Source: Sabaeifard, P., Abdi-Ali, A., Gamazo, C., Irache, J. M., & Soudi, M. R. (2017). Improved effect of amikacin-loaded poly (D, L-lactide-co-glycolide) nanoparticles against planktonic and biofilm cells of Pseudomonas aeruginosa. *Journal of medical microbiology*, *66*(2), 137-148, https://doi.org/10.1099/jmm.0.000430

Improved effect of amikacin-loaded poly(D,L-lactide-co-glycolide) nanoparticles against planktonic and biofilm cells of Pseudomonas aeruginosa

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Abstract

Purpose. Amikacin is one of the most effective antibiotics against Pseudomonas aeruginosa infections, but because of its high toxicity, the use of this antibiotic has been clinically limited. In the present study, amikacin was successfully loaded into a new formulation of nanoparticles (NPs) based on poly(D,L-lactide-co-glycolide) 50 : 50 in order to enhance the treatment efficacy. The synthetized amikacin-loaded PLGA nanoparticles with high drug loading and stability were used to eliminate P. aeruginosa cells in planktonic and biofilm states.

Methodology. P. aeruginosa PAO1 biofilm susceptibility studies were done using the minimum biofilm eradication concentration assay. The association of fluorescently labeled amikacin-loaded nanoparticles (A-NPs) with mouse monocyte macrophage cells (RAW 264.7), and the nanoparticles ability to interact and eradicate the bacterial cells even in the form of biofilms, was investigated using Flow cytometric studies and confocal laser scanning microscopy.

Results. Flow cytometric studies showed that these NPs were able to interact with planktonic and biofilm bacterial cells. Moreover, following 1 h of incubation of A-NPs with 1-day-old biofilm, it was found that particles penetrate through the entire biofilm thickness. Live/dead fluorescent staining followed by CLSM analysis showed that the A-NPs were more effective than free drug in biofilm eradication.

Conclusion. The good antibacterial and antibiofilm activities of A-NPs, in addition to their ability to enter macrophages without any cytotoxicity for these cells, make them a potential candidate to treat P. aeruginosa infections.

Keywords: amikacin; PLGA nanoparticles; Pseudomonas aeruginosa; biofilm; CLSM; macrophages RAW