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, 4,284 accepted personal letters of invitation from their general practitioners and 5,954 volunteered to take part in the project in response to publicity; 9,819 (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 8,235 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, 4,284 (52%) accepted.

(2) There were also 5,954 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 workmates. 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°C ± 1.0°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°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 woman'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
sequela of a high false positive rate must also be
considered.
We have been relatively successful compared with
many other studies. Moskowitz et al23 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 Projects 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 Edinburgh2 and British
United Provident Association26 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%27 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.

We thank the Department of Health and Social Security
for their generous support for this project. Our thanks
are also due to the general practitioners, consultant
surgeons and pathologists of the Bath Health District
for their help and cooperation, and to all those who
organised and ran the screening clinic.

Validity of clinical examination and mammography as
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study group on thermographic screening. Recommended
procedure for breast examination. Br J Radiol 1976; 49:
1037-8.
D. Lack of efficacy of thermography as a screening tool for
minimal and stage I breast cancer. N Engl J Med 1976; 295:
249-52.
4 Bashra O, Shapiro S, Smart C. Report of the Working Group
to review the National Cancer Institute-American Cancer
5 Edinburgh Breast Screening Clinic. Screening for breast
6 Last PA. The case for breast cancer screening. Pulse 1983; 15
January.
7 Forrest P. (Chairman), Breast cancer screening. Report of
a working group to Health Ministers of England, Wales,
Scotland and Northern Ireland. London: Her Majesty's
8 Gautherie M, Gros CM. Breast thermography and cancer risk

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

<table>
<thead>
<tr>
<th>Thermogram</th>
<th>Breast cancer present</th>
<th>No evidence of breast cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>36 (61.0%)</td>
<td>2645 (25.4%)</td>
</tr>
<tr>
<td>Negative</td>
<td>23 (36.9%)</td>
<td>7520 (74.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>10 170</td>
</tr>
</tbody>
</table>

Table II Thermographic findings in relation to
tumour size

<table>
<thead>
<tr>
<th>Thermogram</th>
<th>Tumour &lt; 10 mm</th>
<th>Tumour 10 mm +</th>
<th>Tumour 20 mm +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>7</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Negative</td>
<td>4</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>23</td>
<td>25</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Thermogram</th>
<th>Developed breast cancer</th>
<th>Did not develop breast cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>17 (28.3%)</td>
<td>2540 (26.0%)</td>
</tr>
<tr>
<td>Negative</td>
<td>43 (71.6%)</td>
<td>7219 (74.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>3269</td>
</tr>
</tbody>
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