In vitro antimicrobial activity of light-activated phthalocyanines

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Abstract: Background: Photodynamic antimicrobial therapy (PACT) is proposed as a topical, non-invasive approach suitable for treatment of locally occurring infection. Research of photosensitizers, (PS) as well as their development, is aimed at finding effective antimicrobial substances which would have a broad-spectrum potency. The aim of this paper is to evaluate the antimicrobial effect of phthalocyanine (Pc) derivatives. Methods: Fifteen different Pc compounds were investigated. Their photokilling activity was tested on Staphylococcus aureus, Escherichia coli and Candida albicans. After treating of microbial cells with Pc at the concentrations: 1 mg/l, 2 mg/l, 4 mg/l, 8 mg/l for 30 minutes, the cultures were irradiated with low-power laser light at a wavelength of 670 nm (20 J/cm², 40 J/cm²). The effectiveness of photoinactivation was evaluated based on the decrease in number (log10) of viable bacteria. Results: Eight Pc compounds tested showed antibacterial effects against S. aureus, but only four were effective against E. coli and two against C. albicans. The most effective photosensitizers were amphiphilic sulphonated zinc Pc compounds [(3-diethylammonium)-propylsulphonamide citrate (Pc3) and cationic tetramethylenepyridinium chloride of hydroxyaluminum Pc (Pc7)]. Conclusions: The most efficient phthalocyanines (Pc3, Pc7) cause a significant decrease in viable counts of all tested microbes.

Keywords: Phthalocyanines • Photodynamic antimicrobial therapy • In vitro photoinactivation • Staphylococcus aureus • Escherichia coli • Candida albicans © Versita Sp. z o.o.

1. Introduction

Nowadays growing resistance to antibiotic drugs represents a real threat in hospitals as well as in the community. New approaches to overcome this problem are being investigated. Photodynamic antimicrobial therapy (PACT) is proposed as a topical non-invasive approach, which could become an effective alternative to using antibiotics and antiseptics in treatment of local infections.

The so-called photodynamic phenomenon is used, where the microorganisms are eradicated by the action of photosensitizers (PS) and suitable light. The PS itself has no or negligible antibacterial effect, however, after irradiation by light of appropriate wavelength in the presence of oxygen, reactive cytotoxic products (mainly singlet oxygen \( ^1O_2 \)) are created and microbial cells are lethally damaged [1,2]. The advantage of photodynamic inactivation, based on the principle of targeted application of photosensitizer to the infected area and targeted irradiation, is minimizing the risk of damaging physiological microflora and host cells outside the treated area [3,4]. Photodynamic antimicrobial therapy has been studied largely in vitro under laboratory conditions but there have also been some studies on animal models [5,6]. Most recently the method has also been described in patients with periodontal disease [7,8] and diabetic foot infections [9]. Some well known pathogens, especially Gram-negative bacteria, are poorly responsive to PACT using traditional photosensitizing agents, including xanthen or acridine orange and negatively charged porphyrins used

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