

Thermography in screening for breast cancer

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Abstract

Study objective—The aim of the study was to determine whether thermography could be used to identify women with breast cancer or women at risk of developing the disease within five years.

Design—Women were screened for breast cancer and a documentary follow up was conducted five years later through general practitioner records.

Setting—The project involved Women resident in the Bath District Health Authority area, who were invited to attend a breast screening clinic.

Subjects—10 238 women aged between 40 and 65 were screened. Of these, 4284 accepted personal letters of invitation from their general practitioners and 5954 volunteered to take part in the project in response to publicity; 9819 (96.5%) were traced after five years.

Measurements and main results—All the women had a thermographic and clinical examination of their breasts. If either examination was abnormal they were referred for mammography. Sensitivity of thermography was found to be 61% and specificity 74%. A documentary follow up of each woman was conducted five years later, when it was found that 71.6% of the women who developed breast cancer had had a normal thermogram at the time of examination, as did 73% of those who did not.

Conclusions—Thermography is not sufficiently sensitive to be used as a screening test for breast cancer, nor is it useful as an indicator of risk of developing the disease within five years.

It is now accepted that mammography is the best method for screening for breast cancer. However, before deciding on which method should be adopted for a national screening programme, the Department of Health and Social Security funded projects to test the validity of clinical examination and thermography as well as mammography. The purpose of the study reported here was to determine the specificity and sensitivity of thermography as a screening test for breast cancer and to show whether or not it could be used to identify women at high risk of developing the disease within five years.

Although it is customary, when discussing screening tests for breast cancer, to call tumours arising within 12 months of screening false negatives,¹ for the purposes of this study a false

negative is defined as a woman with histologically proven breast cancer, in whom the thermogram was normal. A false positive is defined as a woman in whom the thermogram was abnormal, but clinical examination and mammography showed no evidence of malignancy.

Methods

Women were recruited to the project by two methods:

- (1) We identified 8235 women aged 40 to 65 through the age/sex registers of six general practices in the Bath area, who were then sent personal letters from their own doctors inviting them to take part. Of these, 4284 (52%) accepted.
- (2) There were also 5954 women in the same age group who volunteered to take part after reading about the project on posters in general practitioners' waiting rooms throughout the Bath Health District, or hearing about it from friends and work mates. Within this group there were 229 symptomatic women. As pain was such a common complaint, for the purpose of this study symptoms were confined to skin tethering, a discrete lump, or nipple abnormality.

After receiving an explanation of the aims of the project and the methods employed, each woman gave a history while cooling for her thermogram. Two thermographic systems were used: a scanner developed by AWRE, Aldermaston, in conjunction with Barr and Stroud, and a system made by Rank Precision Industries. The women cooled for 10 min at an ambient temperature of $19.0^{\circ} \pm 1.0^{\circ}\text{C}$, stripped to the waist with her hands on her hips. The examination was then made with her hands on her hips, three positions being viewed, anterior and right and left obliques. The procedure has been described in detail by the Anglo-Dutch Thermographic Study Group.² The criteria used to decide whether a thermogram was positive were (a) a localised area of increased heat emission; (b) increased heat of one areolar area; (c) generalised increase of temperature of one breast; and (d) a localised increase in vascularity with more numerous, tortuous or dilated vessels. For (a)–(c), a temperature difference of more than 1.5°C was taken to be significant. The thermograms made with the AWRE/Barr and Stroud system were recorded in digital form on magnetic tape, and those from the Rank System on 35 mm black and white film.

The examining doctor assessed the thermographic data before proceeding to a clinical examination. If the thermogram was classified as positive in a premenopausal woman a further examination was made during the second week of her menstrual cycle. If significant temperature

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differences persisted, she was referred straight for mammography, as were women in whom there was a clinical abnormality.

A documentary follow up was conducted five years after each women's screening examination to determine whether she had subsequently developed breast cancer.

Results

A positive thermogram was found in 2681 (26.2%) of 10 229 women at their screening visit (9 sets of data were missing). Of these 2444 had no clinical or radiological evidence of breast cancer.

Two hundred and one were premenopausal women whose thermogram reverted to normal at a different time in their menstrual cycle. These women were clinically normal but did not have a mammogram. Thirty six (61%) of 59 women found to have breast cancer at the time of screening had a positive thermogram. Nineteen of these 59 women were symptomatic. Of these 16 had a positive thermogram (table I). Sensitivity of thermography was thus 61% and specificity 74%.

The relationship between the thermographic findings and tumour size in the cancers found at the clinic is shown in table II.

Five years after the date of their screening examination 9819 (96.5%) of the normal women were traced through their general practitioner's records. Sixty were found to have developed breast cancer since their visit to the screening clinic. The relationship between the thermographic findings in these women at the time of screening and the outcome five years later is shown in table III.

Discussion

An ideal screening test would not only be safe and acceptable to the population examined, but would have specificity and sensitivity of 100%. Provided sensitivity remains high, specificity can be reduced, particularly if the test is to be used as a preliminary screen for identifying persons requiring further investigation. As first stage screening is primarily a cost cutting exercise, the acceptable loss of specificity would depend on the financial implications. The psychological

sequelae of a high false positive rate must also be considered.

We have been relatively successful compared with many other studies. Moskowitz *et al*³ examining 42 women with tumours of stage I or less found thermography to be no more accurate than totally random selection, while we found seven of 11 tumours less than 10 mm to be thermographically positive. The Breast Cancer Detection Demonstration Projects⁴ in the USA examined 280 000 women aged 35 to 74 and found the sensitivity of thermography at first screening to be 37%. In the UK the Edinburgh⁵ and British United Provident Association⁶ screening clinics abandoned the technique because of poor specificity and sensitivity. Nevertheless, even if our figure of 74% specificity was thought to be acceptable for a prescreening test, sensitivity of 61% does not approach that of mammography at 78 to 94%⁷ and we conclude that thermography is not sufficiently sensitive to be used as a screening test for breast cancer.

In assessing the significance of a positive thermogram as an indicator of high risk of developing breast cancer, Gautherie and Gros⁸ found that more than a third of a group of 1245 women diagnosed as either normal or with benign disease by clinical examination and mammography, but having an abnormal thermogram, developed breast cancer within five years. In our study, 71.6% of the women who developed breast cancer within five years of screening had a normal thermogram at the time of their screening examination, as did 74% of those who did not develop breast cancer. Thus we were not able to show that thermography was useful as an indicator of high risk of developing breast cancer within five years.

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Table I Relationship between thermographic findings and presence of breast cancer at screening examination

Thermogram	Breast cancer present	No evidence of breast cancer
Positive	36 (61.0%)	2645 (25.4%)
Negative	23 (38.9%)	7525 (74.0%)
Total	59	10 170

Table II Thermographic findings in relation to tumour size

Thermogram	Tumour < 10 mm	Tumour 10 mm +	Tumour 20 mm +
Positive	7	13	16
Negative	4	10	9
Total	11	23	25

Table III Relationship between thermographic findings in normal women at the screening clinic and the outcome five years later.

Thermogram	Developed breast cancer	Did not develop breast cancer
Positive	17 (28.3%)	2540 (26.0%)
Negative	43 (71.6%)	7219 (74.0%)
Total	60	9759

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