Intelligent wound dressing with antimicrobial properties

Sebastian Kersting[1], Sophia Ohnesorg[1], Markus von Nickisch-Rosenegk[1]

[1] Fraunhofer Institute for Cell Therapy and Immunology, Branch Bioanalytics and Bioprocesses IZI-BB, Am Muehlenberg 13, D-14476 Potsdam, Germany

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Fraunhofer Institute for Cell Therapy and Immunology, Branch Bioanalytics and Bioprocesses IZI-BB

Poorly healing wounds such as the so-called "diabetic foot" are often treated inadequately and unspecifically. The KISMADI project aims to create an intelligent wound dressing with additional antimicrobial properties. In addition to the continuous sensor-based wound monitoring and AI-supported digital feedback, an antimicrobial function in the wound dressing is achieved using antimicrobial peptides (AMPs)

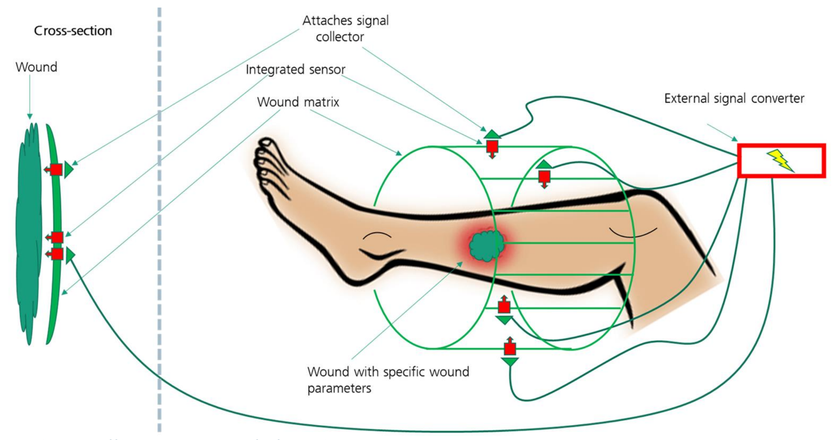

Fig. 1: Intelligent wound dressing

Selection of antimicrobial peptides

In the project, various natural or naturally derived peptides as well as sequence-optimized short peptides were selected and subsequently evaluated based on their effect on relevant resistant bacterial and fungal pathogens (e.g. MRSA, *Pseudomonas aeruginosa, Candida auris*).

Rational designed AMPs

Rational designed, artificial AMPs with biocompatible properties were developed. Important structural motifs were identified and optimized peptide sequences were generated. These peptides showed improved antimicrobial activity towards important bacterial pathogens in comparison with naturally occurring AMPs. At the same time, negative cytotoxic or cytostatic effects were evaded. The generation of a deletion and substitution library revealed the minimal sequence requirements and therefore reduced manufacturing costs. These optimized artificial antimicrobial peptides are suitable as therapeutic agents and may be used as templates for the development of new antimicrobial peptides with unique secondary structures.

Surface immobilization strategies

After activating the base material for the wound dressing (silica gel fiber fleece from Fraunhofer ISC), various covalent chemical coupling methods and linker systems were utilized. A selection was made based on the optimal density of peptide and mode of activity of the systems.

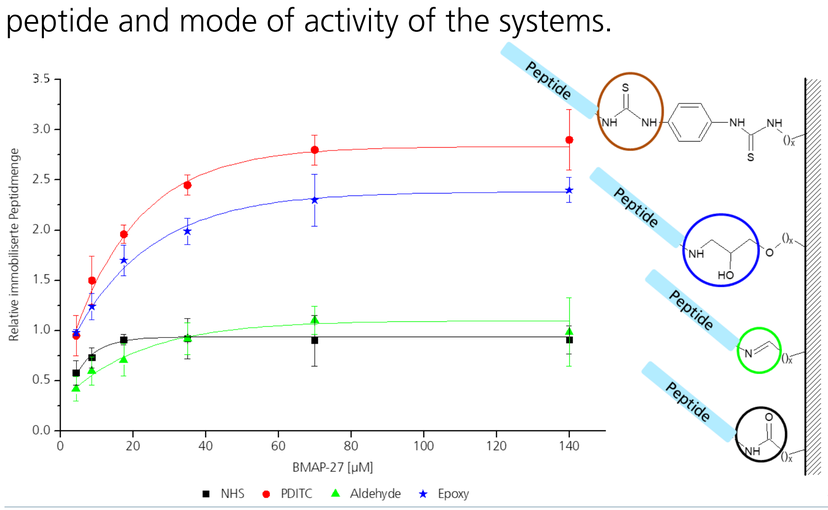

Fig. 2 Example for BMAP-27 based antimicrobial surface coating. Different immobilization strategies lead to differences in surface saturation and activity. Optimization of threshold concentration with lowest amount of peptide.

Characterization of surface couples AMPs

Rapid and efficient screening procedures have been established that allow for the identification and investigating of biologically active peptides for a specific application or to maintain the biocidal activity in an immobilized state. Suitable AMPs that exhibit high antimicrobial activity against disease-specific pathogens but low cytotoxicity are to be preferred for certain applications. Minimal inhibitory concentrations (MIC) against several gram-negative and gram-positive bacterial strains were examined. The membrane disruption properties of AMPs towards the outer and inner membrane were evaluated using a genetically modified bacterial strain.

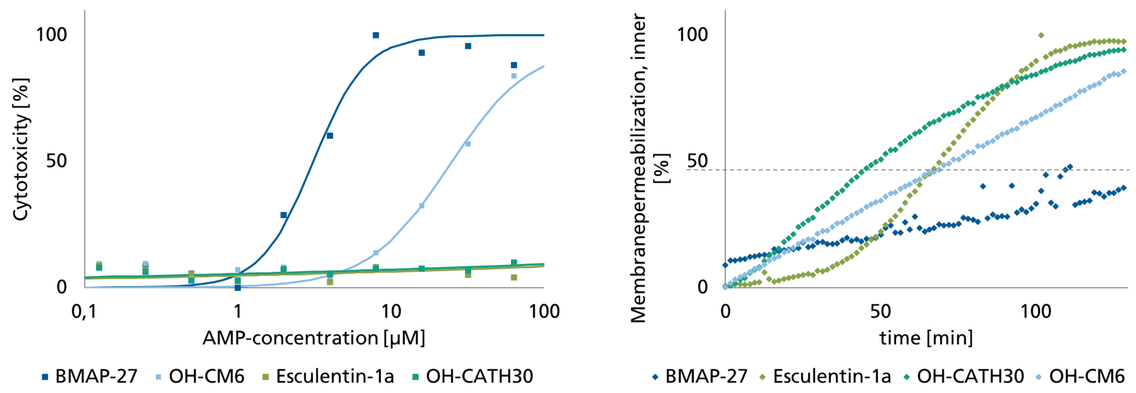

Fig. 3 Percentage cytotoxicity of three AMPs against HCEC-12 cells (left). Permeabilization of the inner bacterial membrane by addition of various peptides (right).

Biological testing of surface coupled AMPs

The activity of the immobilized peptides was tested with relevant bacterial and fungal strains. In the tests, up to a 5-log reduction in the bacterial load was achieved after 2 hours of incubation.

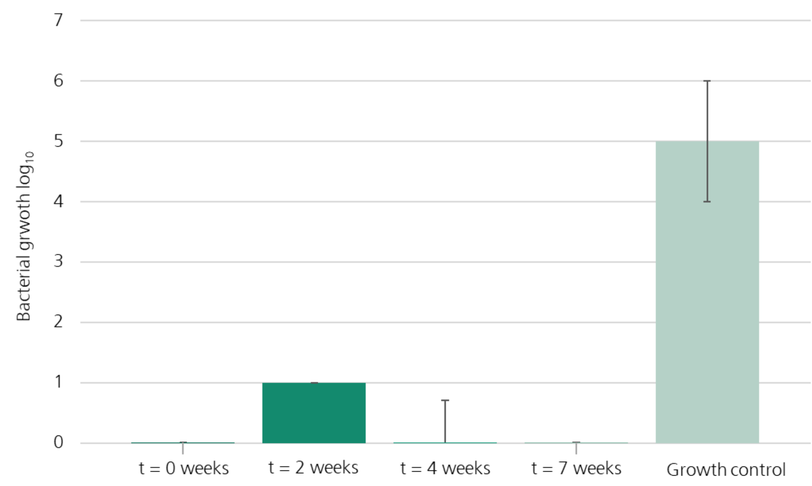

Fig. 4 Long term stability of wound dressings with AMPs

In addition, the wound dressing with AMPs was tested for long-term stability in different temperatures, pH values, and serum. In summary, it can be stated that the approach helps to maintain the sterility of the wound material and to reduce possible biofilm formation. The KISMADI wound dressing with decentralized sensor measurement of important parameters for wound healing, AI-supported digital feedback, and active antimicrobial coating could optimize wound management and extend wearing intervals.

Contact

Dr. Sebastian Kersting
Molecular Bio Engineering
Tel. +49 331 58187-214
sebastian.kersting@izi-bb.fraunhofer.de
Fraunhofer IZI-BB
Am Mühlenberg 13
D-14476 Potsdam
www.izi-bb.fraunhofer.de

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