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Nanoemulsion-Based therapies: Antimicrobial, anti-inflammatory and drug delivery properties

Nanoemulsions (NE) are oil-in-water emulsions containing high energy nanometer-sized droplets stabilized by surfactants, and specifically designed for topical and mucosal targeted delivery. Due to their size (less than 500nm) and surface-active properties they to traverse the skin via pores, hair follicles, and mucosal membranes, but are excluded from entering the tight junctions of the epithelium. As a result, they can be highly bioavailable in the tissues, without causing disruption of the normal epithelial matrix. Nanoemulsions can delivery agents across the nasal mucosa for the desired clinical (therapeutic) effect. We have testing these formulation in high-throughput screens and found NE induced immunogenicity and antigen delivery are facilitated through initial contact interactions between the NE droplet and mucosal surfaces, which promote prolonged residence of the vaccine at the site of application, and thus cellular uptake. We have incorporated small molecule, peptides/proteins and large macromolecules in optimized nanoemulsion formulation for transmucosal delivery. Nanoemulsions can delivery agents across the nasal mucosa for therapeutic effects. Nanoemulsions delivered topically are inherently antimicrobial and lyse pathogens upon contact, thereby overcoming existing resistance mechanisms. Other anti-microbial, anti-fungal and anti-viral agents can be entrapped inside the nanoemulsion and enhanced drug delivery of these agents. Studies of a novel nanoemulsion formulated with other agents demonstrates significantly higher levels are achieved as compared to commercially available products. Recently discovered, a topical nanoemulsion therapy acting as a topical antimicrobial was found to halt burn wound progression in a swine burn wound model. The nanoemulsion reduced the bacterial growth in the burn wound to minimal levels compared to saline and silver sulfadiazine and significantly reduced levels of dermal inflammatory cytokines. By reducing excess influx of neutrophils into the burn wound and modulating the pro-inflammatory response, the nanoemulsion formulations attenuated burn wound progression in the early post-injury phase and prevented conversion of burn wounds from partial thickness to full thickness. This discovery, if demonstrated in man, would lessen the need for skin grafting, speed recovery, result in fewer infectious complications, and improve the outcomes by preventing the conversion to full thickness wounds. Among its many uses nanoemulsion therapy is a potential new breakthrough treatment for preventing burn wound progression.

Speaker Biography

Susan Ciotti, PhD is the Director of Formulations at NanoBio Corporation, where she directs the nanoemulsion adjuvant formulation efforts. She is responsible for developing novel nanoemulsion formulations, nanoemulsion manufacturing (process optimization/scale-up) and clinical trial materials for the vaccine clinical trials. Her career has focused on principally on developing nanotechnology formulations. During her tenure at Johnson and Johnson, she spearheaded several projects related to developing formulations for the treatment of topical and nasal preparation, as well as sterile parental formulation. She has served as the lead for several projects at various stages of dermatological, parenteral and biological drug product development. She is currently leading NanoBio's formulation efforts on a NIAID contract entitled "Next Generation Anthrax Vaccine". She was the co-investigator on Nanoemulsion-based antimicrobials for the protection against burn and wound infection funded by the U.S. Army Medical Research and Material Command (USAMRC, Award Number: W81XWH-11-2-005). Dr Ciotti received her graduate degrees in Pharmaceutical Sciences from the University of Michigan, Ann Arbor, MI. She is a Professor of Pharmaceutical Sciences at the College of Pharmacy where she teaches novel drug delivery and nanotechnology to graduate students.

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