SPECIAL ARTICLE

Practical Problem of Perspiration

By

YASUSHI KUNO,

Emeritus Professor, Nagoya University, Member of Japan Academy—

Med. J. of Mutual Aid Asso. *9* : 1, 1960.

1. Apocrine Gland and Eccrine Gland

In sweat glands, there are apocrine and eccrine glands. The former are in the entire hairy skin of the mammal, but in mankind they exist while localizing mainly on axillae, and the latter, in the whole skin surface. The eccrine glands of the animal are only on the sole of feet and open directly to the skin surface. Accordingly, the apocrine glands are the sweat glands for the animal, whereas the eccrine glands can be said that they are for human beings. The main difference between the two is in their secretory structures. In apocrine glands secreting cells are long and their pointed ends are broken into fragments, which become secretion matter. The secreting quantity is small, but their components are complicated. The axillary smell mentioned in the latter part of the statement is attributable to this, and the eccrine glands excrete considerable amount of thin perpiration, so that the amount reaches up to two litres per hour. The total number of eccrine glands on the whole body of a man amounts to 2 million 300 thousands among the Japanese on the average. However, since they are very small, the total secretive amount does not come up even to 20 c.c. The fact that this small capacity produces such great amount of perspiration is a surprising story that can never be seen in other glands.

2. Thermal Perspiration and Mental Perspiration

Perspiration of human race is classified into two kinds (in 1928 by *Yasushi Kuno* and *Koki Ikeuchi*, and in 1929 by *Takao Kosaka*). Thermal perspiration is caused by thermal origin like high temperature, and appears on the whole body except the palms of hands and the soles of feet. This gradually arises through fixed incubation period and it has the nature of incoasing as the time elapses, and the amount becomes large as the aforesaid. The amount of mental perspiration is little in general and it makes its appearance localizing in three places, palms, soles and armpits by mental work, excitements and sense of pain. Its turning up has a characteristic that is sudden with no incubation period. Those two kinds of perspiration are caused by nerve reflex. The difference of the characteristics is based on the disparity of properties of their nervous centers. The nervous center of thermal perspiration is in hypothalamus, it usually is in dormant state and does not react from stimulus. As the body is heated, excitability is quickened by degrees, and begins to react. On the other hand, the center of mental perspiration is perhaps in cerebral cortex. As it has always

a set excitability, it is able to show immediate reaction upon stimulus. (Diagrams No. 1 and 2—see page 2 in Japanese)

3. Nature of Perspiration and Nightly Sweats

As the aforestated, the nervous center of thermal perspiration undergoes a rapid change in the course of perspiration by bodily condition as excitability alters. When the body is kept warm excitability is in high degree, if there is any stimulus it is ready at a moment's reaction, and gets into a perspiration. So, in the summer season, that is the reason why slight heating like dipping the hand into water causes perspiration. On the contrary, I can understand the such by the fact in the wintertime after entering into high temperatured chamber if needs over 20 minutes to perspire. Viewed in this light the changeable function of perspiration reaction we term as perspiration nature. Perspiration nature varies under various conditions within the body. For example many acute feverish patients whose perspiration stops completely at the stage of rise of their bodily temperature, but the patients suddenly perspire a large amount, which proves effective symptom for healing at the stage of alleviation of fever. I can interpret this is due to probably at the initial stage, perspiration center is paralized by toxin and at about the time when the toxin disappears excitability of the nervous center recovers its normal state.

As to the other interesting case it is known by our daily experience to perspire much at night in summer. It was verified experimentally (in 1936 by *Takeo Kasuga*). While measuring thermal and mental perspiration at the same time on the chest and the palms of hands, if I make a subject sleep most of mental perspiration usually disappears. (This is resulted from the rest of cerebral function). The perspiration of the whole dermal surface is irregular in response to the surrounding temperature. In case that temperature is more than 29° a copius perspiration is attained while asleep. Therefore, in the summer season when sleep comes to one, he exudes thermal perspiration all over one's body.

The result on the diagram No. 3 (see page 2 in Japanese) shows the rise of excitability of thermal perspiration center. That is, when the surrounding temperature rises fairly high, the body is heated, and the excitability of perspiration center is increased to a certain degree, which does not yet reach the point to perspire and react to surrounding temperature. Under such condition if one sleeps, there will be a remarkable rise in excitability all at once, and it begins to react to the present surrounding, and then perspires. There are no experimental proofs, adequate yet, as to why rise of excitability of such perspiration center is originated by sleep. The controling center is in the cerebrum, so I can presume its control action is lost by sleeping. It is the normal state of healthy person that when the surrounding temperature is further lowered, by the action of such sleep alone, perspiration cannot be induced.

For tuberculosis consumptives perhaps by the affect of toxin, the excitability of perspiration center is waxed, and since even in the cool

atmosphere the condition being similar under over 29° to the normal healthy person, because of the aforestated reason he immediately perspire in his sleep. I conclude that that is the reason of the cause of night sweating.

4. Development of Sweat Gland and Origin of Perspiration

First sweat glands are formed at the embryonic stage, and that is endowed with secretary function; i.e. they are organized. Such organization was mostly made during the embryonic period, a certain part of sweat glands is kept on developing even two years after the birth. But, other sweat glands cannot get a chance to be organizable, throughout the lifetime, they became glands without secretory ability even though the forms were arranged properly. In consequence, the glands can be classified into two kinds, active and inactive glands. The aforementioned 2,300,000 is the number of sweat glands of active kind.

Such being the case with them, the majority of sweat glands has already secretory ability at birth time. As all the perspiration of human body is caused by nervous reflex, to it the function of perspiration center should be added. Therefore, clinically speaking, especially in pediatrics an interesting problem is proposed. That is, the problem on the beginning of perspiration for newborn infants. To this question, definite answer was given (in 1939 by *Shigeru Uchino*). Nearly 100 newborn babies were examined their perspiration by putting them into high temperatured baths immediately after their births. Among them, I can recognize definitely the advent of perspiration for 28 infants. There were difference by the infants from 2—18 days' period of time after the birth. However, the half of infants perspired on the 3rd—5th days; this fact became on the whole as the standard. The diagram No. 4 (see page 3 in Japanse) shows an example of beginning of perspiration on the 5th day.

Together with this experiment, I carried out an experiment on the mental perspiration on the newborn infants' palms. I could check up much delay than the former, the startng was discerned on the 33rd—87th days, i.e. such days fell on 1—3 months time after the birth. Since mental perspiration is usually exuded on the palms and soles of feet to some extent, we can fairly judge its existence by whether those parts are wet or dry. Accordingly, as a help to the treatment it is convenient for the doctor to hold infants' hands at the time of giving medical examination.

These perspiration appearances are not only problem of perspirapiration, but also they have significant meaning as regards enabling doctors to investigate the development of nervous center. As aforementioned the appearance of perspiration is meant to be the function of perspiration center, so that the manifestation of thermal perspiration is meant to be development of hypothalamus which exists in the center and that of mental perspiration indicates likewise the display of function of cerebral cortex.

Now that perspiration is once revealed, as it intensifies by small degrees through the childhood, the perspiration is obtained promptly, and arriving at puberty perspiration function is controlled to a certain degree and finally it becomes adult type. It is inferred from the control of the excitability of perspiration center by probably the efficiency of some hormone, but its details are not yet made known clear

5. Perspiring at Armpits and the Smell

The armpits are unique parts indeed for perspiration study.

First, there are apocrine glands as stated already but also eccrine glands are in the armpits. Both exist in an intermingled state. Secondarily, these parts are the only place on which both thermal and mental perspiration make their appearance. Thirdly, the perspiration on these parts, especially mental perspiration manifests when one comes up to puberty period. Also, the sweat glands are developed at this period. Viewed from these points, I assume that there is other perspiration center for armpits. As stated in the latter part, there is hyperhidrosis localized at the armpits which could be the reason for this inference, but the localization of such perspiration center is not yet made known.

Aprocrine glands in armpits are classified roughly into two kinds. One of them is comparatively small in size. The secretory cells are in general short and their secretion is little. Another is much bigger and secretory cells are long and secrete much and also iron is contained in these cells which can never be seen in other glands. In the former perspiration there is no special offensive smell, but in the latter it has so-called axillary smell. The Japanese and Mongolian race have mainly the former. Approximately 10% of them have the latter, giving out axillary smell, and among the Caucasian and the Negroes there are much of the latter, accordingly, send for the offensive smell of the armpits more or less.

It is not not made known what substance will cause this offensive smell of armpits, but specified fatty acid has its relation with it and the high grade of fatty acid is included in this perspiration. By the studies of *Shelley, Hurley* and *Nicholas* (in 1953) made recently, and found the secretion of axillary odor of apocrine glands has no foul smell originally. If this perspiration is directly taken into capillary glass tube from the sweat gland, it keeps odorless for one hour but six hours later it gives out the smell and this increases more and more. If the perspiration is taken aseptically there is no bad smell, even it is left to be settled for two weeks. Accordingly, the disgusting smell of armpits is begun to emit soon after the bacilli on the dermal surface of axillae react on axillary odor of aporine glands, so that if the armpits can be kept without bacilli, offensive smell can be held in check. For that purpose the preparation of Hexachlorophene is used, which, they say, has adequate efficacy to the extent of some dozen hours.

We can not smell the offensive smell in children. This is due to the fact that their apocrine glands of armpits are not yet developed.

The perspiration ability of armpits develops from 3 to 4 years before the puberty, but the offensive smell comes out later than that.

6. Colored Perspiration

That there is the colored perspiration is konwn from the ancient times. The existence of black colored perspiration was reported by Royal Society in London in 1709. There are many technical terms expressing the colored perspiration in China. The example is cited that sometimes there is a case whose complexion turns black like that of Negro's. However properly speaking, it is a rare disease seen many among womankind. It appears on both symmetrical parts of the face. By the research made by Shelley and Harley (in 1954) that the coloured perspiration is due to a secretion of aporine glands which have a great many coloured granules in them. Among the coloured sweaters these glands exist in groups in the various parts of skin, secret and then colour. The kinds of colours are black, brown, blue, green and yellow. Among these, yellow, green and black emit yellow flourescence. In the old reports, rose colour was stated. The quality of pigments are still unknown, but they have closest relation with lipofuchsin, so that we assume by the degree of oxidation the colour shows a tendency to turn black.

The existence of apocrine glands of this kind do not always, not rare, many of which make groups, but very seldom show the colour. Therefore, for example, in case of many workers' coloured perspiration seen at the factory is not real perspiration, but it should be concluded that the common perspiration is coloured by some mechanism outside their bodies.

7. Non-Perspiring and Hyperhidrosis Cases

What is termed unhidrosis is a very rare affection. In this century there have been reported approximately 50 cases. They are congenital, developmental disturbance of skin, and running short of glands. Together with this, there are cases enumerated of developmental abnormality in thyroid gland, brain, nail, hair, teeth, and nasal mucous gland and medulla of suprarenal gland. But, there is a case that it is not such congenital one, and by some disease perspiration centre is affected, which caused anhidrosis of the whole body. As for the leper perspiration nerve is paralysed. So, it is the case that the stopage of perspiration observed as usual. The paralysed skin surface is extended over the most part of the body, many of which indicate similar condition to anhidrosis case.

Adiaphoretic patients in the cool season are free from the difficulty of living, but when the summer season comes round the heat stagnated in the bodies makes the bodily temperature rise, and they feel a great pain. In high summer bodily temperature records over 40° Centigrade with ease and becomes sunstroke. For its prevention, taking cold bath often is the only way to lower the bodily temperature temporarily.

As the aforestated, the sweat gland is the one which has great secretive power without an equal. It can exude perspiration as much as two

litres per hour as its maximum. For insance in daily life, the perspiration amount at walking time in summer amounts to 400 c.c., and if the labour is added to this in accordance with the degree, it comes up to 1 litre. The said perspiration amount is the quantity which can be evaporated when one stays outdoors against the wind blowing; while in the indoor living when a man wears his clothes the whole quantity can not be passed off in vapour after all.

The diagram No. 5 (see page 5 in Japanese) shows the measured result in the course of 30 minutes' perspiration concerning 5 persons who engaged in the light work in the room in a temperature of 30° Centigrade. The total perspiration amount (g) of each experiment (expressed by pillar) is written down on the top of it. Among them the evaporated perspiration corresponds to the upper blank space and the perspiration amount attached on the dermal surface is indicated in the middle of stairs and that oozed out of the body, in the lowest stair within the vertical lines. Upon evaporating, the perspiration began to show radiating effect. The perspiration which does not evaporate moistens the body to no purpose and makes the man unpleasant. There are many who feel that they perspire several times as much as others. However, on the contrary the perspiration of individual difference is rather little. The perspiration amount by the measured result on 100 healthy persons walking for 2 hours under the sunshiny summer day, is made as 1 as its minimum. The maximum becomes 1.4 and the average value is regarded as the standard, the personal difference is said to be within 20%. Man feels uneasy about such little amount of difference, -none-evaporating amount. (Diagram No. 5-see page 5 in Japanese).

Next, for hyperhidrosis there are not a few cases that call for changing men's clothes every time a great amount of perspiration streams from the whole bodies all of a sudden. Perhaps this is due to some pathological stimulation arisen in perspiration centre. Some are caused by the injury of brain. Nevertheless, the systemic hyperhidrosis is in general an uncommon disease.

To the contrary, the local hyperhidrosis is quite frequent, and the following are their 3 types.

a. Hyperhidrosis of Palms of Hands and Soles of Feet

There is a type that palms of hands and soles of feet are at all times wet in perspiration and sometimes getting into a great deal of perspiration, and to crown all when they wave their hands it flies about scattering. This is mental perspiration. In case in mental work and in perspiration, people are to be shut out from all the occupations which require technique, so that pain for the persons concerned is great. This type of perspiration occurs usually on the palms of both hands and the soles of feet simultaneously.

b. Hyperhidrosis of Armpits

Perspiration on the axillae on both sides of body is much and apart from axillary offensive smell, this has no smell. In the winter months

they do not perspire that much, but in the summer months axillae always moisten, and sometimes it increases to wet their clothing. This type of hyperhidrosis feels the least pain.

c. Facial Hyperhidrosis

This type is the hyperhidrosis which occurs most frequently. Its type is not identical. Among those, there is a case in which tear and snivel together with perspiration comes out in volume; on the face and head or halves of them; or, to some people perspiration localizes on the noses, lips and palpebrae: to some persons much perspiration is set limits to only symmetrical parts on both sides of cheeks, etc. The common point for those is the stimulation of quotation, i.e. at table it appears in case of mental excitement. The rate of perspiration is irregular.

The cause of facial hyperhidrosis is as follows. That is, the secretory nerve of all the sweat glands is the sympathetic nerve, but only for the facial glands one other cerebral secretary nerve is distributed in them. This para-sympathetic nerve comes out from brainstem and passes through between trigeminal and facial nerves. We presume that through stimulation given by glossopharyngeus the aforementioned nerve stimulates the sweat glands. The many people the function of this nervous fibre is counted little, but to some people, the said function develops to become sensitive and as the same easily causes reflex it brings about hyperhidrosis. However, hyperhidrosis of localizing nature of cheeks' parts is possibly originated by other factor; this seems to have relation with parotid gland, and it is said that hyperhidrosis occurs after the injury or operation performed on the parotid gland or its adjacent parts. In consequence, judging from the statement, at the secretory time of parotid gland, Acethylcholine produced at the end of secretory nerve exudes into lymphatic duct and reaches sweat glands in the part, — that possibly stimulates directly. If so, it is not the nerve reflex for this localized perspiration occurring during a meal, but it is due to the secretion of salivary glands.

8. Antihidrotic Treatment

a. Antihidrotic Treatment for Whole Body

To give clinical treatment for hyperhidrosis is very difficult, but the ideal treatment for systemic hyperhidrosis, to calm down the irritability of perspiration centre is desirable. However, there is no appropriate method. The use of considerable amount of salt has effect more or less, but it is impossible for the patient to use habitually. Of late, among many nerve blocking agents, I consider some can block perspiration nerve and be antihidrotic, but the appropriate one is not yet found. Last year we made antihidrotic experiments by using several kinds of agents. Among those Banthine showed due efficacy at the first medication. As for antihidrotic degree by that agent there were much differences individually, but on the whole it could reduce the perspiration amount by half temporarily providing its duration period

Very sero-positive case (quantitative test) was clinically examined and attempt was made at elucidation of as compleee and reliable history as possible. Information about previous antisyphilitic treatment, was ccollected. Only those sero-positilve mothers who did not receive any anti-syphilitic treatment with penicillin in previous deliveries were studied and had been treated with penicillin alone. Simultaneously another group of sero-negative cases with similar age, parity and term of pregnancy was separately studied. This was termed as :Identical Cases' or matching group. Both the groups were followed to the maternity wards and the outcome was studied. It has been necessary to follow this method in the assessment of value of penicillin treatment in prenatal syphilis, as expectant mothers with positive S.T.S, coul not be kept untreated and thus cfontrol group of untreated cases could not be had.

Babies of sero-positive treated mothers were examined clinically and serologically (quantitative test) at delivery. Blood of sero-positive mothers and babies was re-examined, about 8 weeeks after delivery, and both of them were clinically re-checked up. Such a procedure helped in assessing the value of penicillin treatment in mothers and its effect on the offspring. By this procedure, it was also possible to differentiate between pre-natal syphilis and 'passive reaginaemia'.

2698 cases were examined antenatally at Sassoon Hospitals, Poona as per procedure described above. 291 cases were found to be positive (10.8%). 67 cases from these were completely studied.

40 serologically positive cases were fully treated and were followed up. In this group all the mothers gave birth to live babies. Clinically the babies were healthy. Serologically the mothers and babies born seropositive at birth showed serological improvement on re-examination aftsr about twelve weeks. Sero-negative babies remained so during the observation period.

In the group of identictal cases one baby was still born, tko died within three days.

27 weakly positive mothers were not given any treatment, they also were matched with identical seronegative cases. The babies and mothers were rechcked up after a period of eight weeks. In 26 cases there was serological improvement both in mothers and in their positive offspring. The seronegative offsprings continued to remain so. In one case there was no serological improvement either in the baby or in the mother. The matched identical group of mothers gave birth to normal healthy children.

1. From the above results it can be computed that the results of penicillin treatment are aslubrious, in that there is reduction in foetal loss rate (almost as much as of normals.)

2. Weak positive serological reactivity seems to be due to high sensitivity of the test and it seems all the weak positive mothers excepting one were really normal.

Observations

Diagnosis of prenatal syphilis presents all problems of diagnosis of syphilis with the additon of pregnancy. During the course of our study, we noticed that the visible clinical lesions were prominent by their absence. This may be due to the fact that most of the cases come to these clinics only at 28 weeks of gestation or after; or may be due to the suppressive effect of pregnancy on the course of the disease (Burk-Text Book of Venereal Diseases). Thus most of the cases had to be handled as 'Latent Cases'. This naturally shifted the diagnostic emphasis from clinical signs to obstetric history and the results of S.T.S. (Quantitative), and the results of S.T.S. of the spouse. It was thought worthwhile o err on safer side by treating all cases on these criteria as T.P.I. test was not possible at this institution. Therefore it is quite likely that some of our cases may not be cases of syphilis. We could not collect the samples of bloods as frequently as desirable on account of wrong notions of the patients. Even after giving due weightage to hese points it is clear hat the results of penicillin (alone) are beneficient to successful termination of pregnancy and birth of live healthy babies. Even the results of treatment given as late as 32 to 36 weeks of gestation are very encouraging.
