Title: Physiological Effects of Eccrine Gland Activation on Skin Tissue Dielectric Constant

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Background: Skin TDC values are usually measured using the open-ended coaxial transmission line method. At the normally used frequency (300 MHz) the TDC value, which is in effect the real part of the complex permittivity, is mainly dependent on skin water (free and bound). TDC measurements are noninvasive and require simple touching of the skin with a suitable probe for a few seconds to obtain a measurement. This method has been used to assess skin properties and there change in variety of conditions including diabetes, edema and lymphedema. However, because this is a skin-related measurement that includes within its measurement volume eccrine glands it is important to have an estimate of the impact of eccrine gland activation on the measured TDC value. There is essentially no information on this issue. In fact, the effect of eccrine glands and their activation on TDC values is unknown.

Objective: To examine and clarify the potential role of eccrine gland activation on the tissue dielectric constant (TDC) measure on skin.

Methods: Major factors whereby eccrine glands may affect TDC values have been investigated and methods for experimental assessment of the likely dependency has been formulated.

Results: Whole body has approximately 4 X 10^6 eccrine sweat glands with the forehead containing 360 ± 50 /cm^2 and forearm 225 ± 25 /cm^2. Eccrine tube length and diameter are on average 5mm and 0.02-0.05mm respectively. Sweat is composed of 99.0-99.5% water with about 75 Mm Na^+ and Cl^- thus is likely to affect TDC values in a pore-density and activation state dependent manner. Pilot measurements on forehead and forearm suggest that heat-induced sweating can elevate TDC-measured estimates of tissue water by as much as 30% and possibly more. To relate such changes to pore-density a method to measure pore-density is needed and is being developed along with a mathematical model to assess the possible range of effects. The model being developed considers the eccrine glands as an added parallel inclusion within the tissue and calculates the effective dielectric constant as a function of simulated eccrine density. Such calculations are then to be compared with measured TDC values of skin that has had its eccrine glands activated via whole body heating.

Conclusion: The amount and content of activated eccrine glands appears to have the potential to impact TDC values. The significance of this fact lies in the way such activation may confound TDC measurements aimed at detecting and tracking edema or lymphedema or other conditions. Our future research focus is thus to fully develop both the analytical and experimental procedures to better characterize the impact range of such eccrine gland activation on measured TDC values.