

Minimum Temperature Felt as Hot (MTH)—a New Concept for Grading the Loss of Temperature Sensation in Leprosy Patients¹

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The common method of using test tubes containing hot and cold water for evaluating the sensation of temperature in an area of skin is crude, because the temperature of the water in the test tube is hardly ever recorded. Moreover, the thickness of the glass often varies from one tube to another, making a vast difference in the temperatures inside the tube and on its outer surface. To overcome these problems, one of us (JSP) has designed an instrument (¹)—a Temperature-Sensation-Testing-and-Grading device (Fig. 1)—which causes a progressive rise in the temperature of a small metallic sensor, the end plate. The temperature of this end plate is displayed simultaneously on a dial calibrated to indicate temperatures between 0°C and 50°C. The end plate is repeatedly applied on the skin area to be tested, and the temperature at which the patient can feel the end plate as hot is recorded as the minimum temperature felt as hot (MTH). We report here the MTH values in normal subjects as well as in leprosy patients.

MATERIALS AND METHODS

The study was undertaken on normal subjects and on leprosy patients having anesthetic patches.

Method of determining the MTH. For determining the MTH at an area of skin,

the device is connected with the electric supply (220 V). When the main switch is turned on, the needle on the dial indicates the temperature of the end plate. The end plate is applied to the skin area for a period of 3 sec and the patient is asked if he feels the end plate as hot. If not, the heating element is switched on. This leads to a progressive but gradual increase in the temperature of the end plate which is repeatedly applied to the skin area for periods of 3 sec each at 5-sec intervals. The minimum temperature at which the individual feels the end plate as hot is taken as the MTH at that area of skin. If the patient does not feel it as hot when the temperature of the end plate is raised to 50°C, the sensory loss is considered complete. Temperatures higher than 50°C are avoided to prevent burns in a patient having complete sensory loss.

RESULTS

Effect of environmental temperature on MTH. In five normal subjects (aged 19–36 years), the MTH was determined on the flexor surface of the forearm at three different environmental temperatures, 18°C, 29°C, and 38°C. These room temperatures were obtained with air conditioning during the hot weather. The MTH in each subject was found to increase with an increase in the environmental temperature (Fig. 2). The differences between the environmental temperatures and the MTH values were more when the environmental temperatures were lower, and these differences progressively decreased as the environmental temperatures increased.

Individual variations in MTH values. In 36 normal subjects ranging in age between 9 and 51 years, the MTH was determined on the flexor surface of the forearm on the same day when the room temperature was 34°C. The MTH ranged between 36°C and 41°C (Table 1). On another day when the

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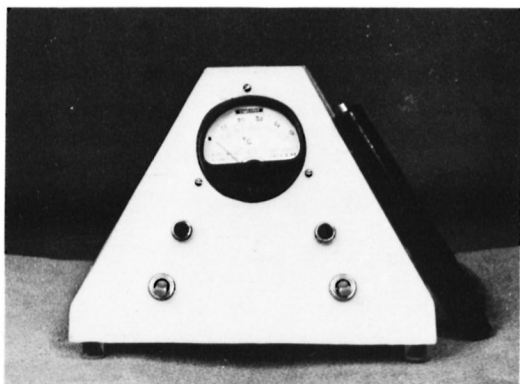


FIG. 1. Temperature-Sensation-Testing-and-Grading device.

room temperature was 32°C, the MTH determined in another 18 normal subjects ranged between 34°C and 38°C (Table 2).

MTH at various body sites. In ten normal male subjects ranging between 21 and 44 years of age, the MTH was determined at the following sites: forehead, left cheek, chest, abdomen, lower back, flexor surface of the forearm, dorsal aspect of the hand, middle of the palm, palmar surfaces of the tips of the thumb and each of the fingers, lateral surface of the thigh, anterolateral aspect of the leg, dorsal aspect of the foot, the sole, and the undersurface of each of the toes. The MTH values varied at each site. Generally, they were higher on the lower

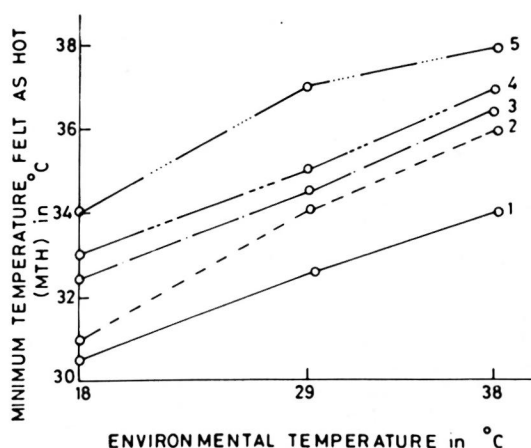


FIG. 2. Variations in the minimum temperature felt as hot (MTH) with the environmental temperature in normal subjects.

TABLE 1. Individual variations in MTH values on flexor forearm (environmental temperature 34°C).

Age range (yr)	Total no. tested	No. tested having MTH value of					
		36°C	37°C	38°C	39°C	40°C	41°C
1-10	1	1	—	—	—	—	—
11-20	13	6	4	2	1	—	—
21-30	15	5	3	4	2	—	1
31-40	3	1	1	1	—	—	—
41-50	3	1	—	—	2	—	—
51-60	1	1	—	—	—	—	—
Total	36	15	8	7	5	—	1

extremities compared to the upper extremities; they were higher on the distal parts of the extremities compared to the proximal parts; and they were lowest on the abdomen and lower back. This trend, however, was not uniform in all of the subjects. The mean values and the ranges are shown in Table 3.

MTH values on symmetrical body sites. In five normal subjects, the MTH was determined on both sides of the body at symmetrical areas. The 12 body sites included the upper arms, flexor surfaces of the forearms, dorsal aspects of the hands, middle of the palms, palmar surfaces of the thumbs and each of the fingers, lateral surfaces of the thighs, anterolateral aspects of the legs, and dorsal aspects of the feet, for a total of 60 paired measurements. In 18 instances the MTH values were identical on the two sides, while in 30 and 12 instances, the MTH values differed by only 1°C and 2°C, respectively.

MTH values in leprosy patients. In 54 tuberculoid and borderline tuberculoid leprosy patients (39 males and 15 females rang-

TABLE 2. Individual variations in MTH values on flexor forearm (environmental temperature 32°C).

Age range (yr)	Total no. tested	No. tested having MTH value of				
		34°C	35°C	36°C	37°C	38°C
11-20	3	—	1	2	—	—
21-30	8	2	3	—	2	1
31-40	4	1	2	1	—	—
41-50	3	—	1	—	1	1
Total	18	3	7	3	3	2

TABLE 3. Regional variations in the MTH values ($N = 10$).

Body site	Mean MTH (range) in °C
Forehead	37.8 (36-40)
Cheek	39.1 (38-42)
Chest	40.5 (38-42)
Flexor forearm	37.8 (36-40)
Dorsum of hand	38.5 (36-41)
Palm	38.9 (35-41)
Thumb	43.1 (37-50)
Index finger	39.2 (35-43)
Middle finger	38.2 (35-41)
Ring finger	38.3 (35-41)
Little finger	37.3 (34-40)
Abdomen	37.4 (35-39)
Back	37.6 (35-41)
Thigh	39.3 (36-44)
Leg	40.4 (35-44)
Dorsum of foot	41.1 (39-44)
Sole	43.0 ^a (40-46)
Great toe	43.4 ^a (40-49)
Second toe	43.0 ^a (40-48)
Third toe	43.0 ^a (40-48)
Fourth toe	42.8 ^a (40-48)
Fifth toe	42.4 ^a (40-47)

^a The figures indicate calculations from 5 cases; in the other 5, the MTH was more than 50°C.

ing in age between 12 and 80 years), the MTH was determined first at an unaffected skin area, either on the adjoining skin or on the corresponding site on the opposite side of the body, and then on the affected skin area. The differences between the MTH values at the affected skin areas and the corresponding unaffected skin areas are shown in Table 4.

Effect of environmental temperature on MTH in leprosy patients. In five leprosy patients, the MTH was determined on the affected and the corresponding unaffected skin areas at three different environmental

TABLE 4. Degree of temperature sensation impairment in leprosy lesions.

MTH difference between affected and unaffected skin areas	No. patients
Nil	7
1-5°C	6
6-10°C	13
11-15°C	8
Complete loss ^a	20
Total	54

^a MTH > 50°C in affected area.

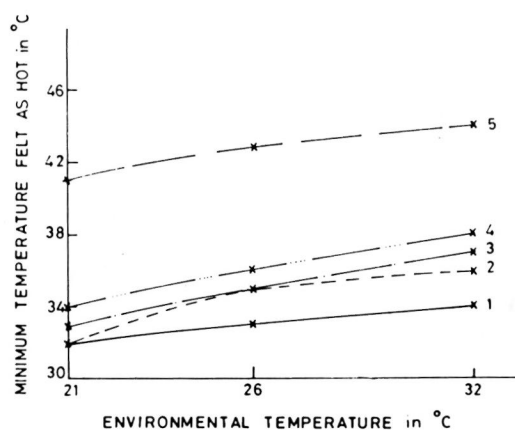


FIG. 3. Variations in the minimum temperature felt as hot (MTH) with the environmental temperature in leprosy patients at unaffected skin areas.

temperatures: 21°C, 26°C, and 32°C obtained by air conditioning. The results were similar to those observed in the normal subjects. In each case, the MTH increased along with the increase in the environmental temperature (Figs. 3 and 4).

DISCUSSION

The MTH value was found to be an arbitrary figure. This value differed from one body site to another; even at the same body site it had different values in different in-

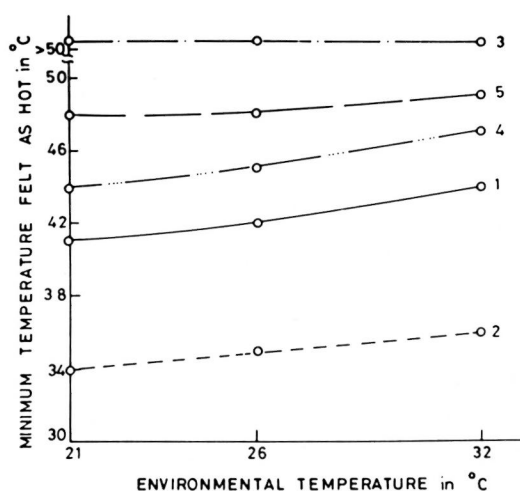


FIG. 4. Variations in the minimum temperature felt as hot (MTH) with the environmental temperature in leprosy patients at affected skin areas.

dividuals, and in the same individual its value changed with changes in the environmental temperature. We did not find any relationship with the age or sex of the subjects. At the same site in the same individual, this value was essentially constant and reproducible when the room temperature remained the same. This was confirmed by determining the MTH in 20 individuals, including two leprosy patients, and repeating the test on the same sites after an interval of approximately 1 hour. The MTH values in 5 individuals were exactly the same; in 12 individuals, the two values differed by 1°C and in 3 cases by 2°C. In another ten individuals, the MTH was determined by two different investigators on the same body site on the same day; there was no difference between the values obtained by the two investigators. This confirms that although MTH value is not fixed at a site in any individual, within the limits described above it is a reproducible and reliable value.

In a leprosy patient, comparison of the MTH value at the affected area with that at the corresponding unaffected area determined at the same time would eliminate the effect of the environmental temperature as well as the variations due to body sites. In cases where the contralateral body site is also involved, the MTH at the adjoining unaffected body site can be determined for comparison. The difference between the two values provides an accurate idea of the degree of impairment of the temperature sensation. This value can then be compared with values obtained later to evaluate whether or not the patient is improving.

SUMMARY

In order to grade the loss of the temperature sensation in the skin of leprosy patients, a newly designed instrument called the Temperature-Sensation-Testing-and-Grading device has been employed to determine the minimum temperature felt as hot (MTH) at the skin area. The MTH in normal subjects was observed to vary from one region of the body to another; it was generally higher on the distal parts of the extremities compared to the proximal parts; and it was also higher on the lower extremities compared to the upper ones. The abdomen and the back generally had the lowest values. There were no variations

according to age (11–80 years) or sex and no differences on symmetrical sites of the body. The MTH value, however, showed a dependence on the environmental temperature, the values being lower at low environmental temperatures and higher at high environmental temperatures. But at the same site and the same environmental temperature, the MTH value was found to be almost constant. Different individuals had different MTH values at the same body site and even at the same environmental temperature. The unaffected skin of leprosy patients showed values comparable to the controls. At the leprosy lesions, however, the degree of sensory loss could easily be determined in comparison with the MTH at the contralateral/adjoining unaffected skin. Out of 54 leprosy patients, 7 patients had no sensory loss; in 27 patients the loss varied between 1°C and 20°C; while in 20 patients the loss was complete—they could not perceive even 50°C as hot. It is concluded that the MTH value can act as a good guide for grading the loss of temperature sensation.

RESUMEN

Se empleó un instrumento recién diseñado y llamado "aparato para la prueba y graduación de la sensación a la temperatura" para determinar la mínima temperatura que da la sensación de calor (MTC) en la piel de pacientes con lepra. Se encontró que la MTC en personas sanas varía de una región corporal a otra; generalmente fue más elevada en las partes distales de las extremidades que en las partes proximales; y también fue más elevada en las bajas extremidades que en las partes superiores de las mismas. El abdomen y la espalda generalmente dieron los valores más bajos. No hubieron variaciones relacionadas con edad (11–80 años) o sexo, y tampoco hubieron diferencias en sitios simétricos del cuerpo. El valor de la MTC, sin embargo, fue dependiente de la temperatura ambiental, siendo los valores más bajos a bajas temperaturas ambientales y más altos a temperaturas ambientales elevadas. Dentro del mismo sitio y a las mismas temperaturas ambientales, los valores de la MTC fueron casi constantes. Diferentes individuos tuvieron diferentes valores de MTC en el mismo sitio corporal y a la misma temperatura ambiental. La piel no afectada de los pacientes con lepra tuvo valores comparables a la de los controles. Sin embargo, en las lesiones leprosas, el grado de pérdida sensorial pudo determinarse fácilmente comparando con la MTC del lado contralateral de la piel no afectada. De los 54 pacientes con lepra, 7 no tuvieron pérdida sensorial; en 27 la pérdida varió entre 1°C y 20°C, mientras que en 20 la pérdida fue completa ya que los pacientes no pudieron percibir como calor

temperaturas aún de 50°C. Se concluye que el valor de la MTC puede servir como una buena guía para cuantificar la pérdida de la sensación al calor.

RÉSUMÉ

On a utilisé un nouvel instrument, dénommé Temperature-Sensation-Testing-and-Grading device, pour déterminer la température minimale encore perçue comme chaude (MTH) au niveau de la peau, et ceci afin d'évaluer quantitativement la thermoanesthésie cutanée chez des malades de la lèpre. Chez des individus normaux, on a constaté que la MTH variait d'une région du corps à l'autre. Elle était généralement plus élevée dans les parties distales des extrémités que dans les parties proximales; et elle était aussi la plus élevée dans les extrémités le plus basses en la comparant avec les parties supérieures. Les valeurs les plus faibles ont le plus souvent été rencontrées au niveau de l'abdomen et du dos. On n'a pas constaté de variations en rapport avec l'âge (11-80 ans), le sexe, ou les deux parties symétriques du corps. La valeur de MTH était cependant en rapport avec la température ambiante; les valeurs les plus faibles ont été enregistrées lors de températures ambiantes faibles, et les plus hautes lorsque la température ambiante était la plus élevée. Néanmoins, pour un endroit donné, à même température ambiante, la valeur du MTH était presque constante. Plusieurs in-

dividus ont cependant des valeurs de MTH différentes aux mêmes endroits du corps, et même lorsque la température ambiante est identique. Chez des malades de la lèpre, les régions de la surface cutanée indemnes de lésions présentaient des valeurs comparables à celles observées chez les témoins. Au niveau des lésions de lèpre, l'amplitude de la perte de sensibilité pouvait cependant être aisément déterminée, en la comparant avec le MTH enregistré soit dans une région cutanée mais sans lésion, soit au même endroit mais du côté opposé. Parmi 54 malades de la lèpre, 7 ne présentaient aucune perte de sensibilité; et chez 27 la perte de sensibilité variait entre 1°C et 20°C. Vingt malades, la perte de sensibilité était complète: ils ne percevaient aucune sensation de chaleur, même à 50°C. On en conclut que la valeur du MTH peut être utile pour évaluer de manière quantitative la perte de sensation à la chaleur.

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