

# Breast Thermography and Cancer Risk Prediction

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Thermography makes a significant contribution to the evaluation of patients suspected of having breast cancer. The obviously abnormal thermogram carries with it a high risk of cancer. This report summarizes the results of patients with questionable or stage Th III thermograms. From approximately 58,000 patients, most of whom had breast complaints, examined between August 1965 and June 1977, the conditions of a group of 1,245 women were diagnosed at initial examination as either normal or benign disease by conventional means, including physical examination, mammography, ultrasonography, and fine needle aspiration or biopsy, when indicated, but nevertheless categorized as stage Th III indicating a questionable thermal anomaly. Within five years, more than a third of the group had histologically confirmed cancers. The more rapidly growing lesions with shorter doubling times usually show progressive thermographic abnormalities consistent with the increased metabolic heat production associated with such cancers. Thermography is useful not only as a predictor of risk factor for cancer but also to assess the more rapidly growing neoplasms.

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**D**URING 12 YEARS of clinical practice utilizing thermography as one of the techniques for breast examination, we had the opportunity to observe the women by repeated studies over a long period of time. The patients were usually symptomatic but a small number were examined because of cancerphobia or a family history that placed them in a high risk category. There was no mass screening of asymptomatic women as is currently under investigation in the United States. Among the patients who initially had questionable thermal anomalies of asymmetry, disordered vascularity or local hyperthermia, but no physical, mammographic or echographic evidence of malignancy, there were some who subsequently were proven to have breast cancer.

Similar observations have been reported by other investigators<sup>2,3,8-10</sup> who have suggested that among the so-called "false-positive" thermograms there are patients with carcinomas that are not yet palpable or visible on mammography. This report will provide some statistical information in these situations.

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## Patients and Methods

Approximately 58,000 patients were examined in our Department of Breast Diseases between August 1965 and June 1977 (Fig. 1). Of these, 1,563 women between 32 and 53 years of age (approximately 2.5% of the total) were initially classified as thermographic stage Th III. In our classification<sup>6,7</sup> thermograms are distributed in five stages from Th I to Th V, according to an increasing probability of cancer. Each stage is identified by thermovascular patterns and areas of hyperthermia, either singly or in combination. Stage Th III represents equivocal situations in which the thermal signs are suspicious but not conclusive and it was this group that was analyzed.

On the first visit the complaints and history are recorded and the patients undergo physical examination, mammography, thermography, and frequently ultrasound examination. If aspiration or needle biopsy is performed, a prompt report of cytologic or histologic findings is obtained.

Thirty-six of the women in category Th III did not return as requested, leaving a total of 1,527 for evaluation. With the exception of the 282 patients with a diagnosis of cancer established on the initial visit, all were followed by re-examinations for periods of time of up to 12 years. It is worth noting that approximately 90% of patients presenting with Th IV and V have a diagnosis of cancer established on first visit as contrasted with only 18% of the Th III group.

The frequency of re-examinations depends primarily upon the clinical impression which is arrived at by

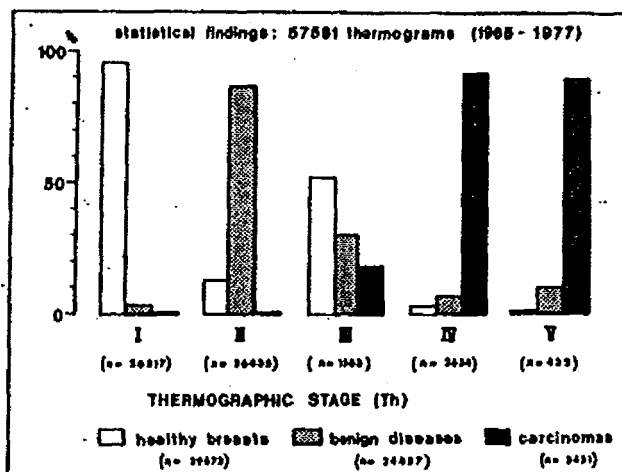


FIG. 1. Total patient population with thermographic staging and diagnosis at initial examination.

studies other than thermography, and patients with benign disease generally have shorter intervals between examinations than those patients considered normal.

### Results

Of the 1,527 Th III patients, 784 (51%) had no abnormal physical, mammographic or echographic findings; 461 (30%) had conditions diagnosed as benign disease, mainly cystic mastopathy; and 282 (18%) had conditions promptly confirmed histologically as cancer (Fig. 2). From among the 784 apparently normal women, malignancy was detected in 177 within the first two years following initial examination, and an additional 121 cases were found during the following two years. The overall rate was 38% (Fig. 3). The mean delay in a histologic diagnosis of cancer is approximately 1½ years after the initial visit. In most of the

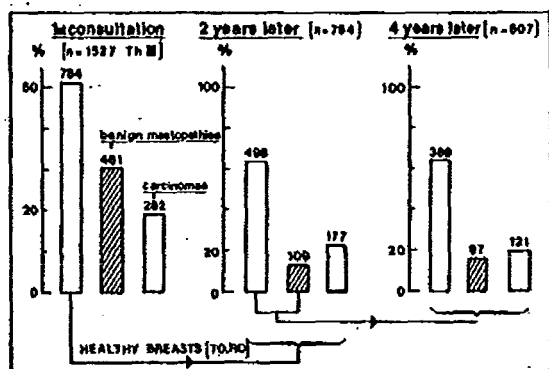


FIG. 2. Evolution of cancer in 784 patients with Th III thermograms but considered normal otherwise. Within the first two years 22% were confirmed malignant and an additional 15% during the following two years.

cases with delay in diagnosis of one year or less, the thermograms demonstrated a change with increase in both the intensity and extent of hyperthermia resulting in a progression to stage Th IV or V.

Comparable results were found in the group of 461 Th III patients considered to have benign disease with a 44% rate of cancer diagnosis (Figs. 4 and 5).

### Case Reports

#### Case 1

A 40-year-old woman was first examined in September 1974 because of bilateral mastodynia and cancerphobia. While results of physical, x-ray and echotomographic examinations were negative, the thermogram was classified Th III because of hyperthermia overlying the left breast (Fig. 6).

The patient was instructed to return in three months for re-examination but delayed her visit until July 1975, a 10-month interval. Thermography disclosed intense hyperthermia of the entire left breast and was reclassified as Th V. Both physical examination and mammography were now abnormal and malignancy was confirmed by cytology and histology.

#### Case 2

A 45-year-old woman was first examined in May 1974 because of bilateral breast pain which was accentuated in the left breast. A diagnosis of Reclus disease (bilateral cystic mastopathy) was made following physical examination, mammography and echography. However, the thermogram was classified Th III because of questionable hyperthermia overlying the left breast (Fig. 7).

Repeat thermographic examinations were performed at six-month intervals with no apparent changes until August

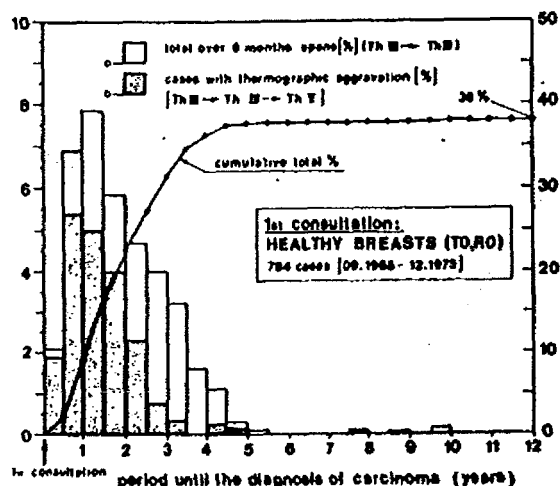


FIG. 3. Evolution of cancer with stable Th III vs. increase in hyperthermia. Mean delay in the histologic diagnosis of cancer is approximately 1½ years. When the diagnosis was established in less than one year progressive thermal abnormality was observed in most of the cases.

1976 when an increase in nipple and peri-areolar heat was noted with some alteration of the thermovascular pattern, resulting in a reclassification to Th IV. Additional studies, particularly ultrasound, revealed a nonpalpable 1.5-cm mass in the subareolar area which was confirmed histologically as cancer.

### Discussion

In our experience, the rate of cancer detection on re-examination of women who initially were considered either healthy or having benign mastopathy by methods other than thermography is significantly higher for those with Th III, 38 and 44% respectively, than for those with Th I or Th II with a rate of only 0.4%. Needless to say, technical skill and expertise in interpretation of the images are required. This is emphasized particularly in view of the criticism that thermography has a high rate of "false-positives," in the range of 10–20%, depending upon classification of abnormalities and the technique used, whether by infrared scanner or liquid crystals. More than one-third of the doubtful or stage Th III thermograms found in association with normal breasts or those with benign disease on the occasion of the initial examination correspond to clinically occult or mammographically negative carcinomas. The remaining cases may be reasonably accepted as false positives provided the thermal anomalies have no explainable basis. Most of these persist over the years and some spontaneously improve.

Fundamental data on thermography of mammary carcinomas have been described previously.<sup>4,5</sup> An unequivocal relationship exists between growth rate and metabolic heat production, and, for the cancers with a rapid growth rate or short doubling time, the heat production is very high (Fig. 8). The heat generated by the cancerous tissue with a very short doubling time of less than 50 days is intense, about 70 mW/cm<sup>2</sup>, which is more than that recorded for the most thermogenic normal tissue,<sup>1</sup> and much more than the maximum value of 12 mW/cm<sup>2</sup> that we have found in normal glandular breast tissues. The relative percentages of cancers associated with progressive thermal anomalies versus a stable Th III, as shown in Figs. 3 and 5, suggest that the earlier detection of malignancy is related to a more rapid tumor growth rate.

We wish to emphasize that in no case is the diagnosis of cancer made on the basis of thermography alone but it does serve as an alarm signal drawing attention to a possible cancer at an early stage. Patients with apparently healthy breasts and a questionable thermogram are kept under observation by routine follow-up examinations, and each year between 35 and 50 cancers representing approximately 10% of our total are thereby detected at an earlier stage. Since the shortest

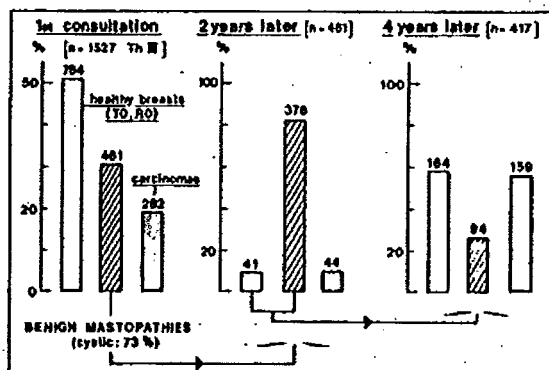


FIG. 4. Evolution of cancer in 461 patients considered to have benign mastopathy with Th III thermograms. Within the first two years 9% were confirmed as cancer histologically and an additional 34% during the following two years.

measured doubling time is about 45 days, consideration should be given to more frequent follow-up examinations by thermography, particularly in view of its complete safety, but the possible adverse psychological effects in certain selected instances should not be ignored.

In screening for breast cancer an abnormal thermogram should be regarded as a high risk factor requiring regular follow-up examinations. We are currently in the process of investigating possible correlation of an abnormal thermogram with other high risk factors. However, both medical and economic limitations must be taken into consideration when planning programs for early detection of breast cancer. Utilizing thermography in conjunction with accepted high risk factors and medical history may be a reliable way of sorting women into two groups, a larger one with the likeli-

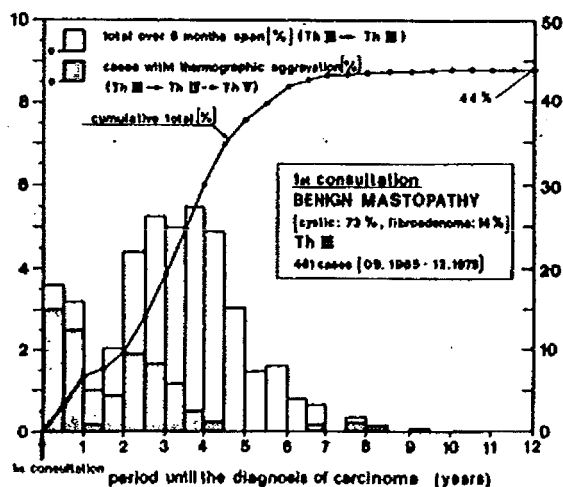


FIG. 5. Evolution of cancer in benign mastopathy with stable Th III vs. progression to Th IV and Th V. Within the first three years cancer was established in about 25% of the cases and within five years 44% were confirmed as malignant.

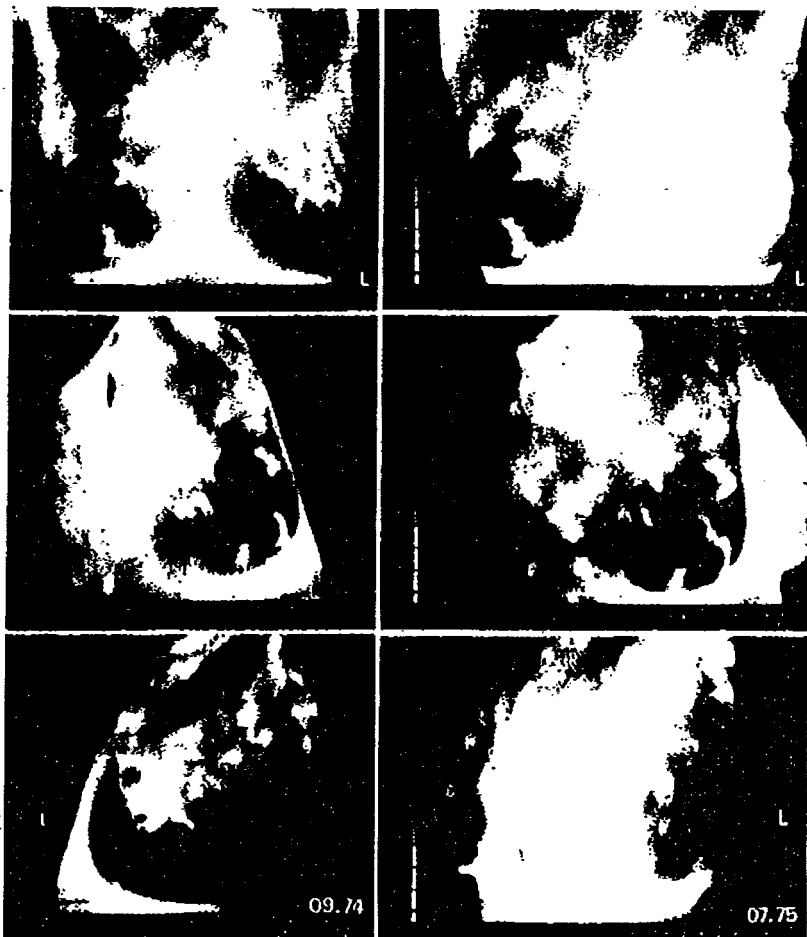


FIG. 6. Case 1. Frontal and oblique view (left vertical row) of 9/74 compared with similar views (right vertical row) of 7/75. Light shade represent warmer areas. Left nipple and areoli hyperthermia, Th III, progressing to diffuse hyperthermia of the entire left breast, Th V.

hood of normal breasts and a small one in need of immediate investigation by other modalities and sequential follow up. This approach has proved to be effective by others,<sup>9</sup> and although we have not had the opportunity to engage in such a study it does seem reasonable.

Based upon our experience and statistical findings in patients with Th III thermograms the following suggestions for their supervision are made:

1. The thermographic interpreter should indicate the significance of the anomalies. Some of the abnormalities may be explained by anatomical differences; superficial veins may be responsible for vascular hyperthermia; a hot spot may correspond to a scar or skin lesion. Some benign diseases such as rapidly growing fibroadenomata or cysts associated with inflammation may give rise to relative hyperthermia. Evaluation of the thermal anomalies in conjunction with simple physical data is important.

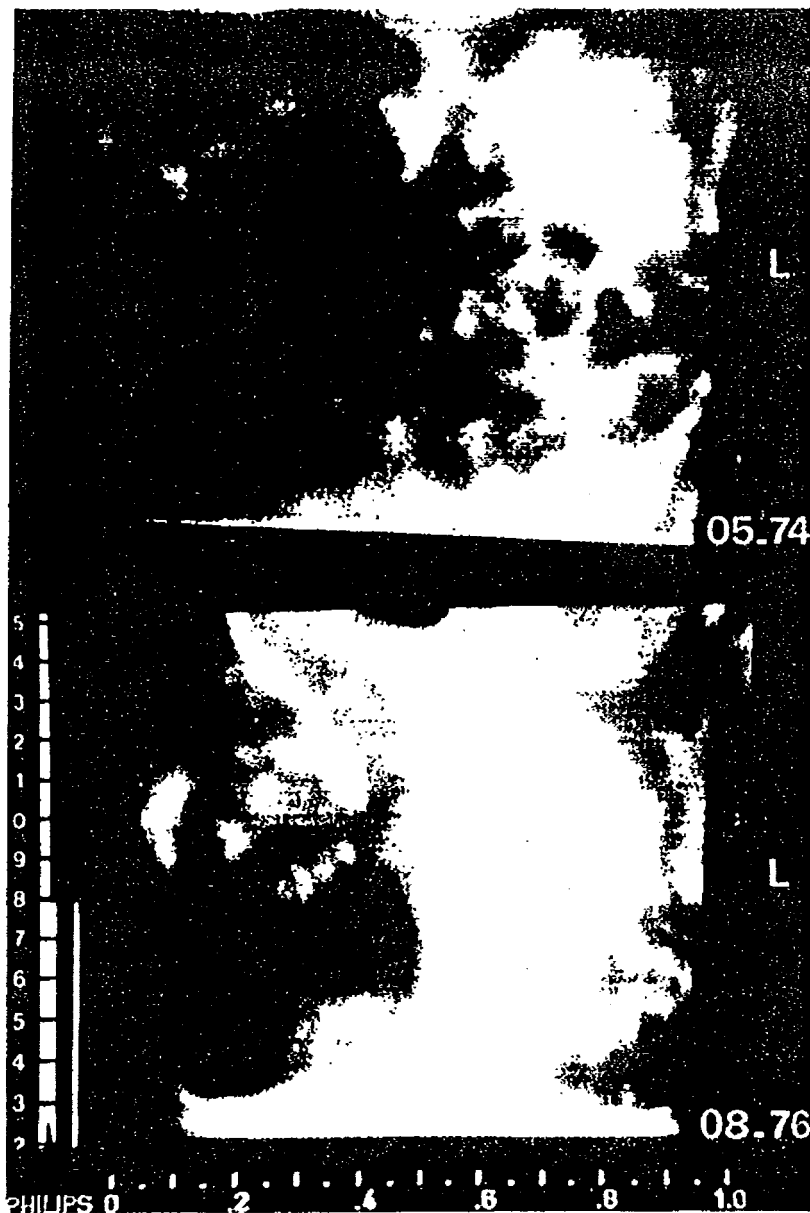
2. Have appropriate complementary examinations performed. A diagnosis may be established by mammography, ultrasonography or fine needle biopsy. One

interesting technique consists of the following thermodynamic test: 1) local cooling of the hyperthermic area under standard conditions; and 2) measurement of the subsequent re-warming rate. The latter varies exponentially with the heat supply from underlying tissues and proved to be very high in cases of fast growing tumors.

3. The recommendation for follow-up examinations. If all of the routine investigations remain negative periodic re-examination is established. The first control examination should take place after one to three months, depending on the clinical findings. Both the chronology and modalities of future examination should depend on the thermographic clinical progression.

Our present findings corroborate conclusions of previous authors, especially those of Isard *et al.*, who state that "Thermography is an innocuous examination that can be utilized for preliminary screening of asymptomatic women to focus attention upon those who should be examined more intensively because of

FIG. 7. Case 2. Frontal view of 5/74 (top) and comparable view of 8/76 (bottom). Irregular vascular hyperthermia of the left breast, Th III, progressing to Th IV with nipple and areolar hyperthermia.



greater risk of breast cancer.”<sup>8</sup> However, this comment can be amplified by noting that thermography not only serves as a risk factor for cancer but also for a more accurate estimation of neoplasms with a rapid growth rate. Since doubling time of mammary carcinomas ranges from about 50–700 days, early effective treatment may be particularly important for the more rapidly progressing lesions.

#### Summary

From approximately 58,000 patients, a group of 1,245 women between the ages of 32 and 53 years was care-

fully followed during a twelve year period because of a questionable thermogram, stage Th III, and the results are presented.

Following initial physical and x-ray examinations, as well as ultrasonic studies when indicated, a diagnosis of normal breasts was established in 784 women and benign mastopathy in 461. Subsequently malignancy was confirmed histologically in 38% of the normal group and 44% of the women with benign mastopathy. This remarkably high rate of cancer development in women with abnormal thermograms emphasizes the risk associated with thermal abnormality.

Breast cancer can produce alterations in the mam-

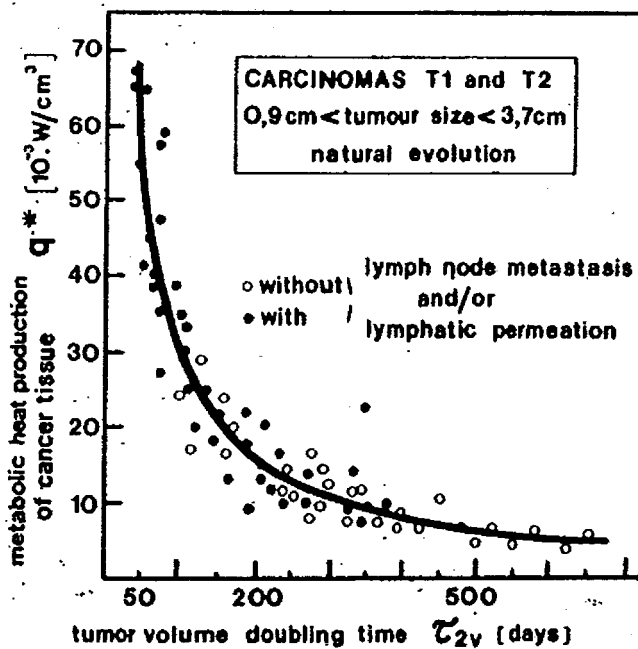


FIG. 8. Metabolic heat production and growth rate of breast carcinomas. The data was obtained by observing the progression of small cancers in patients who initially refused treatment and in whom a histological diagnosis was confirmed. Doubling time was evaluated by measurements of tumor sizes on successive mammograms, and heat production was computed by measurements of temperature and blood flow carried out *in situ* with fine needle probes.

mary thermal pattern prior to clinical and mammographic changes, and lesions with a rapid growth rate and less favorable prognosis can be detected earlier if

thermographic studies are used in conjunction with classical physical and x-ray examinations.

A program for the management of patients with Th III thermograms is suggested.

#### REFERENCES

1. Aschoff, J., and Weber, R.: Kern und Schale im Wärmehalt des Menschen. *Naturwissenschaften* 45:477-485, 1958.
2. Bryne, R. R.: Correlation of thermography, xeromammography and biopsy in a community hospital preliminary report. *Wis. Med. J.* 73:35-37, 1974.
3. Davey, J. B., Pentney, H., and Richter, A. M.: The early diagnosis of breast cancer. A further report for a women's screening unit. *Practitioner* 213:365-370, 1974.
4. Gautherie, M., Armand, M. O., and Gros, C.: Thermogénèse des épithéliomas mammaires. IV. Etude lors d'évolutions spontanées de l'influence de la vitesse de croissance et des corrélations avec la probabilité de dissémination lymphatique. *Biomedicine* 22:328-336 1975.
5. Gautherie, M., and Gros, C.: Contribution of infrared thermography to early diagnosis, pre-therapeutic prognosis and post irradiation follow-up of breast carcinomas. *Medica Mundi* 21:1-16 1976.
6. Gautherie, M., Quenneville, Y., and Gros, C.: Metabolic heat production, growth rate, and prognosis of early breast carcinomas. In *Functional Explorations in Senology*, C. Colin, et al, Eds *Proc. Internat. Symp., Liege, Belgium, 1975*. Ghent, Belgium European Press, 1976; pp. 93-110.
7. Gros, C., Gautherie, M., and Archer, F.: Séméiologie thermographique des épithéliomas mammaires. *Bull. Cancer* 58:60-90 1971.
8. Isard, H. J., Becker, W., Shilo, R., and Ostrum, B. J. Breast thermography after four years and 10,000 studies. *Am. J. Roentgenol.* 115:811-821, 1972.
9. Stark, A. M., and Way, S.: The screening of well women for the early detection of breast cancer using clinical examination with thermography and mammography. *Cancer* 33:1671-1679, 1974.
10. Wallace, J. D., and Cade, C. M.: Clinical thermography. *CRC Crit. Rev. Bioeng.* 2:39-94, 1974.