

Transepidermal Water Loss Related to Volar Forearm Sites in Humans

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The aim of this study was to demonstrate differences in human skin transepidermal water loss (TEWL) in vivo related to site on volar forearm. Fourteen healthy volunteers entered the study and seven sites were tested. After randomization of both forearm and measure order, TEWL measurements were performed using the Servo Med Evaporimeter. TEWL values next to the wrist were found statistically greater than on the other sites. Hence wrist region should preferably be excluded from TEWL measurements on forearm. Key word: Anatomic site.

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Transepidermal water loss (TEWL) is a non-invasive measure frequently used to assess stratum corneum integrity and as an indirect measure of skin permeability and barrier function in health (1,2) and disease (3). As a helpful complementary tool, TEWL is widely employed for the evaluation of cosmetic formulations as well as skin moisturizers and repairs (4,5,6).

Earlier studies have shown the interest of TEWL measurements in order to estimate skin irritation, in comparison with other techniques (skin colour reflectance, laser Doppler flow, visual scores) (7,8,9). Measurement of TEWL seems to be the most suitable, accurate and sensitive method for detection and quantification of skin alterations caused by chemical irritants as surfactants. Nevertheless, TEWL is affected by environmental factors (10), which is why measurements must be carried out with precautions in order to obtain reproducible results.

The aim of this study was to underscore a difference in human skin TEWL in vivo as a function of different volar forearm sites in order to avoid either under or overestimating certain results.

MATERIAL AND METHODS

Subjects

Fourteen experimental subjects were healthy volunteers (6 women and 8 men; age range 20-42 years) with no signs of skin disease. Measurements were performed on the ventral forearm. Seven areas were delimited: four or three on the dominant forearm and three or four on the dominated forearm, in order to obtain seven areas allotted on the two forearms. The sites examined were measured at 3.5, 6.5, 9.5, 12.5, 15.5, 18.5 and 20.5 cm from the fold of the wrist, at 1.5 cm on sides of a median line (Fig. 1). The forearms and the measure order were randomized and minimized.

Measurement of TEWL

TEWL was measured with the Evaporimeter EP1 Servomed (Servo Med, Stockholm, Sweden). This instrument uses the methods of vapour pressure gradient estimation described by Nilsson (2). The pres-

sure gradient is, within a stationary layer of air surrounding the human body, proportional to the exchange of water vapour from the skin surface.

Prior to the procedure, subjects stayed still for 10 min in the room where the temperature was controlled ($17.5^{\circ} \pm 0.5^{\circ}\text{C}$) with a relative humidity of 40-45%. In order to reduce thermic effects and emotional sweating, all measurements were performed inside a windshield (which appears as a box of plexiglass with holes for the placement of the subject's and investigator's forearms) to avoid convection of air, applying the guidelines of the standardization group of the European Society of Contact Dermatitis (10).

The probe of the evaporimeter was applied perpendicular to the skin until stabilization (reached by 30 s after the start of measuring). Then, TEWL was measured for 15 s. Instrumental measurements were performed by the same investigator, in February 1991.

Statistical analysis

TEWL values were compared using one-way analysis of variance (S.A.S.) followed by the Student Newman Keuls test (11) (The various factor of variance was the site).

RESULTS

TEWL means and standard deviations of each anatomic site are shown in Table I. The mean TEWL in the wrist region was significantly different ($p < 0.002$) when compared with the others. Statistical analysis of the data did not reveal significant differences between the other regions. Any sex-related difference was underscored.

DISCUSSION

Our data showed that TEWL values were different on various volar forearm sites. When grading these sites by increased TEWL value, the rank order appeared to be as follows: $5 < 6 < 3 < 2 < 4 < 7 < 1$. Only the wrist region differed significantly vis-à-vis other sites. However, our results are in agreement with previous studies (12,13).

Pinnagoda, Tupker et al. (13,14) started by measuring TEWL near the wrist region of the right and left forearms. They suggested that TEWL scores were higher on the wrist

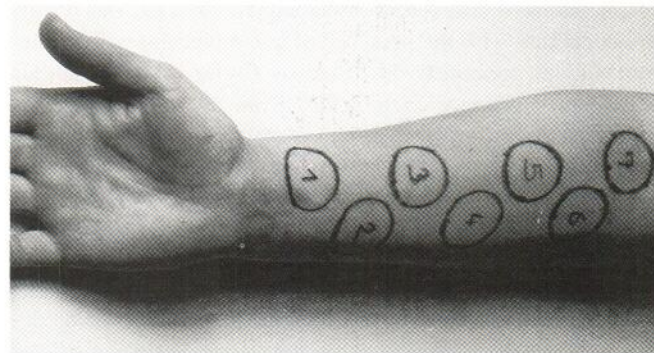


Fig. 1. Anatomic sites tested.

Table I. Transepidermal water loss (TEWL) means and standard deviations related to anatomic sites (from site 1 to site 7)

	TEWL, g m ⁻² h ⁻¹
Wrist	4.20 ± 1.61
	2.91 ± 0.97
	2.68 ± 1.18
	3.03 ± 0.98
	2.44 ± 0.90
	2.66 ± 0.46
Elbow	3.07 ± 1.26

because first measurements showed more fluctuations than the following owing to emotional sweating. But our study shows the same results although the order of measurements had been randomized. Thus the subject's apprehension does not explain the higher TEWL value next to the wrist fold. The sweat gland density and activity increasing towards the wrist should explain our results (13).

Van der Valk & Maibach (12) also found higher TEWL baseline values close to the wrist, but only on one forearm. Our measurements were performed on seven sites allotted to both forearms. Thus the prevalence of one forearm on the other could be eliminated. Several studies showed differences in the thickness of the human stratum corneum (15,16). A relationship should exist between the thickness of the stratum corneum and TEWL as certain authors suggested (12).

Other unpublished data underscored a relation between TEWL and the depth of skin wrinkles, i.e. the developed skin surface. However, in most studies (1,6,7,12,14), TEWL measurements were performed on the volar forearm. Our data showed a higher TEWL value for the wrist region.

Whatever the mechanism(s) involved, this area should be preferentially excluded in order to minimize inter- and intrasubject differences, but randomization of other sites and measurement order might be preferable owing to the observed differences.

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