NEW APPLIANCES

Skin Temperature Measurement by Radiometry

Mr. E. F. J. RING and Dr. J. A. COSH, Royal National Hospital for Rheumatic Diseases, Bath, write: In certain situations it is an advantage to be able to measure skin temperature without direct contact with the skin area under study. The principle of measurement of infrared radiation has long been put to use in industry (for example, in recording furnace temperatures) and in astronomy (in measuring temperatures of far-distant objects), but has been relatively little used in clinical medicine.

The human skin is a highly efficient radiator of infrared energy, irrespective of pigmentation and colour, and its qualities approach that of the ideal black body radiator. Consequently the energy emitted bears a simple relation to the skin temperature, so that measurement of infrared radiation from the skin can be used as a reliable basis for measurement of its temperature. The range of wavelength emitted is from 2μ to 3 cm., with peak activity at 9–10μ.

The first study of infrared radiation from the skin was made by Hardy (1934), who used a bismuth–tin junction as his detector. Military needs in the second world war stimulated the development of infrared detectors. Some of these, such as the indium-antimonide cell, were so sensitive and rapid in response that they have been used in scanning systems to build up a pictorial display which is the principle of thermography (Lloyd Williams *et al.*, 1963). Clinical uses of thermography include the study of breast cancer, of tissue damage in burns, and of vascular disorders in the skin and the periphery (Gershon-Cohen and Bowling Barnes 1964 ; Cade, 1966). However, scanning systems are elaborate and costly, and it is possible to obtain clinically useful information with simpler instruments, such as the one described. This has proved to be remarkably stable and sensitive over a period of three years.

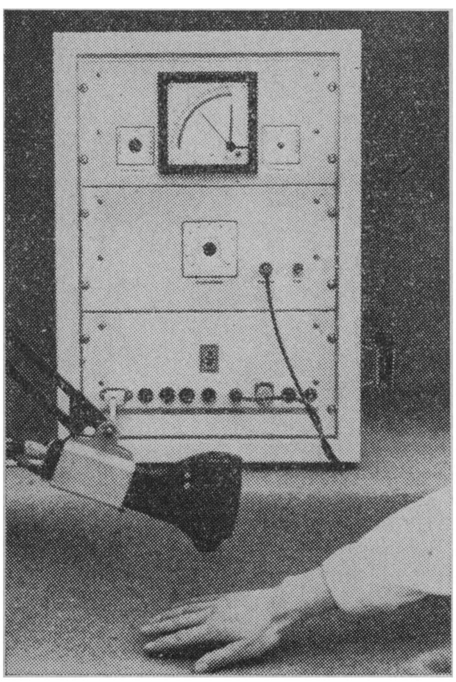

FIG. 1.—Radiometer in use. Skin temperature is indicated by dial reading or, if necessary, by a recorder.

The radiometer comprises a detector weighing 2 1 lb. (900 g.), which can be held in the hand in a pistol-type grip or fixed in an adjustable bracket. Its signal is amplified and displayed as a dial reading in a metal cabinet, and its power supply is through the mains (Fig. 1). An alternative display can be through a direct-writing recorder.

The sensitive element of the radiometer consists of two bismuth electrodes mounted in vacuo and forming two resistances in a Wheatstone bridge. Incoming radiation passes through a quartz window on to one bismuth electrode and is interrupted by a rotating chopper disc at a frequency of 12.5 per second. The disc itself is maintained at a temperature of 41° C. and acts as an internal reference standard. The upper limit of temperature response range is thus set at 41° C., but alteration of the degree of amplification changes the lower limit of the range. Convenient scales for clinical measurement are 11–41° and 26–41° C., which give a simple relation with the scale on the dial, which has a range of 0–150 units. The angle of incidence of incoming radiation is 6 degrees, so that at a distance of 10 cm. the radiometer is receiving from a skin area of 1 cm. in diameter, and at a distance of 30 cm. the area under study is 3 cm. in diameter. Its spectral sensitivity is in the wavelength range 0–25μ. The warming-up time for the circuit is 30 minutes, and the response time in individual readings is about three seconds.

Calibration has been made against a stable electrically heated black body, and reveals a satisfactory straight line relation (Fig. 2). Recalibration over a period of three years has shown a maximum drift of 0.3 degrees, and this followed an episode of relatively rough handling.

Clinical applications of the radiometer are listed below.

Skin Hyperaemia.—The skin temperature gives a good indication of the degree of hyperaemia resulting from an intradermal test injection—for example, of histamine or tuberculin (Vaubel *et al.*, 1965). Moreover, this measurement, being uninfluenced by skin pigmentation or colour, has obvious advantages over the measurement of weal or flare in quantitation of skin reactions to allergens in coloured patients (Kaufman and Sulzberger, 1967). The rate of spontaneous rewarming of grafted skin after a standardized period of cooling has also been measured as an index of graft acceptance (Vaubel and Dore, 1967).

Eye.—Studies of corneal temperature are being made by a radiometer in patients with uveitis (Mapstone, 1968). Corneal temperature measurement can also be used as an index of blood flow to the eye in patients with unilateral carotid arterial lesions. The freedom from direct contact with the cornea, which makes local anaesthesia and sterile precautions unnecessary, is an obvious advantage.

Rheumatoid Arthritis.—The internal temperature of the knee is known to be raised in active rheumatoid arthritis, and a comparable rise in skin temperature over the patella has been reported (Horvath and Hollander, 1949). A study by thermography of the heat patterns over the knee in rheumatoid arthritis suggests that there are probably advantages in measuring the temperature of an area of skin rather than a single point in the assessment of inflammation in the underlying knee. Moreover, the difference between normal and inflamed knees may be accentuated by the application of an ice-pack under standard conditions and after the natural rewarming process with a radiometer (Cosh, 1966 ; Cosh and Ring, 1967). Serial studies of this nature may be made as a basis for the assessment of anti-inflammatory drug therapy.

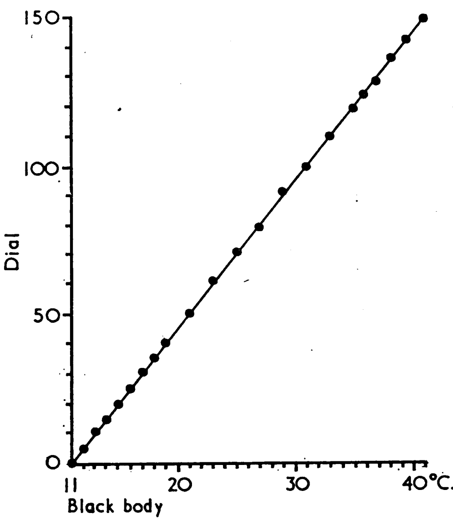

FIG. 2.—Calibration curve relating dial reading with temperature of an electrically heated standard black body.

In all of these studies it has proved to be an advantage to measure the temperature of an area of skin rather than a point, and to do so without direct contact.

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