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Patterns of Sensory Loss in Lepromatous Leprosy[1, 2]

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Sensory loss plays a key role in the development of the digital absorption and trophic ulceration which characterize leprosy. When host resistance is high as in tuberculoid and some dimorphous cases, the sensory loss tends to be roughly coextensive with skin lesions, whereas all types of leprosy may develop typical nerve trunk sensory deficits. In lepromatous leprosy the pattern of sensory loss has been less precisely defined as "stocking-glove" ([2, 5, 10]) in distribution. This pattern, strictly interpreted, is seen only in hysteria ([7]), but the expression is often used to describe the familiar pattern of symmetric distal sensory loss with gradual increase in acuity to normal as one moves proximally. This pattern, seen in a variety of toxic, metabolic, nutritional, and hereditary neuropathies, is likely related to an increasing vulnerability of the nerve fibers as the distance from their cell bodies increases. Absent deep tendon reflexes are commonly associated with these neuropathies. Patients with lepromatous leprosy do not show this type of purely distal symmetric sensory loss and absent reflexes are exceptional. Nor do the patterns of sensory deficits conform perfectly to the distribution of subcutaneous nerves, nerve trunks or nerve roots. This paper attempts to correlate the configuration of sensory loss in lepromatous leprosy with the relatively cool surface areas of the body.

MATERIALS AND METHODS

The Barnes Medical Thermograph (Model M-1 A)[4] was used to make photographs of the infrared radiation emitted from various areas of the skin of normal subjects and of lepromatous patients. Leprosy patients may show alterations in skin temperature due to destruction of autonomic nerve fibers. Figure 1 shows the thermal gray scale; each square, moving from dark to light, representing a carefully calibrated fixed temperature source with increments of one degree over the range of 29.0°–38.0°C. The number of shades of gray between total saturation (white areas) and no saturation (black areas) is the temperature delta ($\triangle$T) and is indicated with each thermograph. Though the ambient temperature was maintained at 72-74°F, no effort was made to control emotional state, level of prior physical activity, time of most recent meal, etc., because our goal was not to establish normal values for skin temperature, but to observe any constant features in the temperature patterns. Sensory examinations were carried out for pinprick by the usual clinical methods. Patients were cautioned to make the distinction between pressure and a painful pricking sensation. Twenty-five cases with histologically established lepromatous leprosy were examined.

RESULTS

The results are best appreciated by comparing the sensory and thermal patterns in the accompanying representative illustrations. A few general points might be emphasized on a regional basis.

The extremities. The earliest deficits of sensation occur in both upper and lower extremities. In the lower extremities, the dorsum of the feet and lateral aspects of the legs are first involved while in the upper extremities sensory loss occurs earliest over the dorsal aspects of the hands and forearms (Figs. 2, 13). Skin surface temper-

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[4] Barnes Engineering Co., Stamford, Connecticut. Company name and model are mentioned for the purpose of identification and do not imply endorsement by the USPHS.

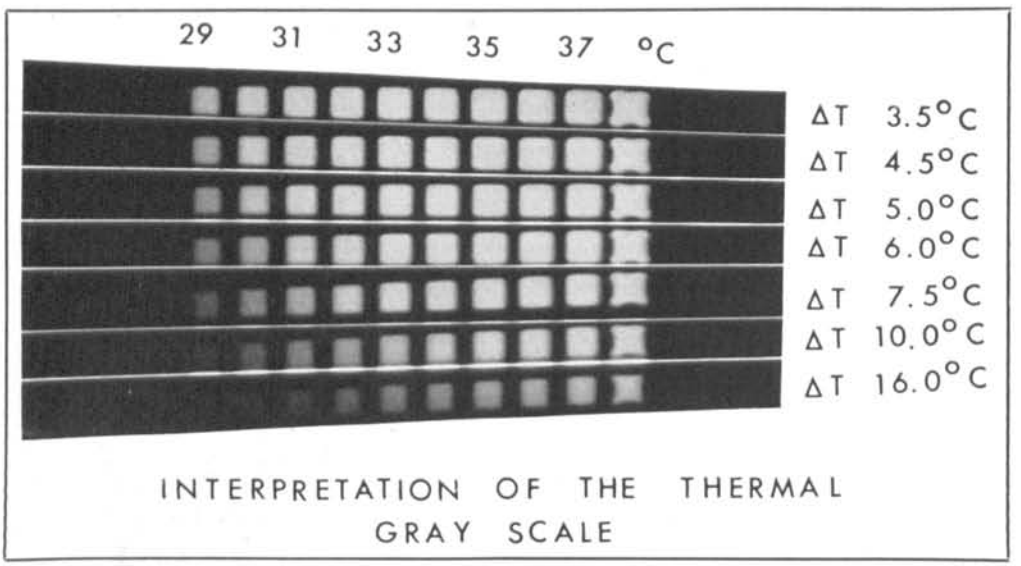

FIG. 1. Interpretation of the Thermal Gray Scale.

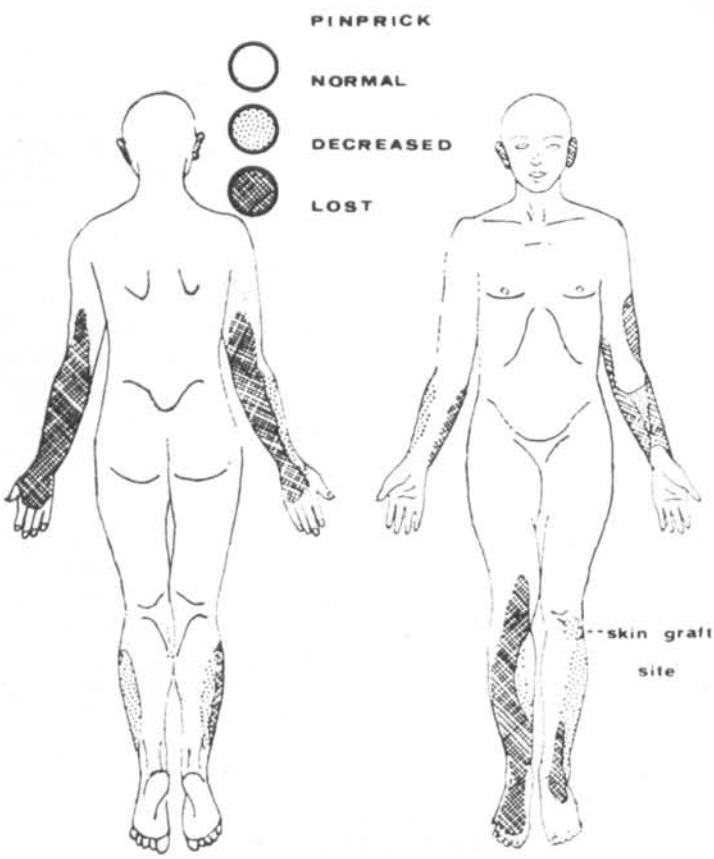

FIG. 2. Early sensory loss in lepromatous leprosy.

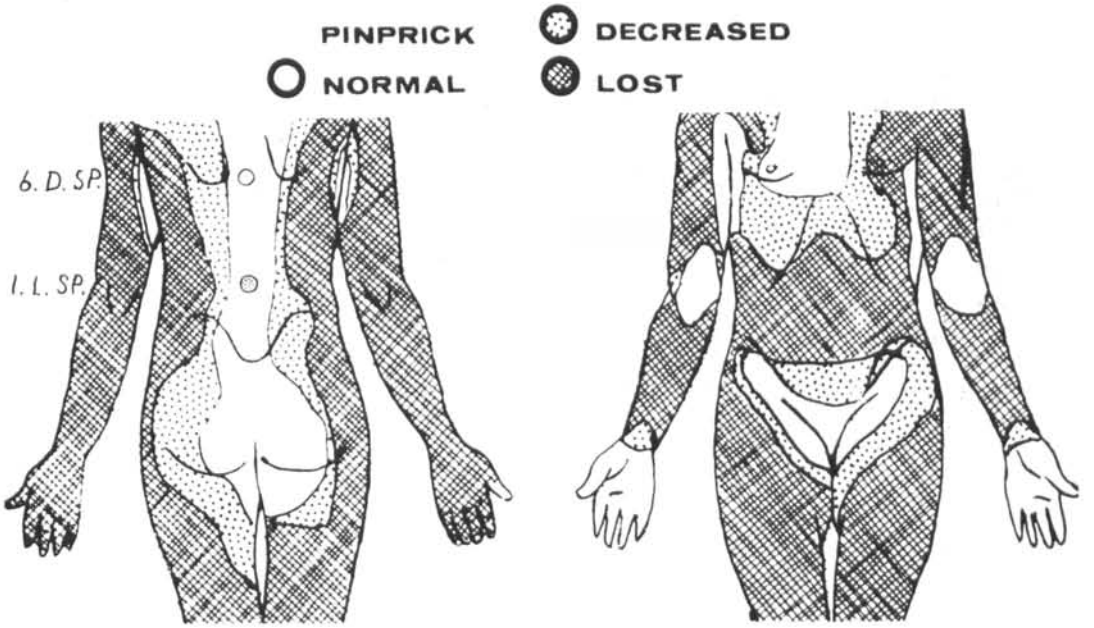

FIG. 3. Areas of sensory sparing in more advanced lepromatous leprosy.

atures on these distal segments are known to be cooler than elsewhere on the body ([1]). Dramatic sparing of the palms, soles, antecubital and popliteal fossae in the presence of profound sensory loss is a frequent observation (Fig. 13). Figures 4 and 5 show that the pattern of sensory sparing approximates the relatively warmer skin surfaces. Figure 8 shows the popliteal fossae thermographically. This pattern in the upper extremity is the subject of another communication ([11]) where the cooler skin temperatures showed a definite correlation with elevated pain threshold as measured by the Hardy-Wolff-Goodell Dolorimeter. An additional factor increasing the temperature of the bacillary milieu in the palms and soles may be the insulating effect of the thickened stratum corneum.

The trunk. When the back shows sensory loss there is a frequent stripe of preserved sensation down the center of the back which is a consistently warmer area thermographically (Figs. 3, 6, 9). Other such areas of sparing on the trunk are the intergluteal fold, the inguinal creases, and the axillae (Figs. 3, 7, 8, 9). Hair appears dark on the thermograph because it is not an infrared emitter; the skin beneath hair tends to be warmer than surrounding skin ([3]).

Head. The ears, nose, malar areas and lateral brows are involved early when there is loss of sensation over the face. Thermographically, these same areas are relatively cool, and indeed these thermographs of the face are shadowy caricatures of the classical leonine facies (Fig. 11.). When facial sensation is diffusely lost, normal sensation appears abruptly at the hairline. One patient has nasolabial folds so deep that the skin surfaces approximated one another and only within this crevice was facial sensation acute (Fig. 12).

Three patients showed patches of dense analgesia not consistent with the overall pattern (Fig. 13). In each case the patient insisted that the patch long antedated (10-30 years) the appearance of their leprosy symptoms. Possibly, the leprosy was remotely dimorphous and over the years somehow became transformed into a lepromatous type. The history of the disease may be written in the sensory examinations of the patient.

DISCUSSION

The observations on the significance of temperature as a determinant of the distribution of the lesions in lepromatous leprosy are longstanding. In 1916, Dyer and

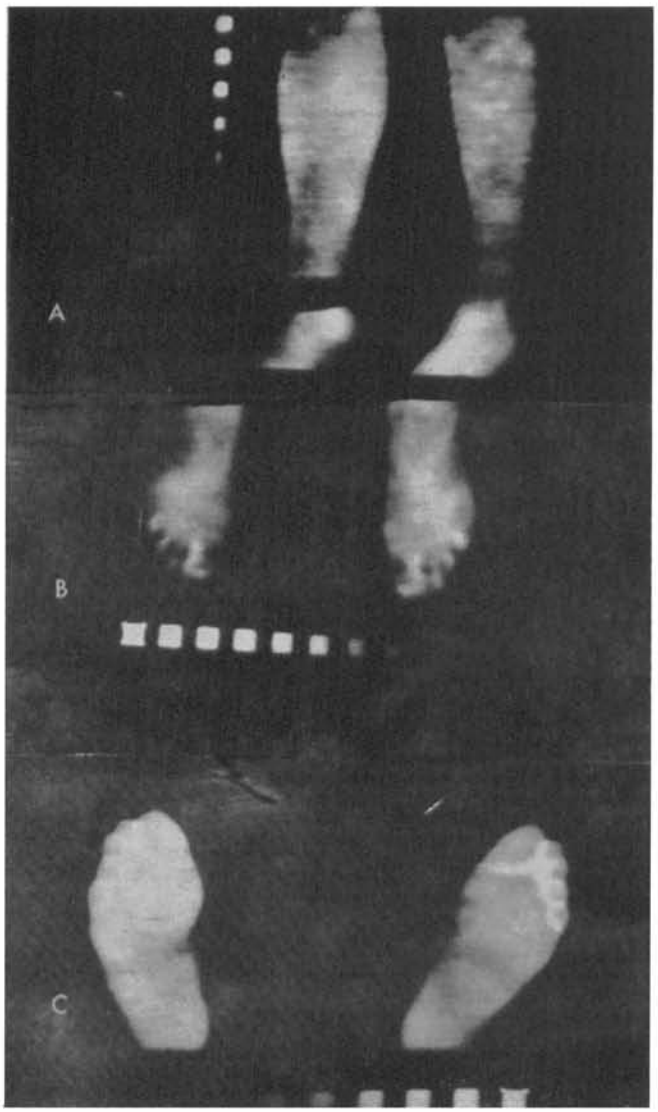

FIG. 4. **A.** The medial aspect of the leg (left) is slightly warmer than the lateral aspect (right) (△ T=3.5). **B.** The dorsal surfaces of the feet are cooler than **C.** plantar surfaces (△ T=7°C).

Hopkins [8] in testimony before the United States Senate concerning the establishment of a national leprosarium speculated that the location of leprosy lesions and the death of bacilli with fevers indicated that elevated temperature impedes the growth of *M. leprae*. In 1956, Binford [4] suggested that the apparent propensity of *M. leprae* to grow at relatively cool temperatures should be considered in attempts to grow the bacilli in animals. Brand [6] in 1959, re-emphasized the fact that the skin, anterior third of eyes, nerves, testes, and upper respiratory mucous membranes were the major sites of destruction in lepromatous leprosy and these sites were likely some degrees below core body temperature. The clearly segmental involvement of nerves at sites where they are most superficial was lucidly underscored.

Recently, Hastings *et al.* [9] demonstrated that the stripe down the center of the back averaged 1.3°C warmer than areas 10 cm. lateral to it, and that biopsies from these areas showed statistically significant fewer bacilli in the midline warm area. Shepard [12, 13] found that the most active proliferation of *M. leprae* occurred when the temperature in the mouse foot pad was lowered to a range of 27-30°C.

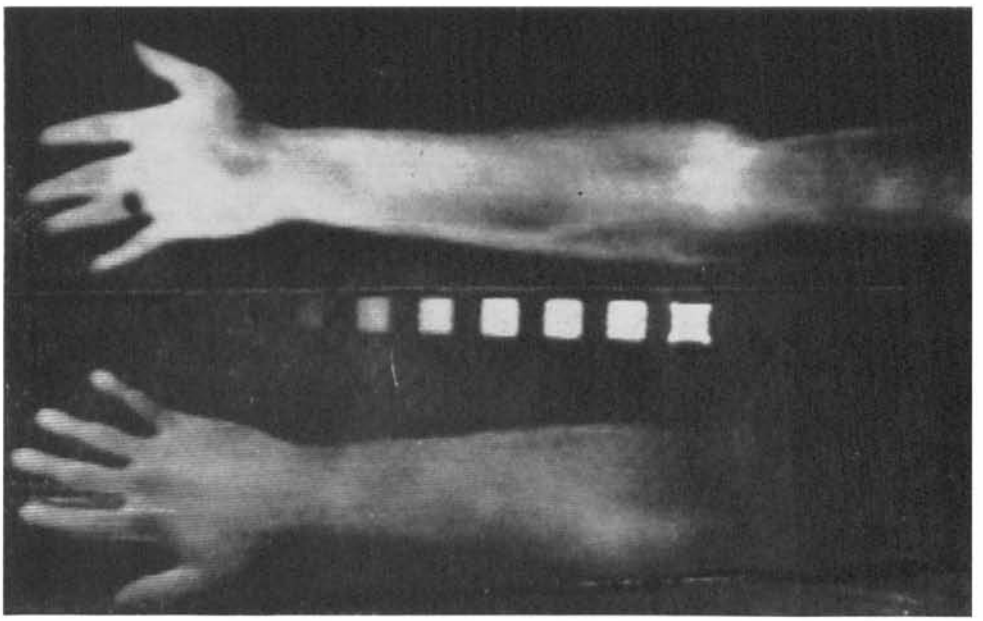

FIG. 5. The palm and antecubital fossa (upper) are warmer than surrounding and dorsal (lower) skin surfaces ($\triangle$ T= .7°C).

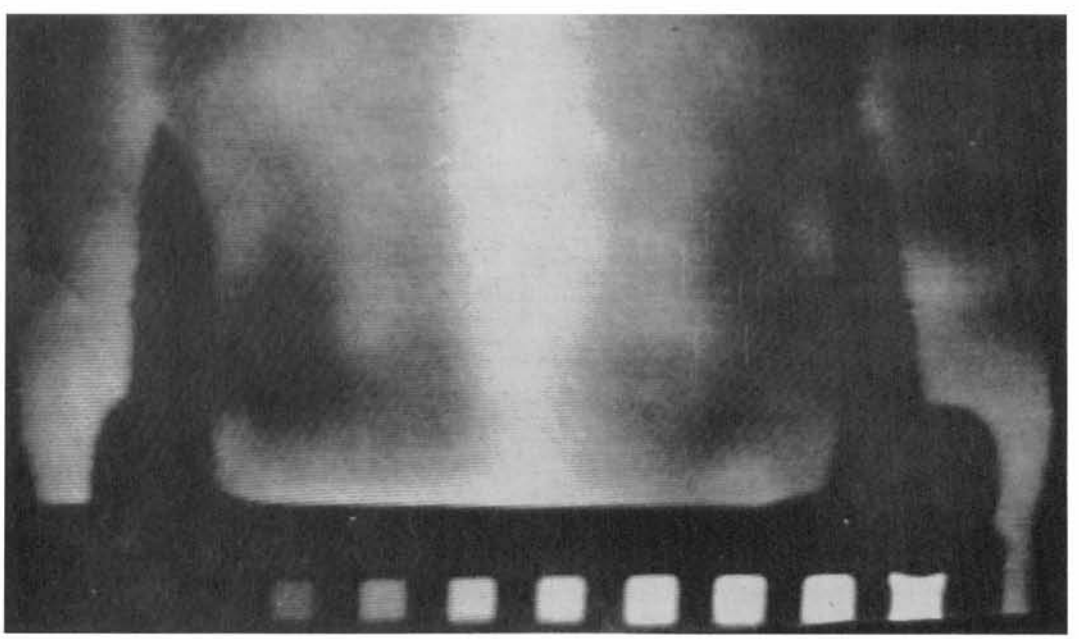

FIG. 6. A thermograph of the lumbar back showing the stripe of relatively warm skin down the center ($\triangle$ T=7°C).

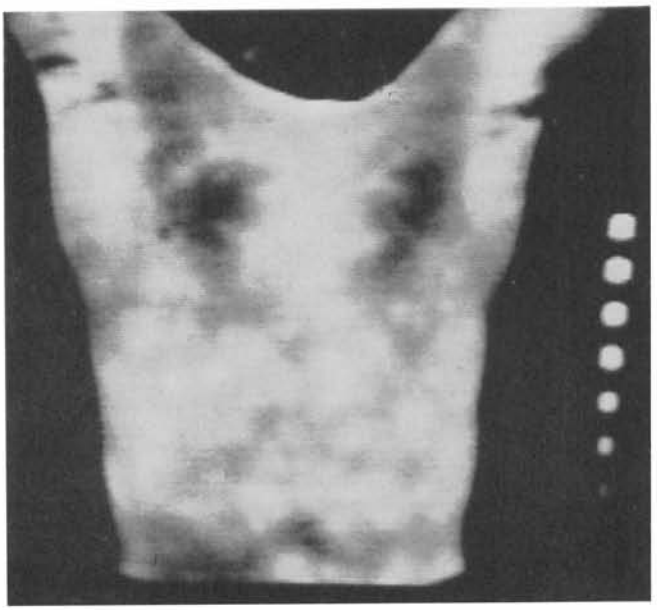

FIG. 7. Thermograph of anterior trunk with arms abducted to show warmth of axillae (△ T=5°C).

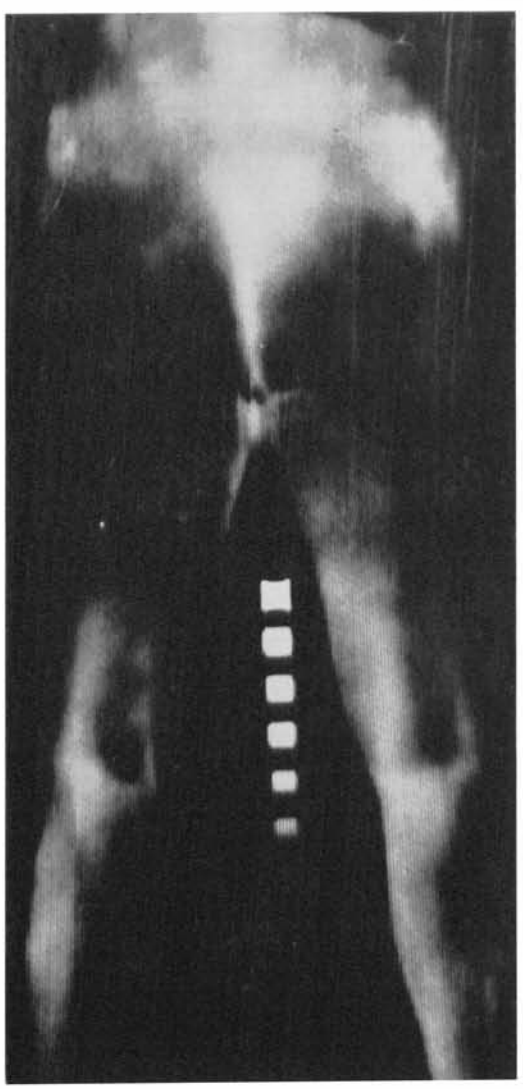

FIG. 8. Thermograph of the buttocks and legs demonstrating the relative warmth of the low mid back, intergluteal fold and popliteal fossae (△ T=5°C).

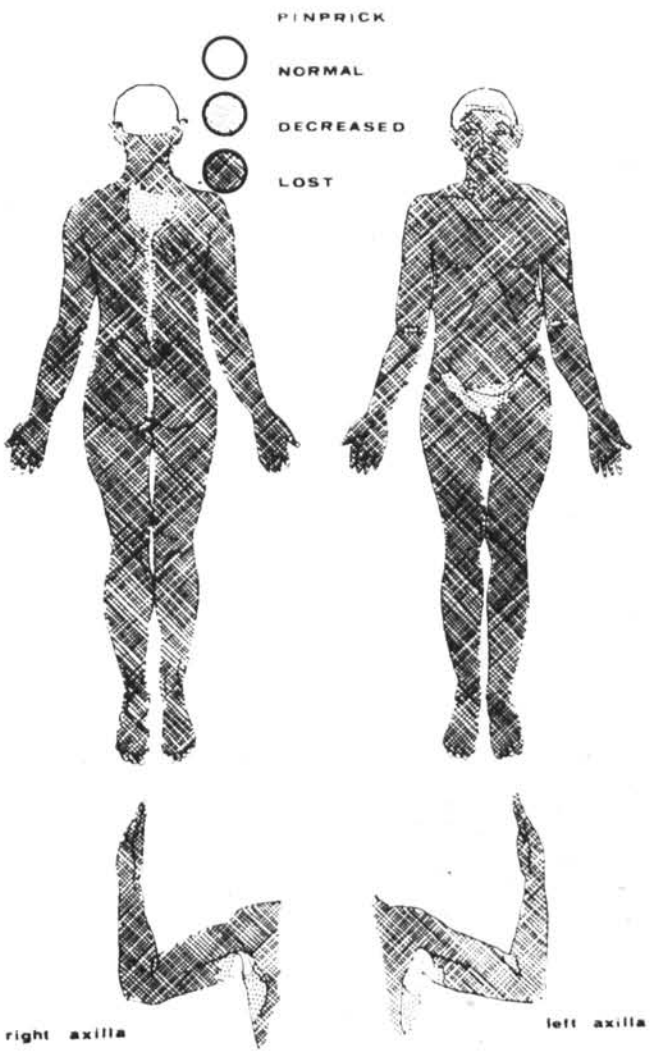

FIG. 9. Extensive sensory loss with small islands of sparing in relatively warm skin surfaces.

Such evidence indicates that the growth rate of *M. leprae* is exquisitely sensitive to the temperature of its milieu in a situation of low host resistance. The sensory patterns depicted here suggest that the basic pattern of sensory loss in lepromatous leprosy is determined by relative skin temperature and apparently follows the bacterial density in the skin. This pattern of sensory loss tends to involve the cooler skin surfaces earliest and then progresses on the basis of relative skin temperature. The scalp (when covered by hair), the axillae, the intergluteal fold and the inguinal areas are all warm areas that tend to show normal sensation even in far advanced cases. This basic pattern may be modified by areas of anesthesia due to pre-existing dimorphous leprosy, or the superimposition of a typical nerve trunk deficit.

SUMMARY

Thermographs depicting skin temperature patterns of normal subjects are compared with the configuration of sensory loss to pinprick in a series of patients with

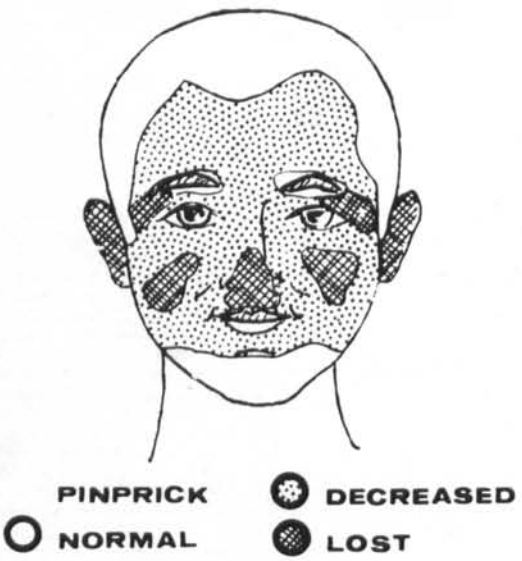

FIG. 10. Sensory loss on the face.

lepromatous leprosy. Sensory loss appears to begin in the cooler skin surfaces and progresses on the basis of relative skin temperature. This pattern is modified by the presence of a pre-existing patch of sensory loss due to dimorphous leprosy or the superimposition of sensory loss typical of a nerve trunk lesion. Evidence that the proliferation of *M. leprae* is favored by an environmental temperature several degrees below core body temperature is briefly reviewed.

FIG. 11. Thermograph of face ($\triangle$ T=7°C).

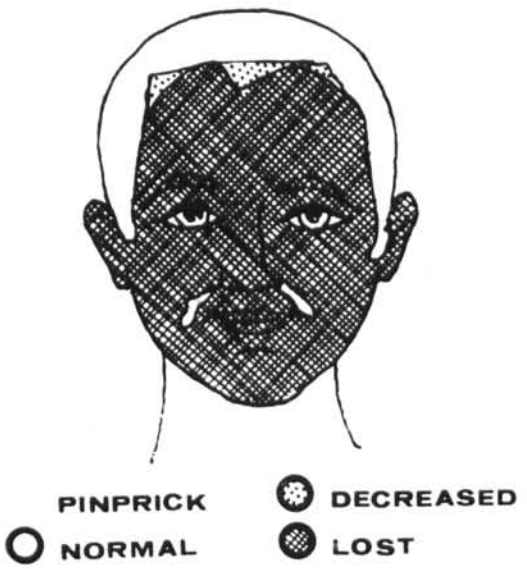

FIG. 12. Extensive sensory loss on face with sparing under scalp hair and in the deep naso-labial folds.

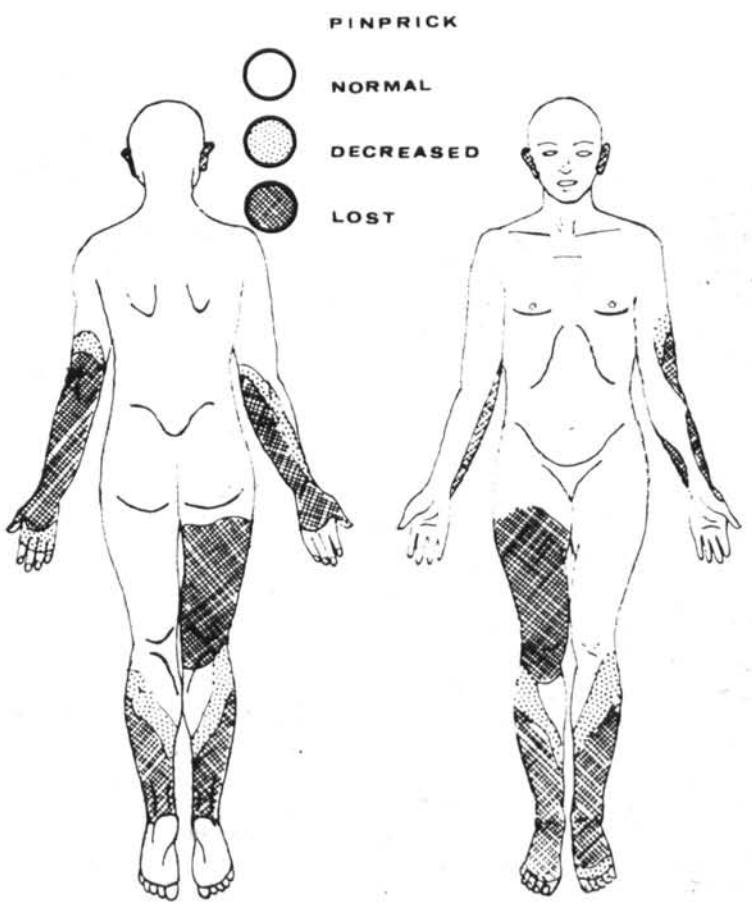

FIG. 13. The patch of sensory loss on the left thigh antedated the symptoms of lepromatous leprosy by 22 years.

RESUMEN

Termógrafos dibujando modelos de la temperatura de la piel en pérsonas normales se comparan con la configuración de la perdida al alfilerazo en una serie de pacientes leprosos lepromatosos. Pérdida sensoria aparece comenzar en las superficies mas frescas de la piel, y progresa en la base de la temperatura relativa de la piel. Este modelo se modifica por la presencia de una mancha pre-existente de pérdida sensoria debida a lepra dimorfa o la superimposición de pérdida sensoria típica de una lesión del tronco nervioso. Evidencia indicando que la proliferación de *M. leprae* se favorece por una temperatura ambiente unos grados bajo la temperatura básica del cuerpo se revisa brevemente.

RÉSUMÉ

On a comparé des thermographes fournissant les profils de la température cutanée chez des sujets normaux, avec la configuration de la perte de la sensibilité à la piqûre dans une série de malades atteints de lèpre lépromateuse. Il apparaît que la perte de la sensibilitè débute dans les surfaces cutanées les plus froides, et progresse selon la température relative de la peau. Ce profil est modifié par la présence de zones pré-existantes de perte de la sensibilité, dûe à la lépre dimorphe, ou à la sur-impression d'une perte de sensibilité typique d'une lésion des troncs nerveux. On passe brièvement en revue les données qui révèlent que la prolifération de *M. leprae* est favorisée par une température du milieu de plusieurs degrès inférieure à la temperature interne du corps.

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