

Photodynamic method as a potential tool for eradication of *Staphylococcus aureus* colonizing patients with atopic dermatitis

ABSTRACT

In the vast majority of patients with atopic dermatitis (AD), skin lesions are colonized by *Staphylococcus aureus*. These bacteria produce several virulence factors, including toxins with superantigenic properties. The action of superantigens (SAg) leads to massive stimulation of T cell proliferation and the release of pro-inflammatory cytokines, resulting in exacerbation of inflammation in AD patients. Decolonization of *Staphylococcus aureus* from the skin of AD patients is an important process that will restore the proper functioning of the skin and rebuild its bacterial flora. Moreover, untreated patients are a potential reservoir of *Staphylococcus aureus*, which may favor transmission in the population and the development of severe bacterial infections.

As current methods of *S. aureus* decolonization are associated with many side effects and limitations, this study proposed an alternative method of antimicrobial photodynamic inactivation (aPDI) to decolonize *S. aureus* from the skin. The method is based on the action of (i) a photosensitizer, (ii) visible light of a defined wavelength, and (iii) oxygen. As a result of the action of these three factors, reactive oxygen species are created that damage the bacterial cell wall and other cell components, leading to the death of microbes.

The aim of the study was to genotype *S. aureus* isolated from AD patients, to verify the efficacy of aPDI against clinical isolates and reference *S. aureus* strains and to analyze the effect of aPDI on staphylococcal toxins. Finally, the possibility of skin decolonization was verified using an *ex vivo* (porcine skin) and *in vivo* (mouse skin) model.

The studied group of *S. aureus* isolates from AD patients was shown to be highly heterogeneous. aPDI using green light-activated rose bengal successfully eliminated both clinical and reference *S. aureus* strains, and the toxin genes had no effect on the efficacy of this process. The sub-lethal conditions of aPDI resulted in a marked decrease in the expression of four out of the five tested toxin genes. Such an effect was not observed at the protein level, but it has been proven that staphylococcal toxins have lost their biological function after treatment with aPDI. In an *in vivo* mouse model, aPDI was shown to lead to a statistically significant reduction in the number of *S. aureus* on the skin surface. The following observations indicate that aPDI may be an effective method of skin decolonization in patients with AD. Moreover, reducing the level of bacterial virulence factors and the loss of their biological functions with aPDI treatment may be effective in reducing inflammation in AD patients.