated as strong antibacterial activity according to JIS L 1902:2002 (log-reduction > 3). Furthermore, it was found that treatment of the Staphylococcus aureus biofilm with the dressings efficiently reduced biomass in vitro (figure 2). Significantly less viable bacteria were observed after incubation with CS, VS, VA Ag and SX+PHMB. However, only the PHMB-containing biocellulose dressing SX+PHMB exhibited a remanescent effect and was able to inhibit biofilm regrowth over a time period of 48 hours (figure 3).

Conclusion
It could be shown that antimicrobial dressings can decrease multiplication of bacteria by passive mechanisms based on securely binding the microbes in or to the dressing as observed for the DACC-coated dressing CS or the SAP-containing dressing VS. However, dressings that actively release antimicrobial agents like silver ions or PHMB are thought to have an additional effect reaching bacteria beyond direct contact to the dressing. Here, PHMB was found to be superior to Ag+ demonstrating a remanescent effect and preventing biofilm regrowth in vitro.

References