

# Thermography and Cancer of the Breast

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In essence, a thermogram is a pictorial representation of the infrared radiations of the skin. The method depends upon the Stefan-Boltzman law, which states that the quantity of infrared emitted by a surface varies directly with the 4th power of its absolute temperature and the emissivity of the surface. In 1956, R. N. Lawson<sup>4</sup> noted that the temperature of the skin in the vicinity of palpable mammary cancers was generally higher than in the corresponding area of the opposite breast. Although the measurements were made with a contact thermometer, Lawson speculated upon the diagnostic potentialities of a heat-sensing imaging device and in 1958 published the first examples of thermograms of the breast. Subsequent studies by Lloyd-Williams et al.,<sup>7</sup> Gershon-Cohen et al.,<sup>3</sup> Swearingen<sup>9</sup> and Connell et al.<sup>1</sup> have confirmed Lawson's original observations and further demonstrated the thermogram's clinical potential.

Our experience with clinical thermography began in June 1964, following the acquisition of a Pyroscan R<sup>0</sup> thermographic unit by the Department of Radiology of the Jefferson Medical College Hospital. Subsequently, in May 1967, a second unit was installed in the Department of Diagnostic Radiology of the University of Texas M. D. Anderson Hospital and Tumor Institute. The performance characteristics of both units have been standardized, and identical reporting formats and interpretive criteria are used by both institutions. To date, 4,726 examinations have been performed in an attempt to evaluate the potential of thermography as a cancer detection and mass screening technique.

## Equipment and Technique

The Pyroscan is a solid-state unit which employs a liquid-nitrogen-cooled indium antimonide detector. A scan from neck to waist may be produced in about 30 seconds with a minimum differential temperature sensitivity on the order of 0.2°C. The image, a montage of about 37,000 bits of information, is produced on electrosensitive paper by a facsimile recorder and may be viewed as the patient is scanned. The thermal scans are made after reasonable stabilization of the patient's skin temperature has been obtained by 10-minute exposure in a room maintained at an ambient temperature of 68°-70°. The patient is usually seated, although the supine position may be used. Scans are made first in the anteroposterior position, at which time the thermograph is calibrated to the temperature range of the patient. Then additional scans are made in both oblique projections. Although originally a temperature reference scale was incorporated in each scan, this practice was abandoned after continuous telemetric monitoring of breast temperatures (100 to 500 hours) indicated that absolute temperature differences were of no significance in the differential diagnosis of benign and malignant processes (Figure 1). Our experience has shown that a fixed 6°C black-to-white range is sufficient to encompass the temperature variations in the majority of patients. However, we have found it important to avoid fixed sensitivity settings because information apparent at either end of the 6° window may be obscured. For this reason, 3 scans are made in each projection at 2° increments across the thermal window. This is feasible because of the short scanning time and provides the composite information necessary for thermal pattern analysis.

We have chosen an image presentation which differs from those employed by other investigators. It has been the practice, beginning with the earliest thermograms made by Lawson,<sup>5</sup> to present the recording as a gray scale with black representing the cold areas and white the warm. However, it is a well-established principle of visual physiology that the human eye is capable of perceiving a significantly greater number of shades of gray at the dark or lower end of the gray scale. Brightness contrast also serves to enhance perception when a light

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‡ R<sup>0</sup> Smith Industries Ltd., London, England.

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