Background

Failure to account for the physiological condition of exposed skin during work ignores two important human factors that may enable exposure: skin pH (which influences bioaccessibility) and skin barrier integrity (which influences penetration through the stratum corneum). While guidance exists for measurement of skin surface pH, transepidermal water loss (TEWL), and hydration index (HI) in controlled clinical settings, scientifically credible guidance is lacking for measurement in less controlled workplace settings. The purpose of this workshop is to gather international experts in dermatology, skin physiology, exposure assessment and relevant disciplines to discuss the utility of workplace measurement of skin surface pH, TEWL, and HI and if feasible, develop guidance for making these measurements.

Skin surface pH

The skin surface is hydrophobic and does not contain pure liquid water. Rather, the surface film is an aqueous mixture of lipids. The universal method for clinical measurement of skin surface pH is the glass planar electrode that is connected to a voltage meter. What is measured at the skin surface is referred to as *apparent skin pH* because it is unknown whether surface pH actually reflects H^+ ion concentration of intracellular water or if it represents the combined acidity of corneocytes, lipids, and water-soluble compounds diffusing into water applied to the surface by the electrode (Parra and Paye, 2003; Agache, 2004a).

Many variables influence measurement of skin pH, including endogenous (physiological), exogenous factors, instrumental, and human factors (Parra and Paye, 2003). In clinical settings, many of these factors can be controlled and guidance for non-invasive *in vivo* measurement of skin surface pH is available from groups such as the European Group on Efficacy Measurement of Cosmetics and Other Topical Products (EEMCO) (Parra and Paye, 2003). In the workplace,

many factors that influence measurement of skin pH cannot be fully controlled, necessitating development of guidance for scientifically credible determination of skin surface pH.

Skin transepidermal water loss

Water has two options for crossing the skin from the viable tissues towards the outer environment: active transport (sweating) and passive diffusion through the stratum corneum. TEWL instrument contains hygrosensors and thermistors mounted at two discrete points and aligned perpendicularly to the skin surface to determine the water vapor pressure gradient of the skin diffusion boundary. Different chamber designs exist, including unventilated, ventilated, and open and each design has unique advantages and disadvantages.

As with skin pH, many variables influence TEWL measurement. EEMCO and individual investigators have assessed variables affecting TEWL measurement and provided practical guidance for clinical *in vivo* assessment (Pinnagoda *et al*., 1990; Rogiers, 2001; Gabard and Trefel, 2004). The workplace is a dynamic environment and presents many challenges for measurement of TEWL. Hence, a need exists to develop scientifically credible guidance for workplace determination of TEWL.

Skin hydration

The water content of the stratum corneum is necessary for proper differentiation and desquamation (Verdier-Sévrain and Bonté, 2007) as well as maintenance of the skin barrier (Fluhr *et al.*, 2008). Normal hydration levels range between 20 and 30% in the lower half of the stratum corneum, but decrease to between 5 and 10% near the surface (Agache, 2004b). The electrical properties of the skin are related to the water content of the stratum corneum. Hence, measurement of electrical impedance of the skin can be exploited to assess the hydration state (expressed as HI) of the skin surface (Gabard et al., 2006). There are several commercially

available instruments for hydration measurement. The principle of operation of the most common instruments is based on measurement of capacitance contribution to impedance, though some instruments operate on measurement of conductance contribution to impedance, or total impedance.

Measurement of hydration state is influenced by many of the same factors that influence TEWL measurement and include biological (proteins and chemicals on skin, etc.) and physical (electrode geometry, frequency of current, etc.) factors. Additionally, reference values for anatomical regions of exposed skin in occupational environments are needed for understanding hydration measurements. As such, the need exists to develop scientifically credible guidance for workplace determination of hydration state.

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