FROM LOUISIANA STATE UNIVERSITY SCHOOL OF MEDICINE, NEW ORLEANS, AND TEMPLE UNIVERSITY SCHOOL OF MEDICINE, PHILADELPHIA, U.S.A.

# DIAGNOSTIC SCORING SYSTEM FOR MAMMARY CARCINOMA

J. W. BIRSNER and J. GERSHON-COHEN

The sensitivity and specificity of such diagnostic measures as physical examination, roentgen examination of the breast and thermography were recently appraised in 862 patients with mammary carcinoma in six large medical centers. This was a conjoint effort under the auspices of the American Cancer Society, and the results were analyzed by expert statisticians. All three disciplines were found to have approximately the same degree of diagnostic accuracy (LILIENFELD et coll. 1969).

One of the present authors (J. W. B.), when discussing deficiencies in the discovery of early mammary carcinoma, proposed the evolution of a simple 'point system', which would assign appropriate weights to the various diagnostic modalities contributing to better clinical judgement. Once the system was tentatively established, the other author (J. G.-C.) agreed to test it retrospectively.

This is a preliminary report of the efforts to convert the diagnosis of breast diseases from an intuitive or analogue method to a more precise or digitized discipline. The diagnostic items used in the scoring were the following: (1) the patient's age, (2) duration of symptoms, (3) history of mammary carcinoma

Submitted for publication 4 June 1971.

**Table 1**

*Age factor points in the incidence of mammary carcinoma*

| Age | Points assigned |
|---|---|
| 30–34 | 5 |
| 36–39 | 15 |
| 40–44 | 30 |
| 45–49 | 40 |
| 50–54 | 40 |
| 55–59 | 40 |
| 60–64 | 35 |
| 65–69 | 35 |
| 70–74 | 35 |
| 75–79 | 35 |
| 80–84 | 45 |
| 85–89 | 60 |

in (a) mother or sister, (b) mother and sister, (c) aunt, (4) previous breast surgery, including aspiration of cysts and mastectomy, (5) physical examination, (6) roentgen findings, and (7) thermographic findings.

*Age factors.* Since the incidence of mammary carcinoma increases commensurate with increasing age, except for a slight plateau just after the menopause, points varying with established carcinoma incidence were assigned each decade, beginning with the fourth (Table 1). The points assigned to progressive aging are heavily weighted diagnostically because this factor is so well documented (DUNN 1969).

*Duration of symptoms.* Ten points are given for symptoms present less than two months and five points for symptoms present more than two months, on the theory that benign lesions are more apt to be associated with chronicity than malignant ones (Table 2).

*Family history.* If there is a history of mammary carcinoma in a sister, a mother or an aunt, 10 points are assigned. If carcinoma has occurred in both a sister and a mother, 15 points are assigned (Table 2).

*Previous breast surgery.* Patients who have had aspiration of a cyst or other breast surgery are assigned 10 points for the first operation and 5 more points

**Table 2**

*Diagnostic scoring of symptoms, family history and breast surgery*

| | Points assigned |
|---|---|
| Symptoms, duration | |
| Less than 2 months | 10 |
| More than 2 months | 5 |
| Mammary carcinoma in family | |
| In sister, mother, aunt | 10 |
| In sister and mother | 15 |
| Breast surgery | |
| One operation | 10 |
| Two operations | 15 |
| Three operations | 20 |
| Mastectomy | 25 |

are added for each subsequent surgical maneuver. Chronic cystic mastitis (mazoplastica cystica) is usually the basis for aspiration of cysts, and these points are assigned because carcinoma is said to occur more frequently in these circumstances. If one breast has already been removed for carcinoma, 25 points are scored, since such patients may be considered to be in a higher risk category (Table 2).

*Physical examination.* Values for the components of the physical examination are shown in Table 3. If the examination reveals nothing abnormal, no points are assigned. If the findings are indefinite or inconclusive, 10 points are given. The same points are given to any nipple discharge or bleeding. A lump which is movable and 'feels benign' is allotted 20 points. A 'dominant mass' that is fixed or has the classical signs of malignancy is credited with 50 points. This is further substantiated if the recorded diameter of the mass is greater clinically than on the roentgen film. Eczema in or around the nipple also calls for 50 points because of the possibility of Paget's disease. Many more sophisticated physical findings considered to contribute to the 'high risk' classification might be incorporated into the scoring by experienced clinicians.

*Roentgen examination.* The points assigned to various aspects of soft tissue examination are shown in Table 4. If the breasts appear to be healthy, no points are assigned. Should dysplasias be detected, no matter what the type, 5 points are

**Table 3**

*Scoring of physical examination*

| | Points assigned |
|---|---|
| Negative findings | 0 |
| Indeterminate findings, including nipple discharge | 10 |
| Mass, movable, 'benign' | 20 |
| Mass, fixed, dominant, 'malignant' | 50 |
| Eczema of nipple | 50 |

scored if the involvement is minimal, 10 points if it is moderate, and 15 points if it is severe. If a breast is encountered that is either excessively dysplastic or atrophic in respect to the patient's chronologic age, 30 points are tabulated for this 'disproportion', on the premise we entertain that carcinoma develops more frequently in such breasts. If the dysplasia is due to epithelial hyperplasia or sclerosing andenosis, 30 points are warranted, for such breasts seem to have a greater incidence of malignancy than do those associated with the other dysplasias, most of which are due to mild or benign physiologic aberrations.

If 'indirect' signs of malignancy are found on the films, such as the presence of a smoothly contoured but solitary or isolated tumor, especially if its diameter is less than that recorded clinically, or if there is distortion of the morphologic appearance, especially if accompanied by edema and skin thickening, 50 points are scored. For the 'direct' signs, such as a spiculated mass which is obviously a scirrhous carcinoma, or aggregates of microcalcifications that are pathogno-

**Table 4**

*Scoring of roentgen examination of the breast*

| | Points assigned |
|---|---|
| Normal breasts | 0 |
| Dysplasias | |
| Minimal | 5 |
| Moderate | 10 |
| Severe | 15 |
| Disproportion between biologic and chronologic age | 30 |
| Carcinoma, 'indirect' signs | |
| Distorted morphology, isolated smooth mass, edema, skin thickening | 50 |
| Carcinoma, 'direct' signs | |
| Spiculated mass, microcalcifications | 100 |

**Table 5**

*Scoring of thermographic findings*

| | Points assigned |
|---|---|
| Normal appearance | 0 |
| Increase of temperature more than 0.5° C, whether localized, diffuse or venous | 30 |

monic of carcinoma, 100 points are allotted, sufficient to refer the case automatically into the category of malignancy.

There are those who feel that the presence of axillary lymph nodes more than 1 cm in diameter should be given some consideration when found on the films. It is true that such nodes may be due to carcinoma (ALEXANDER & HALL 1970, GERSHON-COHEN & HERMEL 1969). However, enlarged non-solid nodes are frequently associated with dysplasias; metastatic nodes appear to be solid because of blocking and packing of the medullary centers with abundant mitotic cells. We have not used scores for this finding because we do not yet have confidence in the security of these observations. Many radiologists might want to consider different plans of scoring, greater or lesser in scope, depending on their own experience. Such variations are to be encouraged if they prove helpful.

*Thermography.* For those having access to thermography, the scoring of this examination is detailed in Table 5. Where thermography is not available, the scoring system could be appropriately altered.

**Table 6**

*Zone scoring of points among healthy women and those with benign and malignant lesions*

| Score | Normal | | | Benign | | | Malignant | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of cases | Per cent | Cumulative per cent | No. of cases | Per cent | Cumulative per cent | No. of cases | Per cent | Cumulative per cent |
| 0—25 | 3 | 3.0 | 3.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30—75 | 58 | 58.0 | 61.0 | 10 | 31.0 | 31.0 | 0 | 0 | 0 |
| 80—105 | 31 | 31.0 | 92.0 | 10 | 31.0 | 62.0 | 15 | 23.0 | 23.0 |
| 110—140 | 8 | 8.0 | 100.0 | 6 | 19.0 | 81.0 | 13 | 19.5 | 42.5 |
| 145—165 | | | | 6 | 19.0 | 100.0 | 17 | 26.5 | 69.0 |
| > 165 | | | | | | | 20 | 31.0 | 100.0 |

About 20 per cent of all women will have one or more localized signs of increased infrared emission, and this is also true of about 40 per cent of women with dysplasias (GERSHON-COHEN & HERMEL 1969, GERSHON-COHEN et coll. 1970 a). But because some 90 per cent of women with malignancy also display such signs, the scoring for thermographic infrared radiation is placed at 30 points.

Originally we insisted that the localized 'hot spot' be at least 1° C greater than in the counterpart area of the opposite breast, but we no longer adhere to this criterion. In some proved carcinomas the difference in temperature was less than 0.5° C, and in others the increase in heat was diffuse rather than localized, or was confined to a segment of a superficial vein. Moreover, we have frequently found that large temperature differences, such as between 4° C and 6° C, are just as apt to portend active dysplasias as carcinomas. The thermographic scores can be very important. In some 5 per cent of cases a positive thermogram was mainly responsible for the detection of malignancy, and we recently reported 4 cases illustrating this circumstance (GERSHON-COHEN et coll. 1970 b).

## Results

This scoring system has been tested retrospectively on patients selected from those examined during the last 24 months, when an advanced roentgen apparatus, the Senograph (manufactured in France; distributed in the United States by Keleket/CGR, Waltham, Massachusetts), was available. This new equipment makes possible the use of an improved technique with distinctive advantages over conventional equipment, and has materially enhanced the accuracy of the interpretation (GERSHON-COHEN et coll. 1970 c, GERSHON-COHEN 1970). Of about 1 450 patients examined during this period, pathologic reports are available in 97 cases, in 65 cases of carcinoma in 63 women (2 bilateral) and in 32 cases of lesions that proved to be benign. As controls we selected and scored 100 patients of similar ages and symptomatology in whom malignancy was not suggested and who therefore were not subjected to biopsy. The duration of follow-up in these 'normal' patients is less than two years, but in none has evidence of malignancy emerged thus far.

*Controls.* Of the 100 controls, it will be noted (Table 6) that 61 cases scored below 75 points. In the zone between 80 and 105 points fell 31 cases, and the remaining 8 patients scored above 110 points. Reviewing the scores of these 8 patients, we found that their ages ranged from 46 to 69 years, averaging 53 years. These patients will be more frequently examined, since we regard them as 'high risk' patients.

Fig. 1. Mammary radiography. Adenocarcinoma (→) found in a 61-year-old patient who complained of only 'discomfort' in the upper outer portion of the left breast for one month. A movable, tender mass was palpated and thought to be 'benign'. Its measurements were greater on the patient than on the film, and it was scored, according to our system, with 50 points. Other points accrued were: age 35; symptoms 10; breast cancer in family 10; prior breast surgery 25 (aspiration of cysts 4X); physical examination 20; thermography 30, Total points: 180.


Fig. 2. Thermogram of patient in Fig. 1. The red colors in the left breast indicate areas 2.5° C warmer than the green areas in the right breast. There are 5 color changes between red and green, each representing 0.5° C.

*Benign lesions.* Of the 32 cases whose biopsies proved to be benign, it is noteworthy that the radiologist, without benefit of the point system, suggested the presence of malignancy in 12 instances. In the other 20 cases, he suggested biopsy merely to confirm his impression of benignancy which he preferred to be checked by histology.

In the 12 'false-positives', retrospective analysis of 8 of them reveals a range from 50 to 155 points, with an average of 110 points. In the other 4 cases, microcalcifications characteristic of carcinoma were present; and unless we are privileged to re-examine these patients to assure ourselves that the microcalcifications have been removed, our appraisal of them remains sub judice. These cases scored from 140 to 165 points, with an average of 155 points.

In the 20 cases of the total 32 in which biopsy was suggested to establish benignancy, the point system applied retrospectively shows a range of from 30 to 150 points (1 case), with an average of 82 points.

*Malignant lesions.* Our scoring techniques in a case of carcinoma is illustrated in Figures 1 and 2. Without benefit of this point system, it must be noted that in the original diagnosis of the 65 carcinomas, 10 were incorrectly diagnosed as 'negative'. Eight of these 10 false negative fell in the point range between 80 and 105 points.

Retrospective review of these 8 cases shows that the patients ranged in age from 29 to 53 years, averaging 43 years, with an average point score of 90. The difficulties of interpreting the films of the dysplastic breasts of younger women undoubtedly contributed to our failures. It is possible that refinement of diagnostic accuracy might be achieved if Boolean clustering were used in this group (FEINSTEIN 1967). In the other 2 false-negatives, retrospective analysis shows point scores of 145 and 230, high enough to prompt a diagnosis of malignancy.

One of the most difficult features in the interpretation of the films is the recognition of distorted morphology caused by malignancy, usually of the invasive duct cell variety before the formation of a scirrhus. Failure to note such distortions results in only a 10-point assessment, $\pm$ 5 points, whereas detection of distortion results in the allotment of 50 points, a critical difference. In both these 2 false-negatives, morphologic appearance had been overlooked.

In our prospective tests, we are emphasizing special care in appraising cases with scores between 80 and 105 points. Reference to Table 6 indicates that an appreciable percentage of patients with these scores are found to harbor carcinoma. In the next zone, with points between 110 and 140, the percentage of women with malignancy climbs, and those who have greater than 145 points almost uniformly are found to have mammary carcinoma.

## Discussion

When auction bidding in the game of bridge was converted to a point system of contract bidding, it crystallized in the bidder's mind the full worth of his hand. By analogy, we feel that by employing a scoring system, the diagnosis of mammary carcinoma can be approached more precisely. For the time being, the purpose of this report is merely to introduce the concept. Refinements, such as 'Boolean clustering', high-risk factors such as marital status, fertility, age at menarche and menopause, endocrine profiles, et cetera, can be added later. Since our objective is to keep the system as simple as possible for the present, we elected to give point assignments only to the least controversial factors.

If and when this point system is made firm and is adopted, an entirely new concept of the high risk patient could emerge. Clinicians have generally limited this category to women with a family history of mammary carcinoma, or to patients who have had a mastectomy. This narrow point of view ought to be expanded, and this could be accomplished by placing due weight upon all the factors that comprise an integrated medical consultation.

The use of such a system would stimulate clinicians to make a thorough physical examination, with proper scoring of its various components. The same tenet holds for the radiologist and the thermographer. As medical computers come more and more into play, these are precisely the factors physicians will have to take into consideration for accurate programming.

When a carcinoma has advanced far enough to produce the classic signs of induration, fixation, and the secondary signs of edema and lymph node metastasis, the point system admittely can do little more than confirm the malignancy. It is not, however, the advanced but the early tumor, still localized and therefore difficult to detect clinically, that we hope may be snared by the use of this scoring system. For example, when an isolated, circumscribed mass is detected which could be benign as well as malignant, leaving much ambiguity in the examiner's mind, the 20 points assigned to it by the physical examination and the 50 points assigned by soft tissue roentgen examination are usually enough to result in a total above 125 points, emphasizing the need for biopsy to decide the issue.

Finally, we hesitate less to suggest biopsy in patients with scores between 80 and 140 points. If malignancy is found, we are becoming more and more inclined to favor conservative therapy with reconstruction of the breast rather than mutilative radical mastectomy. Other investigators have found that such procedurs offer results as good as any other form of therapy and can often be combined with radiation therapy (Bader et coll. 1970, Crile 1968).

In light of the difficulties pathologists have in locating minute areas of malignancy, as recently reported by Rosen et coll. (1970) and Hutter et coll.

(1969), the day may come when patients with points falling into the zone between 80 and 105 will automatically be subjected to reconstructive surgery. In such cases, the removed tissue could then be routinely examined roentgenographically so as to guide the pathologist in his selection of tissue for histologic examination. Only in this manner can the pathologist hope to detect the small carcinomas that in ordinary circumstances might be overlooked (BADER et coll. 1970, ROSEN et coll. 1970). Carcinoma in situ occurs far more frequently than is generally realized (FARROW 1970).

## SUMMARY

Various modalities used to diagnose mammary carcinoma were analyzed and assigned diagnostic weights to provide a simple 'point scoring system'. It is suggested that the introduction of such a system of diagnosis could lead to more accurate clinical judgment and be useful for computer programming.

## ZUSAMMENFASSUNG

Verschiedene zur Diagnose eines Mammakarzinoms verwendete Verfahren wurden analysiert und deren diagnostischer Wert bestimmt, um ein einfaches 'Punkte-Rechensystem' zu erhalten. Es wird die Vorstellung entwickelt, dass die Einführung eines solchen diagnostischen Systems zu einer genaueren klinischen Beurteilung führt und bei einer Computer-Programmierung nützlich ist.

## RÉSUMÉ

Les auteurs ont étudié différentes techniques utilisées pour le diagnostic du cancer du sein et leur ont affecté un « poids » diagnostique pour établir un système simple de « calcul par point ». Ils pensent que l'introduction d'un tel système de diagnostic pourrait conduire à un jugement clinique plus précis et pourrait être utile pour la programmation sur ordinateur.

## REFERENCES

ALEXANDER P. and HALL J. G.: The role of immunoblasts in host resistance and immunotherapy of primary sarcoma. Advanc. Cancer Res. 13 (1970), 23.

BADER K., PELLETTIERE E. and CURTIN J. W.: Definitive surgical therapy for the 'premalignant' or equivocal breast lesion. Plast. reconstr. Surg. 46 (1970), 120.

CRILE JR G.: Results of simple mastectomy without irradiation in the treatment of operative stage I cancer of the breast. Ann. Surg. 168 (1968), 330.

CUTLER S. J., ZIPPIN C. and ASIRE A. J.: The prognostic significance of palpable lymph nodes in cancer of the breast. Cancer 23 (1969), 243.

DUNN JR J. E.: Epidemiology and possible identification of high-risk groups that could develop cancer of the breast. Cancer 23 (1969), 775.

FARROW J. H.: Current concepts in the detection and treatment of the earliest of the early breast cancers. Cancer 25 (1970), 468.

FEINSTEIN A. R.: Clinical judgement. Williams & Wilkins, Baltimore 1967.

GERSHON-COHEN J.: Atlas of mammography. Springer Verlag, Heidelberg, Berlin, New York 1970.

— and HERMEL M. B.: Modalities in breast cancer detection: xeroradiography, mammography, thermography and mammometry. Cancer 24 (1969), 1226.

— — and MURDOCK M. G. (a): Priorities in breast-cancer detection. New Engl. J. Med. 283 (1970), 82.

— — — (b) Thermography in detection of early breast cancer. Cancer 26 (1970), 1153.

— — — (c) Advances in mammographic technique. Amer. J. Roentgenol. 108 (1970), 424.

HUTTER R. V. P., SNYDER R. E., LUCAS J. C. et coll.: Clinical and pathologic correlation with mammographic findings in lobular carcinoma in situ. Cancer 23 (1969), 826.

LILIENFELD A. M., BARNES J. M., BARNES R. B. et coll.: An evaluation of thermography in the detection of breast cancer. A cooperative pilot study. Cancer 24 (1969), 1206.

ROSEN P., SNYDER R. E., FOOTE F. W. and WALLACE T.: Detection of occult carcinoma in the apparently benign breast biopsy through specimen radiography. Cancer 26 (1970), 944.