Breast examination in medical practice

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Summary. According to epidemiological data the early diagnosis of breast cancer needs a program based on repeated multidisciplinary controls. Mammography (M.) is the main method (its false negative rate is 9.3% in a series of 130 breast cancers histologically confirmed). Contact Thermography (C.T.) (10% of false negative rate in the same series) is recommended as a com-

plementary method, being able to reduce the false negative rate of the same series to 1.3%. A program for breast serial control in asymptomatic and symptomatic women is suggested in which the role of C.T. associated with other diagnostic methods is pointed out.

Key words: breast carcinoma; contact thermography; screening program.

A) INTRODUCTION

In no other field of medicine the periodical medical check-up has brought more benefit than in gynaecology. Gynaecological screening for cervical cancer by cervical smear (PAPANICOLAOU) is an ideal method for screening and has become worldwide a very useful, simple, but on the other hand accurate method for the detection of cervical cancer.

No comparable method has been existing, as far as now, for the detection of breast diseases. Mammography (M.) has a high accuracy, but it is limited in screening for breast cancer because of high costs and the radiation risk of carcinogenesis following .repeated investigations, especially in young women.

B) EPIDEMIOLOGIC DATA

1. Incidence

Epidemiologic data are a great challenge for the Senologists and force them to draw their attention to the problems in the detection of breast cancer. The official austrian statistic data on the incidence of gynaecological malignancies (Tab. I) prove that in the about 25.000 reported cases of gynaecological cancer from 1970 to 1975, less than 30% were localized at the cervicis uteri and more than 40% at the breast.

Consequently, the incidence rate of new cases of cervical carcinoma is of 36/100.000/yr; this value rises to 50/100.000/yr in the breast cancer. Breast cancer screening therefore is one of the most important investigations in Oncology, in order to achieve an earlier detection of the disease.

Therefore, every clinical investigation in women, has to be completed by a careful physical examination (P.E.) of the breast.

2. Age distribution

In the previously reported series, about 80% of breast cancers were identified in a range starting from 50 yrs of age (Graph 1).

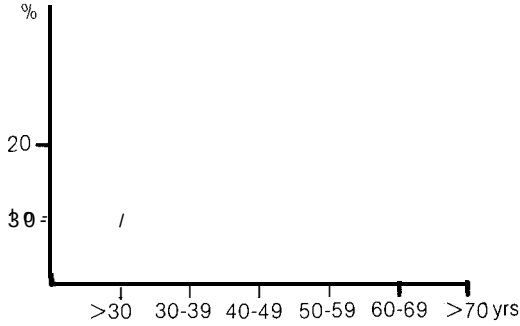
Consequently, a' very careful screening program must take in account this age group, eventually including large use of M.

3. Tumour size

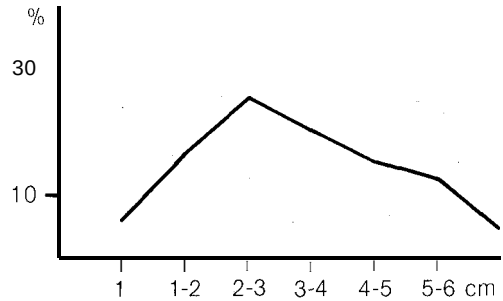
The oncological Literature refers that the clinically diagnosed breast cancers are more than 3 cm in diameter in over 50% of the cases (Graph 2). In most cases breast cancer is detected by the patient herself and therefore

Tab. I. **Incidence of the gynaecological cancers in Austria.**
(Female population: 3.950.000: 19700975).

Site	New cases	Incidence (100.000/yr)
Cervicis uteri	7.158 (29.2%)	36.2
Corporis uteri	3.777 (15.5%)	19.1
Ovarii	2.635 (10.8%)	13.3
Vaginae, vulvae etc	934 (3.8%)	4.7
Mammae	9.965 (40.7%)	40.4
Total	24.469 (100%)	



Graph 1. Age distribution of breast cancers in Austria (1970-1975).



Graph 2. Tumour size in 1496 breast cancers.

often in a too advanced stage.[4] This is very disappointing, as tumours less than 2 cm in diameter can be detected by a careful P.E. Thus, a periodical clinical check-up could reduce the average size of clinically detected breast cancer, which would consequently lead to better survival rates.

C) PLACE OF CONTACT THERMOGRAPHY IN BREAST CANCER

The P.E. of the breast is often underes-, timated by the Practitioner, since its infor-. mation seems to be uncertain for a correct diagnosis; therefore, breast P.E. is very often neglected or performed only when the patient presents herself with some clinical signs in her breast. Contact thermography (C.T.) is a great support in order to add further information to the P.E. findings. The use of C.T. as complementary investigation to P.E. of the breast is justified by:

a) *harmlessness,* easy and fast handling and relative cheapness of the method; β) discrete *accuracy* of the method. The personal experience in breast C.T. is based on 8000 examinations. In more than 95% of these patients, the C.T. results were similar to those of M. examination. Nevertheless, in order to obtain a more reliable evaluation of C.T., only the histologically proved carcinomas were considered (Tab. II). The false negative rate of C.T. (10%) is very similar to that of M. (9.3%). It must be emphasized that the false negative rate of the 2 methods simultaneously applied in this series of breast cancers falls to 1.3% (2/150 breast cancers).

The 10% false negative rate in C.T. has been confirmed by thermographic Literature. GAUTHERIE et Al.[1] reported interesting results they achieved in their great patient series (Tab. III). The French classification of T. patterns is well known: TH1-TH2 (normal breast or benign lesions); TH3 (uncertain); TH4-TH5 (suspect and very suspect). The false positive rate in the normal breast was only of 4% and of 3.6% in the benign diseases. Opposite, the false negative rate in breast cancer was of 8.5%; this figure is very similar to that of personal series.

Also the prognostic value of the T. examination must be emphasized. GAUTHERIE et Al.,' referring to a series of 499 subjects with

Tab. II. **Accuracy of contact thermography and mammography in breast cancer.** (150 obs: histologically confirmed).

Methods	Diagnosis	
	Certain or suspected	False negative
Contact thermography	135	1 5 (1 0%)
Mammography	136	14 (9.3%)

Tab. III. **Accuracy of thermography in breast examination.**
(11290 obs.: GAUTHERIE et Al.').

Thermographic classes	Normal (5220 obs.)	Benign diseases (480 obs.)	Cancers (1261 obs.)
TH1 TH2	5011 (96%)	4636 (96.4%)	107 (8.5%)
TH3 TH4 TH5	209 (4%)	173 (3.6%)	1154 (91~5%)

Tab. IV. **Suggested policy in breast examination.**

No clinical symptoms (Screening procedure)		Clinical symptoms (Diagnostic procedure)
Age	Methods	Physical examination ↓ Mammography ↓ Thermography
< 35 yrs	Contact thermography	
35-50 yrs	Physical examination Contact thermography Mammography (repeated every 3-5 yrs)	
> 50 yrs	Physical examination Mammography (repeated every 2 yrs) Thermography	

negative P.E. and M. examinations, but positive T. examinations, have found breast cancers, at control 2 yrs. later, in 232/499 (46%) patients. Though this incidence of breast cancers seems to be too high, nevertheless it must be remembered that T. depends on metabolic changes of the cancer and is correlated to vascular abnormalities, opposite to P.E. and other instrumental methods which are 'based on morphological pictures. For that reason C.T. can sometimes be able to provide more useful information than those provided by P.E., M. and ultrasound.

D) DISCUSSION

M. examination is surely the most appropriate method for the detection of breast cancer. Nevertheless the accuracy of C.T. justifies its utilization in a diagnostic approach to the breast, in association with P.E., M. and other methods, according to the different clinical situations (Tab. IV).

1. Approach to non-symptomatic women

The role of C.T. in breast cancer screening is clearly indicated by Tab. IV. Preliminary P.E. is always mandatory: C.T. is required in order to confirm the normal findings of P.E.[3]

In the patients under 35 yrs of age, M. examination can be avoided if P.E. and C.T. examinations are negative. On the contrary, in patients aged between 35-50 yrs, M. examination is also recommended and this

radiological control could be repeated every 3-5 yrs.

In the same age group, the P.E. and C.T. control must also be performed every yr. In women over 50, M. is performed at 2 yrs intervals. It has to be emphasized, that the asymptomatic women aged less than 50 represent about 2/3 of all female population in the general gynaecological practice. In this age-group the association of P.E. and C.T. plays the most important role. C.T. is not to be considered competitive to M., because the C.T. aim is to support the information of P.E. A negative T. emphasizes a negative P.E. and the patient too will trust a negative combined P.E.-C.T. examination more than the negative P.E. alone.

Should CT. not absolutely negative, M. is always performed, even though the P.E. tindings are negative.

2. Approach to symptomatic women

Any clinical pathological finding must be followed by M. and eventually C.T. (Tab. IV). If the P.E. examination demonstrates a distinct, palpable nodule, biopsy is mandatory in order to classify its histology, apart from C.T. or M. findings. Of course, a nodule very suspect at C.T. and/or M. examination, required directly surgery with bioptic control during intervention. If no mass is found at P.E. examination (i.e., breast dysplasia), and also C.T. and M. are negative for breast tumour, a C.T. seriated control in patients under 35 yrs of age, and a C.T. and M. control in patients over 35 yrs of age is advised.

REFERENCES

1. GAUTHERIE M., GROS C.: Thermographie und Brustkrebs, Diagnose, Prognose, Überwachung. *Gynäk. Rdsch.*, 19,i83-227, 1979.
2. KUCERA H., MICHALICA W.: Epidemiolonie des Mammakarzinoms in Österreich. *Wien. med. Wschr.*, **129**, 703-706, *1979.*
3. KUCERA H., KUBISTA E.: Möglichkeiten zur Erfassung des Mammakarzinoms durch Einsatz der Flüssigkristall Thermographie in der gynäkologischen Praxis. *Wien Klin. Wschr.*, **88**, 22-28, 1976.
4. ZINSER H.K.: *Mammakarzinom: Diagnose und Differentialdiagnose.* Thieme, Stuttgart, 1972.

Epidemiological issues in breast cancer screening

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Summary The Authors stress the significance of the epidemiological parameters which define a diagnostic technique, the methods for a correct evaluation, and the need that the efficacy of screening programs be tested through mortality rates in comparison with control populations. Referring to the actual experiences in breast cancer and specifically in thermography, the research fields in which further investigation is necessary are identified and discussed.

Key words: screening, breast cancer, thermography, mammography.

A) INTRODUCTION

The breast cancer incidence rates in Western Countries seem to have slightly increased in recent yrs, with rates of SO-90 cases/lOO.OOO women per yr, while mortality rates are stable around 25-30 deaths/lOO.OOO women per yr.[7]

The U.S.A. and Italian mortality rates are quite similar, while the incidence rates seem to be higher in the U.S.A. than in Italy;[6] there-

fore, the incidence/mortality ratio in Italy is lower than in the U.S.A. (2.5 vs. 3.5) but it is uncertain whether this difference depends on different diagnostic and/or therapeutic strategies in the 2 countries or on a different efficiency in estimating incidence rates.

Several risk factors for breast cancer have been recognized, but their overall pathogenic significance has no yet been clearly defined (Tab. I). Anyhow, the present knowledge on the risk factors makes it impossible to plan meaningful primary prevention programs in breast cancer. Thus, strategies for reducing breast cancer mortality rates must point to a secondary prevention, by means of early detection 'programs.

Tab. I. **Breast cancer risk factors.**

- Age
- Familiarity
- Nulliparity
- Late first pregnancy
- Early menarche
- Late menopause
- Chronic breast disease
- Obesity (?)
- Hyperlipidic diet (?)
- Assodiated diseases (?)
- Exogenous estrogens (?)

In planning an early detection program, a cost-benefit analysis is mandatory, as many screening programs yield little, if any, benefit, in presence of high costs and serious negative side-effects. In evaluating costs, side effects and benefits of a screening program, several problems are to be taken into account, which are related to the following aspects: efficacy; prevalence rate and case-fatality ratio of the disease; accuracy, costs and side-effects of each diagnostic tests.

1. The **efficacy of a screening program** is defined as its ability in reducing mortality among the screened population. It depends: a) on the availability of *effective therapy* for the disease; *b*) on the *positive correlation* between early (pre-symptomatic) stage of the disease and effectiveness of therapy; and c) on the *ability of the test* to diagnose cases at a sufficiently early stage. When no effective therapy is available[3] (e.g. lung cancer) a screening program will not only be useless, but even harmful as healthy individuals will undergo possibly noxious diagnostic tests (e.g. X-ray) and false positive cases will be exposed to further diagnostic tests (e.g. fibroscopy, biopsy) with psychological stress, while no benefit will counterbalance financial costs. If the available therapy is effective independently of the stage of the disease at the time of diagnosis (e.g. gall-stones), no screening program is needed.

The efficacy of a cancer screening program can be evaluated only by means of a control of mortality rates comparing general and cause-specific mortality rates in a population subjected to a screening program (includingnon-respondents) with the mortality rates in a control population. Inclusing of non-respondents in the mortality study is crucial, in order to make comparison with mortality in the control group, as mortality among respondents may differ from that among non-respondents, and it is not possible to distinguish between those who would have responded and those who would have not in the control group.

Survival curves of patients with cancer diagnosed in the screening cannot be utilized in evaluating the efficacy of screening programs. This is due to 2 types of bias: lead time bias and length bias.

a) Lead time bias refers to the fact that the earlier the diagnosis, the longer will be the survival rates after the diagnosis even in absence of any effective treatment. Thus, when survival rates (of early cases) are compared with survival rates of symptomatic (late) cases a remarkable difference is to be expected even though no therapy is available; *b) length bias* refers to the fact that cancers with longer duration (e.g. slow-growing cancers) are more represented among prevalent cases (prevalence = incidence X duration) and therefore in a screening program cancers with long survival will be over-presented, making again comparison impossible with survival of all incident cancers.

For 2 types of cancers (breast and cervix), the efficacy of screening programs is accepted, on the basis of available data.[1, 5] As far as colon cancer is concerned, controlled studies of

Haemo-occult test are. still *lacking,* even though there is some indirect evidence in favour of its efficacy in reducing mortality.[4] Breast cancer screening by means of mammography (M.) and physical examination (P.E.) has been shown to reduce breast cancer mortality rates of about 40% in a large randomized study (HIP).*

Present improvements in M. techniques with respect to those used in HIP study do suggest an improved cost-benefit and risk-benefit ratio in future breast cancer screening programs employing M. At the time of HIP study M. showed a sensitivity of less than 50%, while actual estimates are around 92%.[9]

Referring to the possible radio-induced cancer risk, it has been estimated that a single screening of 1.000.000 women employing M. would have caused a breast cancers per rad per yr after a 10 yr latency period.[2,10] Modern techniques deliver about 0.40 rads for 2 M. views.[2]

2. Other parameters to be considered in evaluting a screening program for a disease are the **prevalence** of asymptomatic detectable cases and case-fatality ratio of the disease. In low-prevalence disease, like rare cancers, where several thousands of persons are to be screened for diagnosing one case, costs of early diagnosis programs outweight potential benefits, also because the false positive / total positive ratio increases to very large values as point-prevalence decreases, causing many healthy patients to be classified as positives. It has to be noted that point-prevalence of a disease is roughly determined by ((incidence X duration)): a long detectable pre-symptomatic phase (e.g. in situ cervical cancer) will increase the prevalence while disease with short survival (e.g. lung cancer) will tend to have low prevalence.

In rare diseases, like cancers, cost-benefit ratio of secondary prevention programs can be improved by identifying and screening high-risk groups, in which, due to the high incidence, the prevalence is increased.

3. The third aspect which has to be considered in evaluating a screening program is related to the characteristics of the diagnostic test employed, that is **accuracy, cost** and **side-effects.** A screening device has to be cheap, as it will be employed on large populations. It has to be simple, because large screening programs must rely upon personnel with no specific training. It must involve little or no hazard for the screening population, as the majority of people undergoing diagnostic procedures will be healthy, and large populations cannot be exposed to health hazards in order to detect few cases that will get some benefit from being diagnosed earlier. However, the most crucial problem regarding a screening test is to assess its accuracy. The accuracy of a screening test is defined as its ability to discriminate between positive cases (with disease) and negative cases (without disease). It is usually measured by 2 parameters, sensitivity and specificity. a) Sen*sitivity* is the proportion of true positives (true positives / true positives + false negatives). *b) Specificity* is the proportion of true negatives (true negatives / true negatives + false positives). c) Another parameter is the *predictive value,* which indicates the proportion of the persons resulting positive to the test and who are really affected by the disease, and is related to the specificity of the test, to the prevalence of the disease, and, to a much lesser extent, to the sensitivity of the test (true positives / true positives + false positives).

The lower the prevalence of the disease the more important becomes the specificity of the test, since small decreases in specificity mean hundreds or thousands of false-positives every single true positive: for example every 1% decrease in the specificity of a test used in a screening for a disease with a prevalence of 0.001 means 10 more false positives for each true positive, but if the prevalence is 0.0001 it means 100 more false positives for each truly diagnosed case.

The problem of false positives cannot be overlooked in planing a screening program: physiological and social cost as well as health hazards from unneeded further diagnostic or therapeutic procedures, and financial costs might well counterbalance the benefits derived from the earlier detection of some cases.

For a given test, sensitivity and specificity are linked by an inverse relationship: specificity can be increased by putting the «cut-off»

point at a higher level, but at the same time sensitivity will be decreased. This inverse relationship is roughly proportional only in the central regions of sensitivity and specificity. When one of the 2 parameters (e.g. specificity) has already high,values, in order to attain small increases in it, substantial losses in the other one (e.g. sensitivity) are required.

B) MULTIPLE TESTS IN BREAST CANCER SCREENING

The availability of several tests suitable for a screening program makes it even more difficult to define a screening strategy: the tests can be administered simultaneously or sequentially.

When the tests are all administered on each subject at the same time, it must be decided whether cases with discordant test outcomes will be considered positive or negative: in the first instance the sensitivity will be increased but specificity will be lowered whereas when discordant test outcomes are considered negative the opposite will occur. When multiple tests are administered sequentially, it has to be established who will undergo the second test, the third an so on. If only the positive to the first test will have the second test done, specificity will be increased, but sensitivity will decrease.

The opposite will occur if only negative outcomes undergo a second test. Actually, the choice depends mainly on the characteristics of each test as costs, risk, and accuracy. While, for instance, it is difficult to imagine a mass screening for colon cancer using recto-sigmoidoscopy, this test can well be used for confirming cases detected by a simpler test, like Haemo-occult. On the contrary, if 2 tests seem to cover different areas of pathology like cytology and chest X-ray for lung cancer, their simultaneous use can be justified. In the case of breast cancer screening, 3 tests are considered suitable for large screening programs (Tab. II):

1. Physical examination (P.E.) is very cheap, does not require any device or particular technical skill, does not involve any risk for the screened group; on the other hand best estimates of its sensitivity and specificity are of 80% and 70% respectively.

2. Mammography, (M.) which has been improving both in its diagnostic accuracy and safety during the last 20 yrs, shows much higher sensitivity and specificity (recent estimates are 90% and 99% respectively'); more important*, it seems to be capable to detect cancers at earlier stages. On the other hand it is costly, requires the availability of radiographic facilities, and the presence of trained personnel. Furthermore a small amount of radiation is still delivered even with modern techniques, and its sensitivity is much lower in young women.

Tab. II. **Values of mammography, physical examination and thermography in breast cancer screening**

(population: 1.000.000; prevalent cases: 5.000; breast cancer prevalence: 5%~).

Test / Parameters	Mammography	Physical examination	Thermography
Sensitivity	90%	80%	80%
Specificity	99%	70%	90%
Predictive value	31.11%	1.32%	3.86%
True positive	4.500	4.000	4.000
False positive	9.950	298.000	99.500

3. More recently **thermography** (T.) has been introduced among the available diagnostic methods for breast cancer. Its sensitivity and specificity have not yet been clearly defined but are estimated to be around 80% and 90% respectively.[2, 11] Its costs are quite low (films), and it does not involve any risk, but it is time-consuming and requires long experience for a correct interpretation of its findings. On the basis of the values of specificity and sensitivity of Tab. II, the results of a screening program utilizing 2 methods simultaneously have been considered. Tab. III shows the theoretical results of a screening utilising P.E. and M. simultaneously in a series of 1.000.000 screened women, with breast cancer prevalence of 5%. Tab. IV shows the theoretical results utilising P.E., M. and T.

In the screening approach in which both P.E. and M. are employed on every screened individual, concordant positive cases as well as discordant cases undergo further diagnostic ascertainments: this strategy clearly increases sensitivity, but specificity and predictive value are negatively affected. The 3 tests strategy (P.E., M., T.) allows a significant improvement

Tab. III. **Screening employing physical examination and mammography.**
(Population = 1.000.000; prevalent cases = 5.000; breast cancer prevalence = 50!oo).

Tests outcome	Cancers (5.000)		Non cancers (995.000)		Predictive value
	True positives	Sensitivity	True negatives	Specificity	
+ +	3.600 (72%)	72%.	2.985 (0.3%)	99.7%	54.67%
+ − − +	1.300 (26%)	26%	302.480 (30.41%)	69.6%	
Total	4.900	98%	305.565	69.3%	15.79%
− −	100 (2%)		689.535		

Tab. IV. **Screening employing 3 simultaneous tests.**
(Population = 1.000.000; prevalent cases = 5.000; breast cancer prevalence = 5‰).

Tests outcome	Cancers (5.000)		Non cancers (995.000)		Predictive value
	True positives	Sensitivity	True negatives	Specificity	
+ + +	2.880	57.6%	299 (0.003%)	99.97%	90.59%
+ + - + - + - + +	1.760	92.8%	32.394 (3.31%)	96.66%	12.25%
+ - - - + - − − +	34	6.8%	341.185 (34.29%)	62.37%	1.31%
Total	4.984	99.6%	373.878	62.37%	1.31%
———	20 (0.004%)		620.582		

Tab. V. **Screening employing thermography and physical examination.** (Population = 1.000.000; prevalent cases = 5.000; breast cancer prevalence = No).

Tests outcome	Cancers (5.000)		Non cancers (995.000)		Predictive value
	True positives	Sensitivity	True negatives	Specificity	
+ +	3.200	64%	29.850 (3%)	97%	9.7%
- +	1.600	96%	338.300 (34%)	63%	1.28%
	200 (4%)		626.850 (63%)		

in the validity of the whole diagnostic procedure, only if individuals with one positive test are considered negative, because, on the contrary, specificity rates dramatically decreases (Tab. IV).

C) SEQUENTIAL APPROACH

Costs and risks of M. make it difficult to set up large-scale screening programs employing this technique. A possible approach could be a sequential screening, in which all women of certain age groups 'undergo both P.E. and T., while M. is carried out only in women positive to either test (Tab. V). This approach would select for M. about one third of the female population in which 96% of all breast cancer cases are present, and probably is the most feasible one for large programs so far, at least for age groups below 45-50 yrs, even though the facilities capable to screen with M. l/3 of the adult female population are far from available.

The overall yield of these programs would be satisfactory, with an overall sensitivity and specificity of 86.4 and 99.6% respectively. The final predictive value would be 54% (Tab VI), which means that more than l/2 of all women classified as positive by M. would be true cancer cases.

D) CONCLUSION

Beyond all these hypothetical considerations, the important point to be stressed

Tab. VI. **Effect of mammography on the screened positive cases of physical examination and thermography.**

Mammography	Cancer (4.800)	Non caters (368.488)
+	4.320	3.692
	480	364.468
Total	4.800	368.150

overall sensitivity = $\frac{4.320}{5.000}$ = 86.4%;

overall specificity = m = 99.63%;

predictive value = 34%.

is that no large-scale screening program should be started unless a careful cost-benefit analysis has been carried out, which has shown that the potential benefits of the program can be counterbalanced by the false positive diagnoses, unneeded diagnostic and therapeutic procedures, as well as the financial and organizational problems raised by lots of women coming to the out-patients. clinics.

While the efficacy of early diagnosis in breast cancer has been definitively demonstrated, it is not yet clear whether it is more useful to screen the whole adult female population or selected age-groups. A possible approach could be the selection of high risk groups 'by means of patient history or physiopathologic variables, for more frequent and/or aggressive screening strategies.

Another problem which needs further evaluation relates to diagnostic devices to be

and no risks but its diagnostic accuracy has not yet been tested by means of large reliable trials. Therefore this promising device, before being applied to mass-screening programs, should undergo further evaluation as to its sensitivity and specificity in the various age-groups, and stages of the disease: this evaluation will clarify whether T. can be considered a screening procedure of primary importance or only a supplementary test.

REFERENCES

1. AMERICAN CANCER SOCIETY Report on: *-The cancer-related health check-up.* February, 1980.
2. BEHARS O.H., SHAPIRO S., SMART C.: Summary report of working group to rewiew the NCI/ACS BCDDP. *J. Natl.* Cancer Inst., 62, 647-654, 1979.
3. FONTAINE R.S.: Medical aspects of lung cancer: potential application of Mayo lung cancer project data, *Mayo Clinic,* 1979.
4. GILBERTSEN V.A.: *The detection of cola-rectal cancer.* Presented at the International Symposium on Colorectal Cancer, New York, March, 1979.
5. GUZICK D.S.: Efficacy of screening for cervix cancer: a review. *Am. J. Publ. Health,* **68,** 125-134, 1978.
6. REGIONE PIEMONTE: *Tassi di distribuzione dei tumori in Piemonte negli anni 1965-1971.* Registro Tumori per il Piemonte e la Valle d'Aosta. Edit. Nova Ed., Torino, 1980.
7. SEER PROGRAM.: *Cancer incidence and mortality in the United States 1973-1976.* JL. YOUNG, A.J. ASIRE, E.S. ROLLAK EDS. DHEW Publication n. NIH 78-1837, Bethesda MD 1978.
8. SHAPIRO S.: Evidence on screening for breast cancer from a randomized trial. *Cancer,* **39,** ;772-2782, 1977.
9. SHAPIRO S.: Efficacy of breast cancer screening. In: A.B. MILLET Ed., *Screening in cancer. UICC Techn. Report Scie.,* **40,** 133-158, 1978.
10. UPTON A.C., BEEBE G.W., BROUN J.M., QUIMBY E.M., SHELLABARGER C.: Report of NCI ad hoc working group on the risks associated with mammography in mass screening for the detection of breast cancer. *J. Natl. Cancer Inst.,* **59,** 479-493, 1977.
11. VALDAGNI C., PERANI B.: Thermographic screening for breast cancer. *Med. Biol. Envir.,* **8,** 77-80, 1980.

CONTACT THERMOGRAPHY AND BREAST CANCER

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Summary. The problem of favouring and limiting criteria of C.T. in the diagnosis of malignancy is considered in a prospective study (n=4004) and in a retrospective study (n=19461 patients, with 2702 patients clarified by histology). The advantages of C.T. are: 1) the technical modality of C.T. (simple, quick, not expensive and with a good reproducibility of findings). 2) The more intensive vascular pattern of breast surface and the atypical vessels with a decisive dynamic test are better distinguished in larger carcinomas, that means tumours with a higher number of tumour cells or a more active metabolic activity.

Limiting criteria in the screening by means of C.T. regard: 1) the composition of the screened population: the smaller the number of patients at risk or symptomatic patients, the smaller the number of detected carcinomas. The age distribution of the patients has the same influence. 2) The vascular pattern of the breast is a facultative limiting factor in so far as in the presence of atypical vessels a higher vascularity is sometimes not easily suppressible and the atypia can not be seen quite correctly. 3) The diameter of the tumour certainly represents a limiting factor: tumours of about 1 cm in size can be diagnosed only in 30% of the cases. These are especially the aggressively growing tumours. Thus, a screening program with C.T. is possible, although the screening effect is modest with regard to the diagnosis of breast cancer because of a sensitivity of only 68% compared with a sensitivity of 86% by mammography.

Key words: contact thermography, breast cancer,

A) INTRODUCTION

At the present time mammography (M.) is the most reliable diagnostic modality with a sensitivity of 82% (68%-95%).[8, 9, 12, 15] However, the controversy on radiation hazard has reduced the number of women at risk willing to undergo regular M. examinations to a very small fraction. This makes the search for alternative screening methods very important.

The diagnostic value of thermography (T.) is known;[6, 7, 11, 19, 22] nevertheless, T. proved to be not very effective in the detection of small breast carcinomas (less than 1 cm in diameter) which are diagnosed only in one third of the cases., Similarly, there is little information about favouring and limiting factors in contact thermography (C.T.) in comparison with infra-red-thermography. A few criteria were considered in the C.T. study of the breast. They are as follows:

1) methodological procedure;
2) grouping of patients;
3) vascular pattern of breast surface without neoplasm;
4) vascular pattern of breast surface with benign and malignant tumours.

B) MATERIAL AND 'METHODS

I) Methodological prOCedur,e

C.T. was tested between 1971 and 1978. Totally, 9 physicians and 6 medical students were trained, and performed the examinations. The T. procedure was performed according to TRICOIRE.[26] On the whole, 19.461 patients underwent the T. examination and were documented (Tab. I).

2) Grouping of patients

In 1974 and 1977, in a prospective controlled study, 4.004 patients were examined. Among them 126 malignant, 47 proliferative and 181 benign lesions were present. Three groups of patients were considered: an asymptomatic group (n=2360; no symptoms exist in this group); a symptomatic group (n=661; presence of lumps, pain, secretion, etc); and a control group (n=983; these patients were selected in the wards of the hospital, where they were undergoing some kind of treatment for other reasons than breast disease). These 4.004 patients were tested for age distribution, motivation for examination and frequency of histological findings.

3) vascular pattern of breast surface without neoplasm

This study was based on the material of the above mentioned prospective controlled study of 1974 and 1977. The vascularisation of the female breast surface seems to be influenced by breast size, quantity of glandular tissue, age and hormones. Other variables - for example nursing habits - were neglected for methodological reasons.

4) vascular pattern of breast surface with benign and malignant tumours

For this purpose 19.461 patients (Tab.. I) were evaluated retrospectively. Of these, 2.202 were clarified by histology. The following variables, namely the vascularisation pattern (Type A - E) according to BOURJAT: the tumour dependent atypical hyperthermia and blood vessel, and the tumour size were tested.

C) RESULTS

1) Methodological procedure

Following our experience, we could assess. C.T. to be a simple technique requiring fairly little time to be performed (only 8 mins for

Tab. L. **Patients examined by. COntaCt thermography (1971-1978). Totally, 19.461 patients were examined; 2.202 required histological clarification.**

Patients	No	
without histology	17.259	(88.7%)
with histology	2.202	(11.3%)
- benign lesions	1.338	(6,9%)
- proliferative lesions	146	(0.8%)
- malignant lesions	718	(3.7%)
Total	19.461	(100.0%)

examination and documentation). The information provided is quite accurate, whereas no problems of interpretation of T. pictures do exist.

The vascular pattern becomes sharply and distinctly visible, in accordance to the dynamic test; both typical and atypical vascular patterns are well reproducible, provided the definition of T. findings is homogeneous.

2) Grouping of patients

Age distribution shows a characteristic frequency curve: in the group of asymptomatic patients, 36.35% are younger than 39 yrs compared with 52.19% in the symptomatic group. In the asymptomatic group 35.15% are older than 50 yrs. compared with 22.09% in the symptomatic group (Tab. II). Obviously, younger patients are better motivated for examination than older patients. When assessing the patients' motivation to the examination, we found that in the asymptomatic group 37.8% patients came on their own and 61.8% following the advice of a physician. In the symptomatic group 61,4% came by their own choice, whereas 38.1% were sent by the physician (Tab. III). Considering the frequency of histological findings in the three considered groups (Tab. IV) the symptomatic group presents a high rate of biopsies performed and clarified by histology. Thus, the percentage of diagnosed carcinomas rises.

3) Vascularisation pattern of the breast surface without neoplasm

There is an age-specific dependence (Tab. V): the older the patient the more type A and type B vascular pattern, and the less a type C

Tab. II. **Age distribution in the prospective study in 1974 and 1977 divided into three groups: asyntomatic patients, syntomatic patients, control group.**

Age	No symptoms		Symptoms		Control		Total	
below 19	11	(0.46%)	24	(3.63%)	20	(2.03%)	55	(1 .37%)
20 - 29	157	(6.66%)	93	(14.07%)	152	(15.46%)	402	(10.04%)
30 - 39	690	(29.23%)	228	(34.49%)	311	(31.64%)	1229	(30.69%)
40 - 49	671	(28.40%)	171	(25.87%)	225	(22.89%)	1067	(26.65%)
50 - 59	468	(19.80%)	92	(1 3.92%)	190	(1 9.33%)	750	(18.73%)
60 - 69	282	(1 1.93%)	51	(7.72%)	72	(8.33%)	405	(IO.1 1%)
over 70	81	(3.42%)	3	(0.45%)	12	(1.22%)	96	(2.39%)
Total	2350	(100%)	661	(100%)	983	(1 00%)	4004	(100%)

Tab. III. **Motivation for performing breast diagnosis by C.T.**

Motivation for examination	No symptoms		Symptoms		. Control		Total	
By their own	892	(37.8%)	406	(61.4%)	307	(31 .3%)	1605	(40.1%)
Physician	1459	(61.8%)	252	(38.1%)	672	(68.4%)	2383	(59.5%)
Other reasons	9	(0.4%)	3	(0.5%)	4	(0.4%)	6	(0.4%)
Total	2360	(1 00%)	661	(1 00%)	983	(1 00%)	‘4004	(1 00%)

Tab. IV. **Histological findings in the 3 patients groups in the prospective study.**

Histology	No symptoms		Symptoms		Control		Total	
no histology	2224	(94.23%)	446	(67.47%)	980	(99.69%)	3650	(91.16%)
benign	83	(3.52%)	98	(14.83%)	0	-	181	(4.52%)
proliferative	25	(1 .06%)	19	(2.87%)	3	(0.31%)	47	(1 .1'7%)
malignant	28	(1.19%)	98	(14.83%)	0	-	126	(3.1 5%)
Total	2360	(1 00%)	661	(100%)	983	(100%)	4004	(1 00%)

Tab. V. **Age distribution and vascular pattern according to Bourjat (%I.**

Vascular pattern	5 29	30-39	40-49	50-59	60-69	over 70	Total
A	7.3	4.3	6.0	9.8	16.5	20.4	344
B	19.3	25.9	24.2	32.9	34.9	33.3	1116
C	62.0	55.1	59.2	47.4	42.3	40.7	2113
D	10.7	13.8	9.5	8.1	4.5	9.3	380
E	0.7	0.7	1.6	1.9	1.7	1.9	51
Total obs.	457	1229	1067	750	405	96	4004

Tab. VI. **Vascular pattern and hormonal influence (%).**

Vascular pattern	No hormones	Pill,	Estrogens	Total obs.
A	10.96	6.35	10.15	344
B	45.31	50.76	40.62	116
C	33.03	32.74	30.47	2113
D	8.48	6.59	17.19	380
E	2.21	3.55	1.56	51
Total obs.	2944	800	260	4004

and type D pattern is fre+quent: 46.75% vs. 44.49% in the soft tissue. The number of mastopathic blood vessels increases in the knotty tissue; the breast size has no influence either on quantity of glandular tissue or on the vascular pattern, whereas a hormonal influence on the vascular pattern cab be demonstrated (Tab. VI). Exogenous therapy with hormones, especially oestrogens, has a decisive influence as to a more intensive and numerical increase of typica1 blood vessels. This can also be said with regard to pregnancies. Limiting factor for the interpretation is an interference with age and hysterectomy.

4) Vascular pattern of the breast surface with benign and malignant tumours

The is a significant correlation between the type of vascular pattern and the morphological findings (Tab. VII). In this situation, age, hormonal status and knotty tissue intermingle. Typical tumour-dependent findings are circumscribed heat, hot nipple, atypical blood vessels and vascular rings (Tab. VIII), being atypical blood vessels and circumscribed heat dominant.

Causes of C.T. false positive results are atypical blood vessels (2.9% and 4.3%) and a hot spot (16.9% and 2.0%). The T. findings demonstrate a specificity of 72.2% (% true negative) and a sensitivity of 67.9% (% true positive) (Tab. IX). It is of interest, that the percentage of carcinomas smaller than 2 cm in diameter is 55.9%. False positive results were found in 7% and false negative results were found in 13.5% of the cases, the percentage of dubious findings is thus very high! The size of the tumour has a decisive influence on the T. diagnosis: in fact, the greater the tumour, the more frequent will be the suspicious findings by T.

Tab. VII. **Vascularisation pattern in malignant and benign lesions according to the C.T. findings.**

CT. findings	Vascularisation oattern							
	Benign lesions				Malignant lesions			
	A	B+C	D+E	Total	A	B+C	D+E	Total
negative	0	1402 (72.6%)	(26.9%)	1416 (71.37%)	0	96 (16.7%)	(2.8%)	100 (13.92%)
equivocal	0	426 (22.1%)	(32.7%)	443 (22.32%)	0	127 (22.1%)	(2.8%)	131 (18.24%)
suspicious	1	103 (5.3%)	(40.4%)	(6.30%)	0	351 (61.1%)	136 (94.4%)	487 (67.82%)
Total	1 (0.05%)	1931 (97.32%	2 (2.62%	1984	0	574 (79.94%)	144 (20.06%	718

Tab. VIII. **Frequency of thermographic patterns in benign and malignant lesions. Only the positive findings are listed (%).**

Thermographic pattern	Benign lesions	Malignant lesions
Heat		
discret	16.9	32.4
prominent	2.0	22.8
dissociated	0.7	8.2
Warm nipple	1.5	13.4
Atypical vessels		
one vessel	0.2	0.3
two vessels	2.9	10.7
three vessels	4.3	42.9
four vessels	0.1	2.2
Broken circle	0.3	4.2

Tab, IX. **The CT. findings compared with the results proved by histology (%l.**

C.T. Diagnosis	Benign	Proliferative	Malignant
Negative	72.2	54.8	13.9
Equivocal	20.9	37.7	18.2
Suspicious	6.7	7.5	67.8
Total obs.	1338	146	718

D) DISCUSSION

Breast cancer screening in asymptomatic patients is aimed to detect the malignancy in an early treatable stage. The mass media play an important role in making women sensible to a spontaneous participation to the screening. This depends on numerical facts, since only 20-30% of the addressed women otherwise had an early examination.[2] The above considered group was especially made up by younger women who are usually more motivated to undergo any kind of screening. Thus, young patients necessarily dominate in this research too, especially in the control group. Accordingly, the probability of detecting carcinomas in their early stages declines. In fact, although the incidence of breast cancer increases statistically in the younger groups[18] it is relatively unimportant compared with patients at risk over 50 yrs of age. In the younger patients benign lesions were detected more frequently than malignant ones.' Age is considered a risk factor, being tumours more frequent in certain age periods[17] Considering the available groups it has to be stressed that patients really at risk are under-represented; this, with special regard to the symptomatic group.

A second statement, according to the ,available results, is possible; the symptomatic and asymptomatic groups cannot be exactly separated. Truly, the grouping of patients depends on the primary information provided by the patient himself. However, an inquiry on the patient's history shows the presence in the asymptomatic group of 17% of symptomatic patients. As to the control group few cancers were diagnosed. This was, however, due to the fact that most patients were too young, that they had preliminary inquiries too frequently and finally, that they already were a selected group, being all hospitalized: this makes it not really a control group. The same relation is found in the symptomatic as well as in the asymptomatic group. Therefore, the screening effect is more favourable in picking-up carcinomas than it had been expected (12% in the special care collective in relation to the expected incidence rate of 2,6 - 10%).[9, 16, 20, 21, 23]

The patterns of breast T. vary. Therefore, a T. picture of the normal breast is not defined, being dependent on the morphology of breast tissue, glandular activity and on psychohormanic balance. Usually the breast appears as a relatively cold area in relation to 'the neighbouring regions. The nipple is even more hypothermic, this depending on the minor tissue turgor. The cutaneous heat distribution of the female. breast normally shows thermal spots and lines according to the intra-and sub-cutaneous blood vessels. Each patient has her special thermic topography, keeping constant as long as no physiological, pathological or therapeutic influences or disturbances are present.[4, 24. 25] Negligible differences between right and left side are present; they express a major vascularisation of one of the two mammae. The results achieved are the same as those by BOURJAT.[4] STARK[24] refers to the fact that a completely symmetric distribution pattern is seldom to be found in the vascular system of both breasts. The quantity of glandular tissue as well as the breast size have not decisive importance on breast vascularisation as had previously been supposed. Age, pregnancies, nursing and the use of the pill play more important role. Personal results, as well as those from Literature, demonstrate that quite considerable individual variations are involved, i.e. psychological problems or

individual reaction on determined hormones; this explains why each woman presents an individual vascular pattern. As to a correct evaluation of T. findings, basic information on age, cycle, hormones, pregnancies and nursing are important. Last problem concerns the dependance of benign and malignant tumours on the vascular pattern of the lesion. A first question is the consistency of diagnostic criteria. The findings (negative, equivocal and suspicius) are exactly defined according to TRICOIRE.[26] This concerns both studies (the prospective study 1973 and 1977 and the retrospective one). In addition, several investigators were involved. With insignificant differences the T. findings are identical &both studies; they only depend on the morphological type and the diameter of the lesion. MOSKWITZ[19] and BRUN DEL REP presented similar results.

If the results of LAUTH[14] and JAGER[13] are compared with personal findings a variable interpretation of anarchic vascular pattern and atypical vessels is recognizable:[13,14] LAUTH and JAGER have a higher classification of «vascular anomalies)) results compared with my 'own interpretation from the slides. The same relation is found in the findings of TRICOIRE,[27] although not reproductable by other investi; gators. Especially in the so called early cases (Cis clist T1) personal results as well as those by FRISCHBIER[9] do not indicate the detection rate as described by TRICOIRE.'~ Probably vascular pictures classified by TRICOIRE as suspicious, are considered normal by other investigators.

Other question concerns the dependence on vascular anomalies: the higher the thermogenicity of the malignant tumour, the better the information provided by C.T. Thermogenicity depends on the volume of the tumour, on the turn-over and on the metabolic activity of tumour cells. According to the personal results,[3] a more intensive representation of atypical vessels is more frequently found in tumours with a greater diameter and a significant share of connective tissue and in tumours with a greater number of tumour cells with the cytological signs of malignancy. Morphological expressions of a high turn-over of the tumour cells are a shifting of the cytoplasmatic ratio, an increase and enlargement of the nucleoli, an improved rate of mitosis. GAUTHERIE~' could prove similar correlations performing temperature measurements by. inserting thermic exploring needles in the tumour.

REFERENCES

1. BASSLER R.: Pathologie der Brustdriise. *Handbuch der speziellen pathologischen Anatomic.* Bd XI. Hrsg. W. Doerr, G. Seifert, E. Uehlinger. Springer Verlag, Berlin-Heidelberg-New York, 1978.
2. BLOHMKE M.: Mijglichkeiten und Grenzen van Vorsorgeuntersuchungen. *Der Deutsche Ant, 24, 33-37,* 1978.
3. BOTHMANN G.A. HAAGD., WURSTER K., RUMMEL H.: Beziehungen zwischen metrischen, zyto- und histomorphologischen Befunden beim Mammakarzinom. *Schweiz. Med. Wschr..,* **106,** 1122-1125, 1976.
4. BOURJAT P., GAUTHERIE M.: Thermographie der Mammakarzinome. *Electromedica,* **1,** 17-19, 1972.
5. BRUN DEL RE R.: Perspectives for further studies concerning the validity of plate thermography in the diagnosis of breast disease. I. Int. Congr. Plate Thermography and Breast Cancer. Portofino Vetta. 20-21, 3, 1981.
6. BYRNE R.R., YEREX J.A.: The three roles of breast thermography. *Appl. Radiol.,* **4,** 53-56, 1975.
7. DODD G.D., WALLACE J.D., FREUNDLICH I.M., MARSH L., ZERMENO A.: Thermography and cancer of the breast. Cancer, 23, 797-801, 1969.
8. EGAN R.L., GOLDSTEIN G.T., MC SWEENEY M.M.: Conventional mammography, physical examination, thermography and xeroradiography in the detection of breast cancer. Cancer, 39, 1984-1987, 1977.
9. FRISCHBIER H.J., LOHBECK H.U.: *Frühdiagnostik des Mammakarzinoms.* G. Thieme Verlag, 1977.
10. GAUTHERIE M., QUENNEVILLE Y., GROSS CH.: Metabolic heat production, growth rate and prognosis of early carcinoma. in *Functional exploration in senology,* Colin C. et al. Eds., *European Press,* Ghent, **93,** 1976.
11. ISARD H.J., BECKER W., SHILO R., OSTRUM B.J.: Breast thermography after four years and 10000 studies. *Am. J. Roentgenol.,* **115,** 811-814, 1972.
12. ISARD H.J., OSTRUM B.J.: Breast thermography-the mammatherm. *Radiol. Clin. N. Amer.,* **12,** 167-171, 1974.
13. JÄGER G.: Seminar Plattenthermographie anlässlich 42. Tgg. Dtsch. Ges. Geb. Gyn., 12.9.1978, München.
14. LAUTH W.: Seminar Plattenthermographie anlässlich 42. Tgg. Dtsch. Ges. Geb. Gyn., 12.9.1978, München.
15. LUNDGREEN B., JAKOBSEN S.: Single-view mammography. A simple and efficient approach to breast cancer screening. *Cancer,* **38,** 1124-1128, 1976.
16. LESTER R.G.: Risk benefit in mammography. *Radiology,* **124,** 1-5, 1977.
17. MAASS W., TRAMS G., SACHS H.: Das Mammakarzinom. *Der Gynäkologe,* **3,** 2-6, 1970/71.
18. MAASS W.: Ätiologie und Risikofaktoren des Mammakarzinoms. 14. Hannoversches Symposium: Mammakarzinom, 7.3.1981.
19. MOSKOWITZ M., MILBRATH J. GARTSIDE P., ZERMENO A., MANDEL D.: Lack of efficacy of thermography as a screening tool for minimal and Stage I breast cancer. *New. Engl. J. Med.,* **295,** 249-254, 1976.
20. Screening for breast cancer. Report from Edinburgh breast screening clinic. *Brit. Med. J.,* **2,** 175-176, 1978.
21. Screening for breast cancer. Statement by British Breast Group. *Brit. Med. J.,* **2,** 178-179, 1978.

22. SHABER G.S., NERLINGER R.E., FEIG S.A., PATCHEFSKY A.S., SCHWARTZ G.F.: Thermography to detect breat cancer. *N. Engl. J. Med.*, **295**, 1082-1086, 1976.
23. STRAX P.: Results of mass screening for breast cancer in 50000 examinations. *Cancer*, **37**, 30-33, 1976.
24. STARK A., WAY S.: The use of thermovision in the detection of early breast cancer. *Cancer*, **33**, 1671-1675, *1974.*
25. **STARK** A., WAY S.: The screening of well women for the early detection of breast cancer using clinical examination with thermography and mammography. *Cancer*, **33**, 1671-1674, 1974.
26. TRICOIRE J., MARIEL L., AMIEL J.P.: Thermographie et diagnostic des petits tumeurs du sein. *Nouv. Press Méd.*, **2**, 1117-1121, 1973.
27. TRICOIRE J.P.: Dia-Lehrsammlung für Plattenthermographie.

Perspective for further studies concerning the validity of contact thermography in the diagnosis of breast diseases

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Summary. In a prospective randomized study the Reader of the contact thermograms (C.T.) has no other information than the C.T. images. The study showed -a delegation of the method is possible but not optimal - that C.T. cannot identify patients at a <<histological >s high risk and that the highest specificity for breast cancer has the sign « high increased thermo-dynamic », followed by « hot nipple », « pathologic thermic pattern », « asymmetry » and finally « hyper-vascularisation ».

Key words: risk factor, breast cancer, specificity.

A) INTRODUCTION

There is a rule in high fidelity: a system is as good as its weakest element; this is also true for the diagnosis of breast diseases. Mistakes done by one cannot be rectified by another.

In the past, fundamental studies have been done in thermography (T.) beginning with the studies of the Pioneers of the methods going to the important clinical studies by several French, Italian, German, Austrian and Swiss groups.[1, 3, 5, 6, 7, 10, 11, 15, 18, 19, 20, 27] Many papers deal with the accuracy of contact thermography (C.T.). The Swiss group has also published its result several times.[5, 6, 24, 25] But finally a question arose whether that was the right way to improve the skill and to contribute to the progress of the method, 'More and more one became aware of the dilemma of the breast diagnosis.[12] Since 80% of breast cancers are detected by the women themselves, this justifies the large diffusion of self-examination. This figure seems to be in disagreement with the actual proposal of various diagnostic methods in Senology . .

One peculiarity of the various diagnostic techniques is that each one diagnoses, at least partly, lesions which are not diagnosed with the other techniques (Fig. 1).

Here begins the dilemma of the senological diagnosis. There are many scientifical dibates trying to demonstrate the greater efficacy of a method vs. another. But one has to remember that the positivity of a method vs. the negativity of another, does not necessarily mean that the former is better, differing the explored area of the dark screen from any other, as shown in Fig. 1.

It is well known[2, 6, 8, 13, 17] that the accuracy of 90% is relatively easy to reach with the dif-

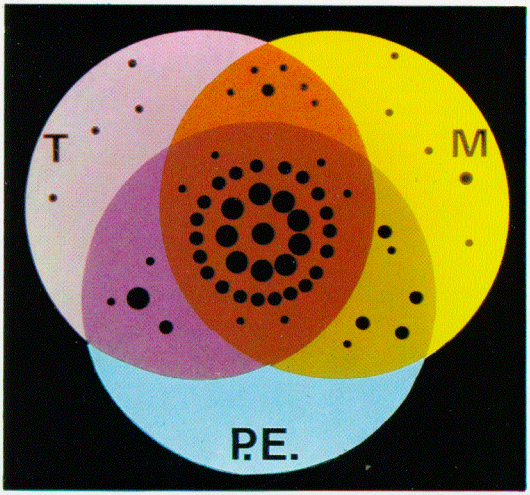


Fig. 1. A dark screen represents the whole female population. This dark screen masks all the breast cancers. Every diagnostic method represents a light spot which evidentldtes only a sector of the dark screen.. The first light spot (Physical Examination = P.E.) detects many breast cancers. The second light spot (Mammography = M) identifies, in part the same lesions as the first one but in part some new lesions. Finally, the same happens with the third light spot (Thermography = T) detecting other new lesions. Neverthless even if several methods are associated, there are some lesions which remain masked in the dark screen, and nobody knows how many other breast cancers are hidden in the unlit surrounding screen.

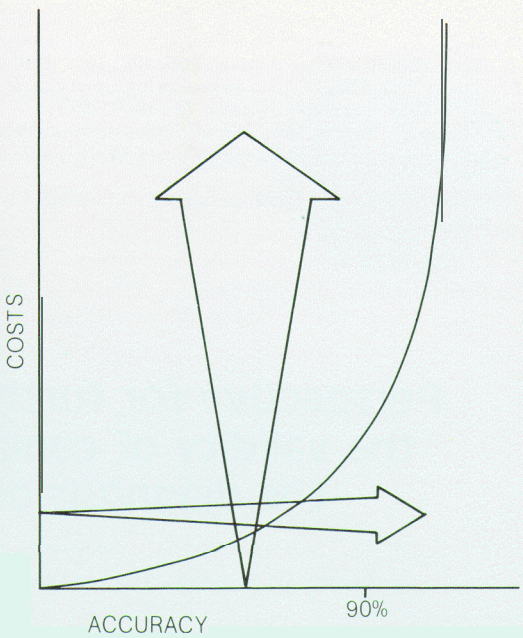
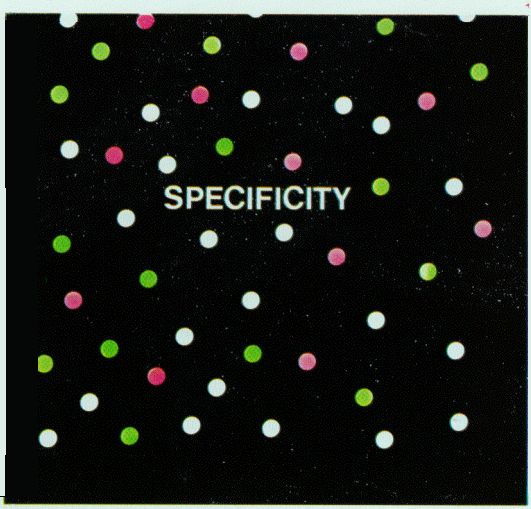


Fig. 2. Exponential increase of the costs, where accuracy is improved up to 90%.

ferent methods. On the contrary, it is more difficult to get over this threshold; this presumes a high expense of personnel time, equipment and consequently a cost increase in an exponential way (Fig. 2).

Why this explosion of cash? Every method has its own sensibility and specificity. Sensibility is the ability to find a lesion (Fig. 3A) and specificity that to distinguish between benign and malignant lesions (Fig. 3B). The

A



B

Fig. 3 A-B. Schemes which illustrate the concept of sensibility (A) (presence of a lesion) and specificity (B) (type of the lesions).

higher the sensibility and the lower the specificity, the more unclear or even false positive findings appear, which must be clarified further. It is this ballast of unclear and false positive findings, which is peculiar to each further employed method, which causes most of the cost explosion. This is a part of the dilemma of breast diagnosis. Taking now in consideration another figure often seen in the statistics all over the world, this shows a diagnosis of 25-35 breast cancers out of 100 biopsies,[17-25] namely about 30%. How is it possible to explain a value of only 30% if the method requiring the biopsy has an accuracy of 90%? First of all, the real false negative rate can seldom be exactly established. Moreover, most of the Authors limit themselves to calculate the accuracy rate on the basis of the detected cancer in a population, without taking into account the false positive rate.

But what are the published accuracy rates for benign lesions? What a surprise! Also 80-90%;.[6, 21] The question arises. Why benign lesions are 70 out of 100 women biopsied, if in 80-90% a, benign lesions is predicted? Partly, this can be explained by the fact that a positive finding by one method cannot be canceled by a negative finding of another method. But partly this results also because people do not believe in their benign results. Already MACDONALD said in 1964 for mammography (M.), what is true for all non invasive methods: «Bad news are most often valid, good news are not much better than no news». What can be done to evade this dilemma and to improve the results? First, all people working with these methods, clinically and/or scientifically, must try to show the real possibilities, but even more important, must try to show the limits of the method. Second, there must be an effort to improve the methods and to improve the reading of the findings. Contact thermography (C.T.), in comparison with M., is a young method, which must be further developped. But further development cannot be done by the confirmation of wellknown facts already proven by several work-groups. In other words, no more time should be wasted to show that C.T. can find carcinomas also found by other methods, or to show that C.T. misses carcinomas found by other methods. Studies are necessary, in order to continue the basic work, setting foot in new territories.

Most Examiners, (the personal group not excluded) performed C.T. with a knowledge of at least the clinical data such as age, palpation, inspection, or even with a knowledge of the M. findings. Under such conditions the. Examiner, although with the best intentions, cannot be free from bias. To prevent any misunderstanding it has to be emphasized that the C.T. findings should always be evaluated together with the clinical and/or radiographic findings but further studies should be done prospectively in randomized well defined populations, without any influence by other than C.T. data.

B) PATIENTS AND METHODS

The present report was filled in collaboration with 3 other radiological Centers (Cincinnati, Wisconsin, UCLA) in which the Readers of the C.T. examinations had no other information than the T. images (cooled and uncooled). I[6] The pictures were taken according to the personal instructions given in teaching sessions before the study started.

1. Aim of this study was to determine: a) if the *teaching* of the technique of the C.T. examination is efficient; 6) if the C.T. examination can detect patients with *proliferative disorders* of the breast; c) if a *delegation* of the C.T. examination is possible; d) which is the *accuracy* of the C.T. examination independent of other clinical or radiological data. Most people believe that C.T. examination requires immediate evaluation of C.T. pictures by the Examiner himself, particularly as to the «dinamic» part of the test. After 8 yrs of experience with the C.T. method and 5 yrs of teaching the C.T. method in over 30 meetings, the personal opinion is that an evaluation of technically satisfactory uncooled and cooled C.T. pictures alone is possible with some restrictions. Otherwise all teaching sessions with slides and all illustrations in textbooks would be worthless!

2. The **evaluation** of the C.T. pictures was done by means of a computer program (Fig. 4).

BASEL HOSPITAL - UNIVERSITY DEPARTMENT OF GYNAECOLOGY
SENOLOGIC DIAGNOSIS

Identification ☐☐☐☐☐ Date: _____

	RIGHT	LEFT
Plate sensibility	6 ☐	☐
Plate choice	8 ☐	☐
Symmetry	☐	1 = symm., 2 = R 1, 3 = r L,
Vascularisation	☐	☐

		24 ☐☐
Axilla	☐☐	
Quadrant	☐☐ ☐☐	☐☐ ☐☐
	☐☐ ☐☐	☐☐ ☐☐
Breast	☐	☐

Dynamic ☐ ☐

Technical errors	37 ☐	38 ☐
Technique	☐ 1 = good, 2 = sufficient, 3 = poor	☐
Judgment	☐ 1 = A/B, 2 = C– 3 = C+, 4 = D	☐
	43 ☐ 1 = C- in presence of veins	44 • I

Notes: _____ _____ _____

Fig. 4. Computer schedule for evaluation of C.T. findings.

Tab. I. **Contact thermography findings.**

	No. cases	A and B	c -	c +	D
Normal breasts	686	62.4%	27.3%	10.2%	0.15%
Non proliferative lesions (benign)	25	72%	12%	12%	4%
Proliferative lesions (benign)	34	64%	23%	11.8%	–
Breast cancers	36	24%	21.7%	12.1%	42.2%

Contact thermographic finding; A/B = normal and/or benign; C– = abnormal, but most probably benign; C+ = suspected; D = malignant.

The following criteria were considered: platesensibility; choice of the plate; symmetry/asymmetry; vascularisation; thermic pattern in all quadrants, axilla and nipple; thermodynamic; technical marks; size of the breast. The classification of the C.T. pictures was done according to TRICOIRE[26] (A = normal; B = benign; C- = abnormal, but probably benign; C+ = suspect; D = malignant). C.T. studies were performed on 2 populations. The first population was made up of 352 screened women who had been controlled for 5 yrs in a screening program and who had been normal at P.E. and M. The second set of the C.T. studies was performed on 87 women which had surgical biopsies for suspected breast lesions.

C) RESULTS

The efficiency of the teaching for a correct technique was proven; 92% of the C.T. pictures were technically good or sufficient.

1. The **contact thermography findings** are shown in Tab. I. No statistically significant difference was found between findings on «normal» breasts, breasts with benign non proliferative lesions, and breasts with benign proliferative lesions. The findings on breasts with cancers were statistically different from all groups.

2. In Tab. II the **«true positive rate»** and **«false positive rate»** are listed. The rates vary depending on whether the threshold was set at C-, C+ or D. When the threshold was set on C- the true positive rate was 75.7% and the false positive rate was 37.6%. At the threshold C+, true positive rate was 54.5% and the false positive rate 10,3% and finally at the threshold D the true positive rate was 42 % and the false positive rate only 0.1%.

Tab. II. **«True positive rate» and «false positive rate. in function of the thresholds C-, C+, D.**

Threshold	True positive	False positive
C–, C+, D	75.7%	37.6%
C+, D	54.5%	10.3%
D	42%	0.1%

3. In a **retrospective analysis** the C.T. pictures were re-evaluated. Important is that in the group of the so called G normal H breasts 63/71 so called «false positive» C.T. were also retrospectively suspected at C.T. examination (Tab. III).

Tab. III. **Contact thermographic findings in «normal» breasts.** (686 obs.).

Approach	C+ and D
Prospective	71 (10.3%)
Retrospective	63 (9.1%)

Fig. 5. «Edge sign».

Striking was that in 4/31 cases with proliferative breast lesions and in 2 cases of cancer a general symmetrical hyper-vascularisation was mismterpreted prospectively as a sign of pregnancy. In 2 cases a sign, the so-called «edge sign», not mentioned so far in the C.T. dictionary, but well known in tele-thermography was observed (Fig. 5).[14]

4. The different **thermic signs** were analyzed by a computer-program.

a) Simmetly (Fig. 6A).

In «normal» breast no thermic dominance of the left side could be found as described in Literature (JOHANNSON 1976).

It was not possible to distinguish the breast with benign proliferative and non proliferative lesions by means of the thermic symmetry or asymmetry. But the group of breasts with cancer showed significantly more asymmetry than all other breast groups.

6) Vuscularisation (Fig. 6B).

It was not possible to distinguish benign proliferative and non proliferative lesions by means of the degree of vascularisation. But «normal» breasts showed less statistically significant hypervascularisation than all other breast groups; 15% of the breast with cancer showed a hypo-vascularisation.

c) Thermic pattern (Fig. 6C).

In normal breasts normal vascular patterns were found statistically more often than in breasts with proliferative lesions and breasts with carcinomas. Venous pattern was found statistically significant more often in breasts with benign lesions. No difference was found concerning the so called «mastopathic vascular pattern» between normal breast and breasts with non proliferative and proliferative lesions. It would be better to drop the expression «mastopathic vascular pattern» and to use descriptive designations.

d) Nipple (Fig. 6D).

Also in normal breasts the thermic level of the nipple may be slightly increased; 17% of normal breasts and 24% of breasts with carcinoma showed a slightly warm nipple. So, there was no significant difference. Whereas a hot nipple has a very high specificity for carcinomas, but only 15% of the carcinomas showed this important sign.

e) Thermo-dynamic (Fig. 6E).

Totally, 80% of the normal breasts had a normal thermo-dynamic, and only 1,3% a highly increased dynamic. Breasts with benign lesions showed a slightly increased dynamic but the difference was not significant.

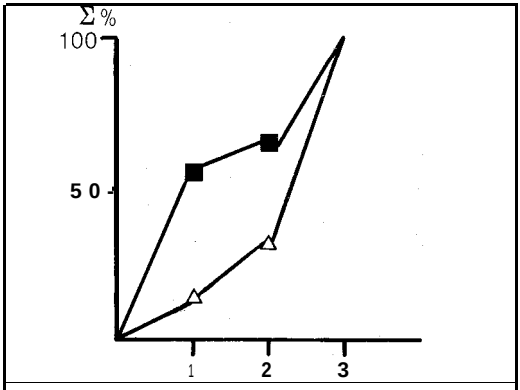
A normal dynamic was found seldomer in breasts with carcinomas than in normal breasts, and the difference was statistically significant. But a normal dynamic cannot rule out a carcinoma, since 34% of the breasts with carcinoma had a normal thermo-dynamic.

f) Specificity of thermic signs.

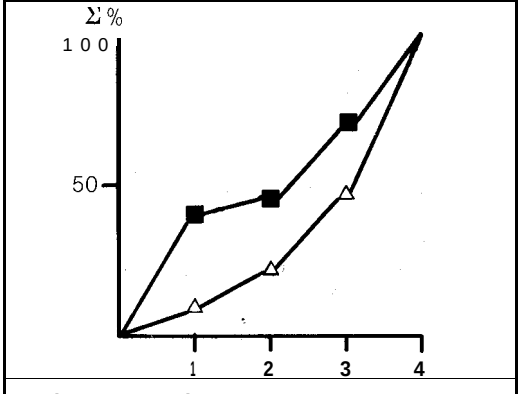
The exact specificity of the different signs is listed in Tab. IV. The highest specificity has the «high increased thermo-dynamic»; followed by «hot nipple», «pathologic thermic pattern», «asymmetry» and finally «hypervascularisation».

D) DISCUSSION

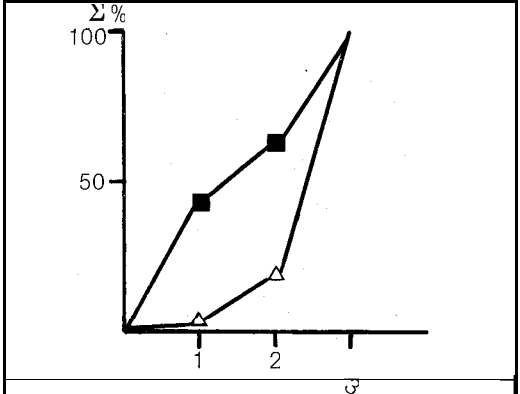
The study showed that: *a)* the *teaching* of the technique of the C.T. method was efficient. b) After a certain time a teaching should be repeated to *efface mistakes. c) A delegation* of the C.T. is possible, but not optimal and it should not be used in clinical practical circumstances. *d)* The *dynamic test* cannot be evaluated as effectively by means of the C.T. as by instant evaluation during the test. e) C.T. cannot identify patients affected by *proliferativ disorders* of the breast, i.e. it cannot identify patients at a ((histological)) high risk. The histological risk factors do not allow one to make a prognosis in an individual case. But there are



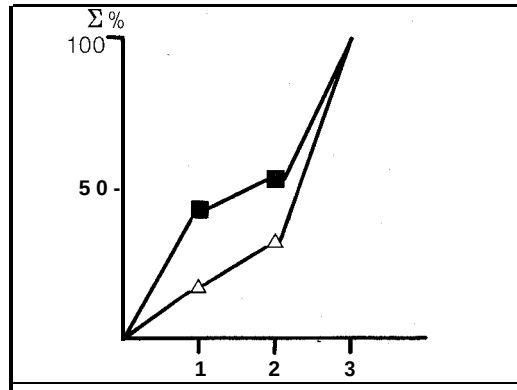
Thermo-vascular symmetry
1. warmer than opposite breast
2. colder than opposite breast
3. symmetrical



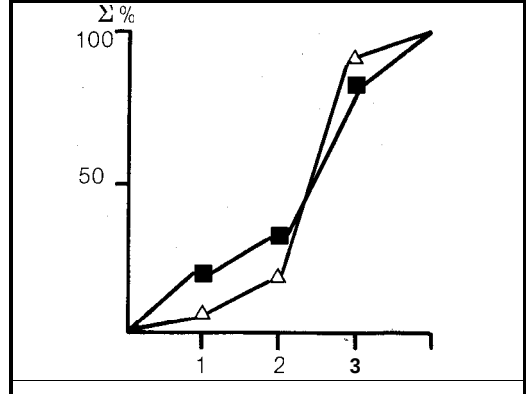
Thermo-vascular pattern
1. pathologic pattern
2. 'spicule' 'crescent-like' 'sickle-like' pattern
3. venous pattern
4. normal pattern



Thermo-dynamic
1. increased
2. slightly increased
3. normal



Vascularisation
1. hypervascularisation
2. hypovascularisation
3. normovascularisation



Nipple
1. hot nipple
2. warm nipple
3. slightly warm nipple
4. cold nipple

Fig. 6 A-F. A) Thermo-vascular symmetry; B) Vascularisation; C) Thermo-vascular pattern; D) Nipple; E) Thermo-dynamic; (■) Breasts with carcinoma and (△) normal breasts.

Tab. IV. **Specificity of contact thermographic signs.**

Increased thermo-dynamic	31.2%
Hot nipple	**16.8%**
Suspect thermic pattern	**5.7%**
Asymmetry (warmer)	**3.3%**
Hypervascularisation	**2.1%**

indications from other studies that C.T. may identify patients with a higher risk other than «histological risk».[9, 22]

Some conclusions can be drawn from this study. The way this study was performed can be used also for other studies, while the thermographic classifications A/B, C-, C+, and D are not suitable for use in studies. Only the analysis of the different thermic signs promises success, although it is so extensive to require a computer. Prospective studies must be done to find the significance of the so called «false positive C.T.», expressed by exactly defined thermic signs. But as with all studies in breast cancer, these studies need a long time, over 5-10 yrs. Progress can only be made, if one dares to question again what has been attained and if one dares to throw overboard false dogmas.

REFERENCES

1. AMALRIC R., SPITALIER J.M., LEVRAUD J., ALTSCHULER C.: Les images thermovisuelles des cancers du sein et leur classification. 1 st. sém. AGA, Thermovision, Toulouse 1972. *Corse médit. méd.*, 216-39, 1972.
2. BJURSTAM N., HEDBERG K., HULTBORN A., JOHANSSON N., JOHNSON C.: Mammography in diagnosis of breast cancer. In: 13th internationalen Kongress für Radiologie. Madrid, 1973. Excerpta med. (Amst.) Sect XIV.
3. BITHMANN G.A.: *Bedeutung der Thermographie für die Beurteilung beigner und maligner Brusterkrankungen.* Habil. - Schr. Heidelberg, 1975.
4. BOTHMANN G.A., HAAG D., WURSTER K., RUMMEL H.H.: Beziehungen zwischen metrischen, zyto - und histomorphologischen Faktoren und thermographischen Befunden beim Mammakarzinom. *Schweiz. med. Wschr.*, **106**, 1122, 1976.
5. BRUN DEL RE R., ALMENDRAL A., DE GRANDI P., HIRSCH H.A., STUCKI D.: Ergebnisse der Abklärung von Brustveränderungen im Rahmen einer speziellen Mamma-Sprechstunde. *Schweiz Rdsch. (Praxis)*, **65**, 1393, 1976.
6. BRUN DEL RE R.: Apparative Ausrüstung des Frauenarztes, Thermographie in der Klinik und in der Praxis. *Gynäk. Rdsch*, **18**, 11-14, 1978.
7. FOCHEM K.: Wertigkeit der Plattenthermographie bei der Brustuntersuchung. In: *Die Platternthermographie*, Hrsg.: K. Fochem. Symposium in Wien, Oktober 1976.
8. FRISCHBIER H.J., LOHBECK H.U.: *Frühdiagnostik des Mammakarzinoms, Lehrbuch und Atlas*, 1977. Stuttgart, Thieme.
9. GAUTHERIE M., GROS C.M.: Thermographie und Brustkrebs: Diagnose, Prognose, Ueberwachung. *Gynäk. Rdsch.*, **19**, 183, 1979.
10. GEISSLER K.-H., RUMMEL W., KINDERMANN G., WEISHAAR J.: Zur Treffsicherheit der Platten-Thermographie bei der Diagnose von Mammaerkrankungen. *Arch. Gynäk.*, **219**, 128, 1975.
11. GROS C.M., GAUTHERIE M., ARCHER F.: Séméiologie thermographique des épitheliomas mammaires. *Bull. Cancer*, 58-69, 1971.
12. HAAGENSEN C.D.: *Diseases of the Breast*, 2. Aufl. Saunders, Philadelphia, 1971.
13. HOEFFKEN W., LANYI M.: *Röntgenuntersuchung der Brust.* Georg Thieme Verlag Stuttgart, 1973.
14. ISARD H.J.: Thermographic « edge sign » in breast carcinoma. *Cancer (Philad.)*, **30**, 957, 1972.
15. KUCERA H., KUBISTA E., MUELLER-TYL E., REINOLD E.: Die plattenthermographische Mammadiagnostik. *Wien. med. Wschr.*, **124**, 739-742, 1974.
16. MOSKOWITZ M., FOX S.H., BASSET L.W., MILTRATH J.R., BRUN DEL RE R.: Liquid crystal thermography as a risk marker for breast cancer: a prospective study. *International Congress of Senology*, Hamburg, 1980.
17. OTTO R. CH.: *Aktuelle Röntgendiagnostik im Kampf gegen den Brustkrebs.* Huber, Bern, Stuttgart, Wien, 1980.
18. PISTOLESI G.F., DALLA PALMA F., GORTENUTI G., LOVISATTI L.: Termografia e cancro della mammella. *Radiol. Med.*, **59**, 881-919, 1973.
19. RACANELLI A.: Rilievi semeiologici con termografia a placche nelle affezioni cancerose mammarie. *Folia Oncol.*, **1**, 16-32, 1978.
20. ROCCHI L.: I rapporti tra biologia del cancro e termografia. *Quad. Term.*, 3, 3-12, 1978.
21. SCHNEIDER G.: 5000 Mammographien - Ergebnisse und Analyse. Oesterr. *Z. Onkologie, 3. 60-62*, 1976.
22. STARK A.M., WAY S.: The screening of well women for the early detection of breast cancer using clinical examination with thermography and mammography. *Cancer, 33, 1671, 1974.*
23. STUCKI D., BRUN DEL RE R., HERBST S., ALMENDRAL A.: Thermographie positive: que faire? *Gynäk. Rdsch.*, **18**, Suppl. 1, 147, 1978.
24. STUCKI D., BRUN DEL RE R., HERBST S., ALMENDRAL A.: Mammographie und Thermographie bei nicht palpablen Mammaveränderungen. *Gynäk. Rdsch.*, **17**, Suppl. 1-83, 1977.
25. STUCKI D., BRUN DEL RE R., DE GRANDI P., HERBST S., ALMENDRAL A.: Affections bénignes du sein observées en thermographie par plaques. Résultats de notre consultation mammaire. *VIII. World Congress of Gynaecology and Obstetrics*, Excerpta Medica 310, 1976.
26. TRICOIRE J.: *Thermographie en plaque.* CAWO PBL., Standtdruck, Greisenfeld, 1976.
27. TRICOIRE J., MARIEL L., AMIEL J.P., POIROT G., LACOUR J., FAJBISOVICZ S.: Thermographie en plaque. *Presse méd.*, **78**, 2483, 1970.