A COMPUTATIONAL MODEL OF TRANSIENT DRUG/CHEMICAL DIFFUSION THROUGH HUMAN SKIN IN THE VICINITY OF A HAIR FOLLICLE

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ABSTRACT

This paper addresses the manner in which drugs and chemicals applied to skin penetrate into dermal tissue around hair follicles. Aside from follicular drug delivery per se, quantitative modeling of this process is important to topical and transdermal drug delivery generally, as well as risk assessment of chemical exposure, because hair follicles and other appendages can contribute significantly to skin permeability by providing shunt pathways through the epidermal barrier. A comprehensive finite difference model has been developed to solve the transient diffusion equation describing transport of any chemical species through stratum corneum, viable epidermis, dermis and hypodermis in a large cylindrical volume surrounding a realistic geometrical representation of the hair shaft and surrounding layers of the follicular sheath. The numerical technique introduces a novel non-orthogonal coordinate system fitted to the follicle's outer boundary. Inputs to the calculation are the partition coefficient and diffusion coefficient of the applied drug in each tissue layer, as well as a volumetric rate coefficient describing clearance into the systemic circulation via the dermal vasculature. Spatial variations in some of these coefficients reflect variations in the degree of vascularization, which is large in the dermal capillary plexus, and in an annular region surrounding the follicle, which is wrapped with blood vessels. The model is used to calculate dermal concentration profiles (concentration as a function of depth and radial distance) for model permeants representing minoxidil as well as the lipophilic dye Bodipy FL C_5. Because of the need to estimate certain dermal parameters, results are cast in the form of reasonable upper and lower bounds on drug penetration. They are compared with experimentally obtained published dye distributions [1] around hair follicles.

REFERENCE

1. Grams, Y.Y., et al., Time and depth resolved visualisation of the diffusion of a lipophilic dye into the hair follicle of fresh unfixed human scalp skin. Journal of Controlled Release, 2004. **98**(3): p. 367-378.