A METHOD OF MEASURING SWEAT FROM THE HANDS

SOME RESULTS IN RHEUMATOID ARTHRITIS

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Sweat is well known to vary in composition and amount over different areas of the body. A wide range of values is found in sweat from corresponding areas in different individuals, and in our experience even from the same subject at different times under apparently the same conditions.

The extent of this range is in itself a matter of considerable interest and invites fuller investigation of the sweat in conditions of disease, as, for instance, in rheumatoid arthritis, since the impression exists among clinicians that clammy hands are more common in arthritic patients than in normal subjects. An additional incentive to further research arises from the work of Conn and Louis (1950), who claim that the concentration of sodium and chloride in thermal sweat is governed by the activity of the adrenal cortex, which may be implicated in diverse pathological conditions.

A distinction is usually drawn between insensible sweat, which is largely due to evaporation of water through the skin, and sensible sweat, the visible secretion of the sweat glands under conditions of thermal stimulation. Sweating on the palms and soles is stated to be independent of thermal stimuli, unless these are very strong, but to be regulated by mental stimuli (Kuno, 1934).

Much of the work of previous investigators has been done on the profuse sweat of the naturally or artificially overheated body. McSwiney (1934) enclosed his subject in a rubber suit provided with tubes to run off the sweat, and placed him in a heat cabinet for periods up to an hour. Dill and others (1938) experimented on members of the Harvard Desert Expedition. Moisture was estimated from the loss of body weight corrected for loss of moisture from the lungs. The solids secreted in the sweat were obtained by washing body and clothes. Conn and Louis provoked sweating by exposing the body to a hot (95° F.) humid atmosphere, samples being collected from the abdomen and hand plus forearm. Locke and others (1951) induced sweating by a high room temperature (32° C.), and by placing one arm in hot water. The sweat was obtained by enclosing the non-immersed arm in a waterproof envelope and weighing the moisture delivered, allowing for adherent moisture. Kuno describes very elaborate methods used in his "perspiration chamber" for obtaining the insensible perspiration from small areas of the body, by the use of collecting covers drawing the air through CaCl_2 tubes; his portable equipment employed a hair hygrometer. Darling (1948) measured the

rate of insensible sweating on an area of the palm of the hand by absorption on a weighed gauze pad (covered with plastic sheeting sealed to the skin), and afterwards dissolved out the chloride, urea, and other substances for analysis.

After consideration of these and other techniques with which tentative experiments were made, the following method was evolved as suitable for observing rapid changes in sweating behaviour under various therapeutic or other special conditions. (Woodmansey, 1951). It is simple and convenient to perform, and the necessary apparatus is readily available. It can be carried out at any time on any patient, and does not rely on a room of constant temperature, though this, of course, enables a greater degree of standardization.

The rate of moisture elimination is measured on a small area of the palm and/or dorsum of the hand or on the thumb. Both hands are taken for the estimation of salt and urea in order to get sufficient for accurate analysis. Other constituents of sweat have not been dealt with in this study.

The measurement of moisture is carried out on a smaller area than is used for the estimation of solids. This does not matter because we are not now considering the tonicity of the sweat or the energetics of sweating.

Method

The patient is kept under resting but not basal conditions. No restrictions of dietary salt or fluids have yet been imposed in our experiments, because, as Newburgh and Johnston (1942) and others have shown, moderate dehydration or hydration of the body, or small variations of salt in the diet, have no effect on the insensible loss of water.

The patient sits in a room thermostatically controlled as closely as possible to $18\cdot3^{\circ}\text{C}$. (65°F .). The hands are well washed in tepid tap water, followed by distilled water, and lightly dried. They are then rested sideways on a clean towel spread over the knee or in large beakers to avoid loss if more actively sweating. After a period of an hour, each hand in turn is well rinsed in 500 ml. tepid ammonia-free distilled water in a tall beaker by immersing to the first crease on the wrist or to some other predetermined mark, the fingers being actively moved to and fro. Half of the washing water (250 ml.) is evaporated to small bulk. The chloride in it, determined by the ordinary method, represents the amount of salt excreted by one hand in an hour (Na and K have not yet been determined separately). The other 250 ml. is incubated with a crushed urease tablet and 2 ml. toluene. On distillation the first 100 ml. contain all the ammonia which is estimated colorimetrically after the addition of Nessler solution. This result represents the amount of urea (plus a little ammonium salt) from the sweat of one hand.

In view of their different control mechanisms, an attempt has been made in a few cases to determine separately the palmar and dorsal secretions of salt and urea. This was done by carefully moving the half-submerged hands in two shallow dishes of water, palm upward in one and dorsum upward in the other, the washings being analysed as above.

The rate of (moisture) sweating from the thumb or from a small area (about $4\times4\text{ cm.}$) of the palm or dorsum of the hand is determined by passing CaCl_2 -dried air through a collector into a weighed CaCl_2 U-tube, and finally through a bubbler to indicate the air flow to an electric or water pump (or aspirator bottles). The flow should be rapid enough to prevent visible condensation. 10 to 30 min. flow is sufficient. The weighed moisture is calculated to an hourly rate.

The volumes of the hand and thumb (measured by displacement) are recorded for further consideration if required. Skin temperatures of palm, dorsum, thumb, and forehead are taken periodically through the test.

Apparatus.—The collector for palm and dorsum (Fig. 1) is made from a short bottle by grinding off the base (this requires care) or from $\frac{1}{8}$ " Perspex in round or square box form. Perspex is easy to work with simple tools, and can be bent over a small flame. A scrap of the material dissolved in ethylene dichloride is used as cement. Inlet and outlet glass tubes passing through rubber corks are also required. A sponge-rubber washer (shown in the diagram) $\frac{1}{4}$ " thick, rendered non-porous with rubber solution, is not usually required. It is better to hold the collector in position by hand during the test than to tie it on.

FIG. 1.—Collector of moisture from palm or dorsum.

The collector for the thumb (Fig. 2) is even easier to make; this consists of a piece of glass

FIG. 2.—Collector of moisture from thumb.

tubing about 3" long and 1 or $1\frac{1}{8}$ " in diameter to fit loosely over the thumb. The long inlet tube (flattened to fit under the thumb) and short outlet tube pass through the rubber cork at one end. A short length cut from the thumb of a discarded surgical glove stretched over the other end makes a perfect seal without constriction.

Results

Tests were made with 42 rheumatoid arthritic patients selected at random, and eleven normal subjects. Clinical data of the former were available, but as these showed no correlation with the sweat figures they have been omitted. The scatter diagram (Fig. 3) shows the wide range of values obtained and confirms the observations of others with regard to the output of moisture and salt. Indeed, the NaCl column should have been extended to show a few isolated points lying far beyond the limits of the scale; the highest was, in fact, 13.6 mg. Such cases may prove to be of particular interest.

The urea output varies less than that of salt, for whereas the points on the NaCl scale are more or less evenly

FIG. 3.—Results in mg. moisture per hour from the thumb, and mg. NaCl and Urea per hour from one hand.

Black dots—rheumatoid arthritic patients.
Circles—normal subjects.

dispersed between 0.2 and 1.6 mg., the urea values tend to cluster in the 0.4 to 0.6 mg. region.

The wide variation between maximum and minimum amounts of salt and urea in insensible sweat from the hands of an ordinary healthy individual taken on a number of occasions on the same and on different days is shown below. The circumstances of these variations still require elucidation.

NaCl		Urea	
Max.	Min.	Max.	Min.
1.37	0.56	1.00	0.53

In eight cases (mostly normals) where the palmar and dorsal washings were kept separate, the results were as follows:

Case No.	Both Palms		Both Dorsi	
	NaCl	Urea	NaCl	Urea
1	2.60	1.22	1.40	0.65
2	0.70	0.44	0.35	0.34
3	2.03	0.56	0.78	0.39
4	3.05	1.07	1.20	0.44
5	1.45	0.81	0.80	0.33
6	1.03	0.97	1.00	0.72
7	0.75	0.46	0.32	0.18
8	3.30	2.25	0.85	0.97

The excretion of both constituents is thus greater from palm than from dorsum. Similarly, whenever measurements of moisture were made, that from the palm was greater than that from the dorsum, but there was no regularity in the ratio.

The technical method described above is at present being used in an attempt to throw light on such problems as

- (a) the apparent vagaries of insensible sweating,
- (b) the differences in sweat behaviour between normal persons and rheumatoid arthritic patients,
- (c) what changes occur when a thermal stimulus is applied or when hormonal or other therapy is being given.

Summary

A simple method is described for the estimation of moisture, salt, and urea in insensible sweat from the hand.

Figures are given, showing the wide range of values to be expected in normal subjects and in rheumatoid arthritic patients.

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MEASURING SWEAT FROM THE HANDS

61

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Une méthode pour mesurer la sueur des mains

RÉSUMÉ

On décrit une méthode simple pour déterminer l'humidité, le taux du sel, et celui de l'urée dans la sueur imperceptible des mains.

On présente des chiffres montrant la gamme étendue des valeurs qu'on peut obtenir chez les sujets normaux et les arthritiques rhumatisants.

Un método para medir el sudor de las manos

SUMARIO

Se describe un método sencillo para determinar la humedad, la sal, y la urea en el sudor imperceptible de las manos.

Se presenta cifras mostrando la gran amplitud de las variaciones de los valores tanto en los sujetos normales como en los enfermos con artritis reumatoide.