ISSN-1560-604X
Thermology international

Thermology

Volume 13 (2003)
Number 1 (January)

International

Literature survey: Thermology 2002

Abstracts of the 30th Annual Meeting of the American Academy of Thermology

Published by the

Ludwig Boltzmann Research Institute
for Physical Diagnostics
Austrian Society of Thermology

This journal is indexed in
EMBASE/Excerpta Medica

THERMOLOGY INTERNATIONAL

Volume 13 (2003) **Number 1 (January)**

Published by the
Ludwig Boltzmann Research Institute for Physical Diagnostics and the Austrian Society of Thermology

Indexed in
Embase/Excerpta Medica

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"Thermology international" erscheint 4 mal jährlich. Ein Jahresabonnement kostet 37.06 , - ein Einzelheft 10.90 plus Porto (4.36 pro Heft außerhalb Österreichs).

Für Mitglieder der Österreichischen Gesellschaft für Thermologie, der Deutschen Gesellschaft für Thermologie und der Amerikanischen Akademie für Thermologie ist die Zeitschrift im Mitgliedsbeitrag inkludiert.

Literatur

(1)International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to biomedical journals. Can. Med Assoc J 1997;156;270-7.

(2) International Committee of Medical Journal Editors. Additional statements from the International Committeof Medical Journal Editors. Can. Med Assoc J 1997;156; 571-4.

Uhlen Verlag Wien,
Ingeborg Machyl, Fachzeitschriftenverlag
Gusenleithnergasse 28a/12, A-1140 Wien
Thermology international
ISSN-1560-604X

Internet: http://www.uhlen.at/thermology-international

Inhaltsverzeichnis (CONTENTS)

Technical/Industrial Thermography (TECHNISCHE/INDUSTRIELLE THERMOGRAPHY)

Original Articles (ORIGINALIEN)

Reports (BERICHTE)

News in Thermology (THERMOLOGISCHE NACHRICHTEN)

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Gautherie M, HaehnelP, Walter JM, Keith L. Long-Term assessment of Breast Cancer Risk by Liquid Crystal Thermal Imaging. In: Gautherie M, Albert E, editors. Biomedical Thermology. New York Alan R.Liss Publ; 1982. p. 279-301.

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The journal "Thermology international" (formerly "European Journal of Thermology") is published four times/year. Annual Subscription rate is 37.06 , a single copy costs 10.90 .- plus mailing costs (4.36 .-/copy; outside Austria).

The journal is supplied free of charge to members of the American Academy of Thermology, the Austrian Society of Thermology and also to members of the German Society of Thermology.

References:

(1)International Committee of Medical Journal Editors. Uniform requirements for manuscripts submitted to biomedical journals. Can. Med Assoc J 1997;156;270-7.

(2) International Committee of Medical Journal Editors. Additional statements from the International Committee of Medical Journal Editors. Can. Med Assoc J 1997;156; 571-4.

Uhlen Verlag Wien,
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Gusenleithnergasse 28a/1, A-1140 Wien
Thermology international
ISSN-1560-604X

Internet: http://www.uhlen.at/thermology-international

"Image ThermaBase" – A Software Programme to Capture and Analyse Thermographic Images

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Summary

"Image ThermaBase" is a software package that was designed and implemented at the Thermology Laboratory of the Paediatrics and Nephrology Clinic, Military Medical School of Medicine in Warsaw, Poland. Its underlying concept is to enable the acquisition, processing and collection of examination results of medical thermal imaging. For that purpose, the package produces and stores thermal images together with medical data to allow the correct interpretation of images. The design of the system is aided by the Power Designer 7.5 CASE software tool and implementation is achieved in the Borland Delphi 5 Client / Server RAD environment. Sybase SQL Anywhere 6 was used as a database engine. First experiences suggest that "Image Therma- Base" is as useful in every day medical practice as originally intended.

In this paper we show also a portion of the data requirement analysis. This analysis was made during the design period of the application. Its main goal was to include patient related data that are not usually considered to be part of a thermological examination. However, this additional information may be useful for clinicians involved in the evaluation and assessment of thermal images. Functionality and coefficients, which are computed by "Image ThermaBase" software, are also included.

Key words: image collection, thermographic images analyse, Image DataBase, software design

„Image ThermaBase" – Ein Computerprogramm zur Erfassung und Analyse thermographischer Bilder

Das Software Paket "Image ThermaBase" wurde für das Thermologie Labor der Klinik für Pädiadrie und Nephrologie, der Militärischen Medizinischen Fakultät in Warschau, Polen entwickelt und implementiert. Das Programm erlaubt es, Daten von medizinischen Thermographien aufzunehmen, zu bearbeiten und Ergebnissammlungen zu verwalten. Um das zu erreichen, generiert und speichert das Programm die Wärmebilder gemeinsam mit den medizinischen Daten, um eine korrekte Interpretation der Bilder zu ermöglichen. Das Design des System wird durch das Software-Tool Power Designer 7.5 CASE unterstützt und die Implementierung wurde mittels der Borland Delphi 5 Client / Server RAD Umgebung bewerkstelligt. Sybase SQL Anywhere 6 wurde als Datenbank-Maschine verwendet. Erste Erfahrungen unterstützen den Eindruck, dass "Image Therma- Base" sich in der täglichen medizinischen Praxis in der gewünschten Art sehr gut bewährt.

In dieser Arbeit wird auch ein Teil der Analyse notwendiger Daten dargestellt. Diese Analyse wurde während der Entwicklungsperiode der Anwendung durchgeführt. Das Ziel war Patienten bezogene Daten einzuschließen, die üblicher Weise im Zusammenhang mit thermographischen Untersuchungen nicht erhoben werden. Trotzdem kann diese Zusatzinformation für den Kliniker, der Thermographien auswertet und interpretiert, sehr hilfreich sein. Auch werden die Funktionalität und Koeffizienten beschrieben, die vom Programm "Image ThermaBase" generiert werden.

Schlüsselwörter: Bildsammlung, Analyse von Wärmebildern, Bild-Datenbank, Software-Entwicklung

Introduction

In this paper we present the requirements, development process, structure and basic set of functions which were implemented in a specially designed software for thermal images analyses, particularly for medical applications. In our opinion the most important things in the future will be the possibility of advanced analysis of thermal images in connection with other medical data.

The thermal image of an object may be acquired by different methods [14]. Depending on this, images can be recorded with qualitative information – when the temperature distribution is presented by a colour palette, or quantitative information – when the temperature value in a selected point of an area is provided [3]. Thermal images are currently recorded by thermal cameras, because this is an easy and accurate method. Depending on the type of camera we can obtain either qualitative or quantitative information. Many cameras also have embedded software for basic analyses of captured images (i.e. the result of an examination) and save the images in various file formats. Manufacturers usually use their own format for image capture, which may vary between different manufacturers. After image recording, this image will be precisely analysed by specialized software, which is usually supplied with the camera. Such software is sufficient for the analyses of thermal images in standard industrial or technical applications. But thermal cameras as used also in medicine, where there are different requirements for software analysis of thermal images. This project was therefore started to develop a software programme for the evaluation of medical thermal images.

Requirements for software to analyse medical thermal images

During the analysis of thermal images clinicians do not usually evaluate the total image, but often look at selected areas, termed Regions of Interest (ROI) [12, 14]. In most software ROIs can be defined in the shape of a segment, ellipse, rectangle or polygon. For each ROI the values for minimal temperature, mean temperature, maximum temperature and standard deviation are computed [8, 14]. In medical applications many additional parameters may be used such as area and circumference of outlined regions, the length of lines, median temperature and the more easily interpreted values of the thermal indexes which have defined in Btherm and Ctherm as S0, S2, S4 [5,9]. In addition to this, this *Image ThermaBase* package has functions to compare selected regions of interest in the same or different images.

Medical information about the patients is essential for the correct interpretation of their thermal images. We therefore include data such as age, weight and height of patient, diagnosis, history of surgery, drugs and other treatments within the software. These medical data can be associated with patients data, examination date or result of examination.

A medical thermal image is usually one part of medical diagnostic imaging. A patient's thermal images can also be linked with their treatment documentation. Medical patient records are currently stored in electronic form. The software for analysis of medical thermal images should therefore be used as a network application which is capable of being connected with the hospital's information system.

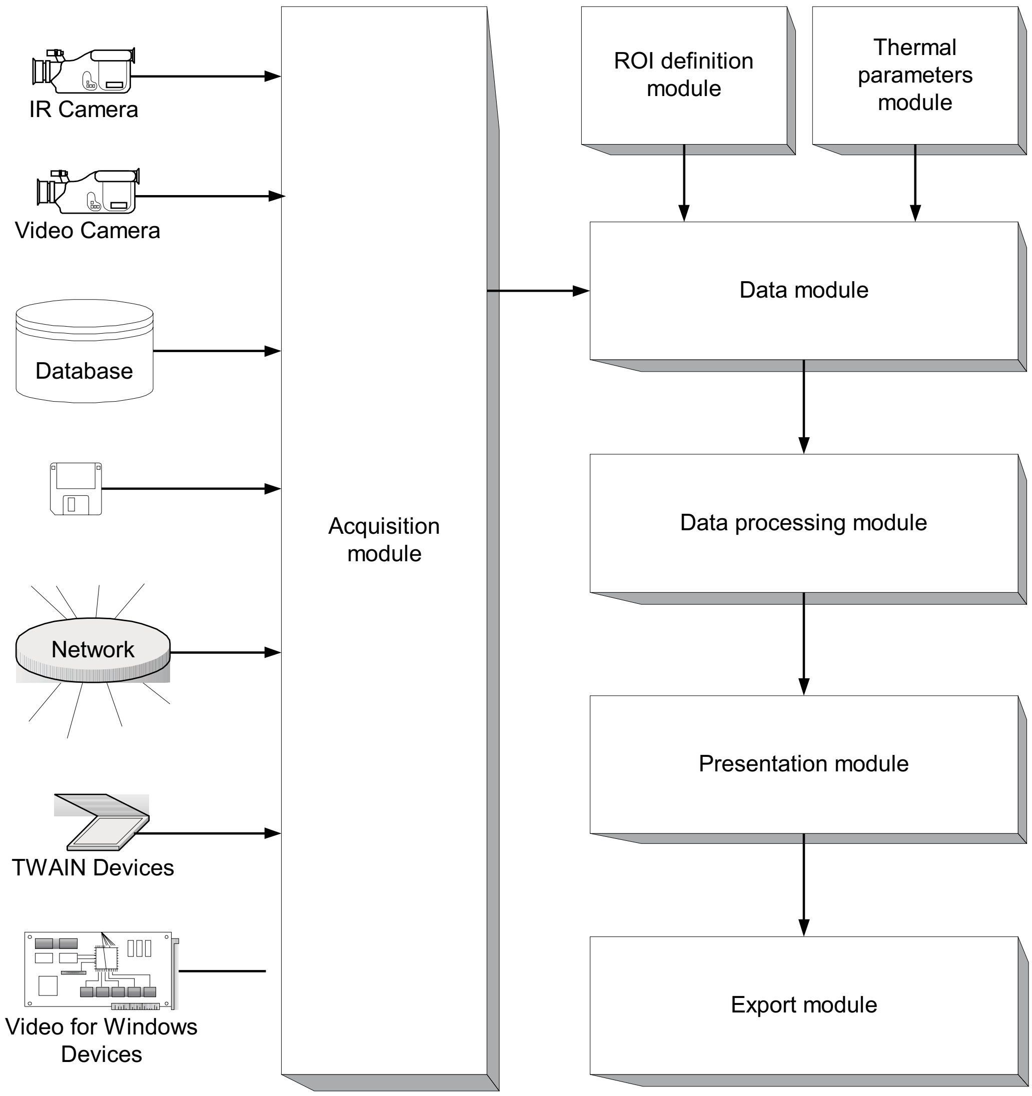
Software Development

At the start of this software development, we described the essential set of data and functions required for medical thermal image analysis [13].

In the next step a model was made of the database and its application. We also defined interfaces between modules. The database model was created with Power Designer 7.5 CASE software [1, 2].

In the third step the database and the software modules were developed simultaneously. In each module the al-

Figure 1
Software structure



gorithm for all functions was defined. The database was built in a Sybase SQL Anywhere database server. Software modules were executed in the Borland Delphi 5.0 Enterprise [6, 7, 11] software environment.

In the last step all modules were connected and tested to check the communication between the database and software modules.

Software structure

For the analysis of medical thermal images a modular software package was created (Figure 1), because it can easily be adapted in the future.

The basic part of the application is the "Acquisition module". This module works with different devices such as a thermal and a video camera, TWAIN devices, floppy disk, and a network. It reads data from these devices and converts it to independent data structure. This means that the designed structure is independent from the type of file and/or device. In the next software module "*ROI definition module*", the user defines ROIs and processes all the specific operations. The "*Thermal parameters module*" manages thermal parameters of an image. These data are used for the„*Data module*". This block works on thermal and ROI data and computes values of temperature. The user can change, for example, the value of emissivity and this module will recompute all values of temperature and statistical coefficients. "*Data processing module*" processes all functions on the area of interest. It can work with an area of temperature or with area of brightness values (standard graphic images). The "*Presentation module*" shows the results of this computation. For the user it serves a graphic user interface. The last module is an "*Export module*". This part of software implements the function and procedures to exchange data between different software applications such as Microsoft Word, Matlab, CTHERM and export user selected data to an external file or a system clipboard.

Software functions

"Image ThermaBase" software is especially designed for medical use. It can work with or without the database based on the users' choice.

When the software works with the database it can store additional medical information together with the thermal images such as:

Patient's information: first name, surname, birthdate, gender, security number (PESEL number for Poland), patient habits such as smoking or alcohol consumption, previous diseases and current conditions e.g. asthma;

Examination's details: date, time, patient weight and height during examination, Body Mass Index, Euro – Qol index, background temperature, humidity, examination code number, description of the examination, clinician undertaking the examination, medication taken prior to the examination, information on surgery or medical treatment before examination (during the previous 6 months);

Examination results: the thermal image itself, its type (for example: thermal image, RTG image, Vision Image), projection type used, a dedicated result code (where applicable) and a verbal description of examination results.

Many software functions are presented in the user interface as a button with a small icon. Image functions are grouped into many toolbars depending on their function (Figure 2).

Figure 2
The "Image ThermaBase" user interface showing coefficients of regions of interest

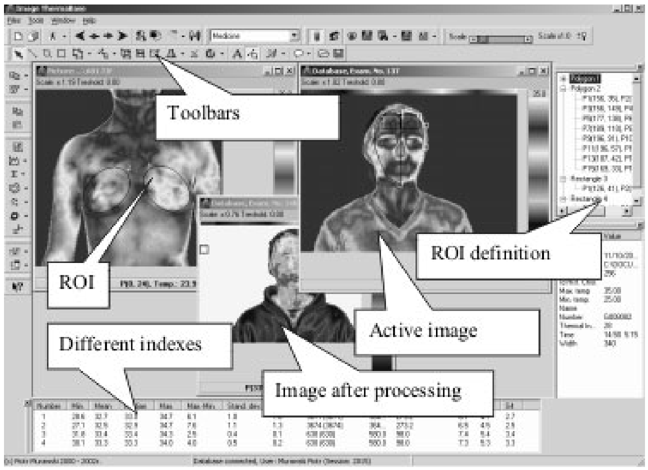


Table 1
Software functions working on Regions of Interest (ROIs)

Function Name	Description
Move	move the ROI around the image
Resize	enlarge or shrink the ROI
Copy	copy a ROI into a different part of the same image or any other image
Mirror	horizontally and vertically around the centre of mass or user defined point
Save	save ROI for re-use in images acquired at later stages
Export ROI	export ROI definition via Windows clipboard function to other software packages
Export image	copy image to Windows clipboard for use in other packages
Slice	drawing of a cross-section through the image
3-D	representing temperature values in a ROI by a 3-D graphic
histogram	histogram of a ROI, option to equalise
Rotate	rotate ROIs such as ellipses
2D FFT	2 dimensional Fast Fourier Transform
mathematical	adding, subtracting and multiplying images / ROIs
Filter	various image processing functions for image filtering such as 'sharpen' or 'average'
threshold	highlighting of image areas above or below a certain temperature
isotherm	drawing a line which connects all pixels with the same temperature value

Table 2
Software functions working on the entire image

Colour scale	changing of the false colour scale to one of the system's scales or to a user defined one
acquisition	image capture using Video For Windows, TWAIN compatible procedures or thermal images grabber devices

Figure 3
Illustration of some software functions

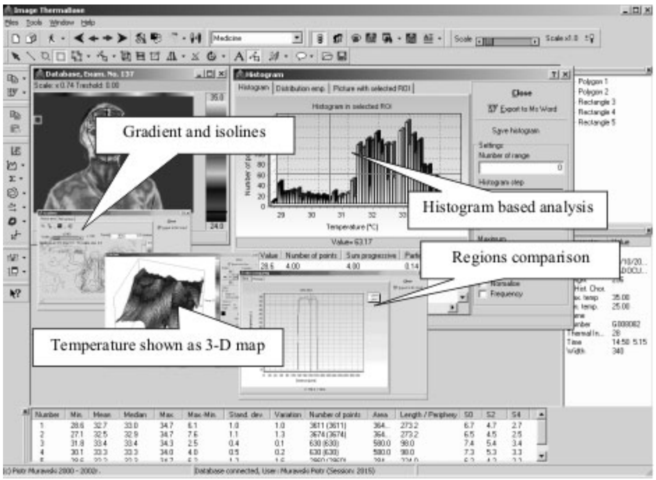


Figure 4
Different kind of regional comparison:
A) A – A', symmetrical B) A – A", asymmetrical

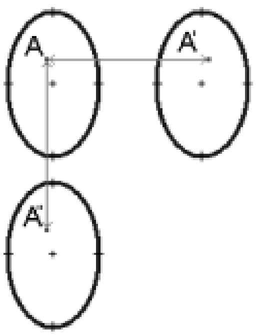


Figure 5
In this case the images are compressed and decompressed with out loss from the compression process therefore image fidelity=1, average difference=0**:**
A) is the source image B) the reconstructed imag**e**

A B

Figure 6
Index values for images before and after loss compression (image fidelity<1, average difference>0):
A) is the source image and B) is the reconstructed image.

A B

The basic set of software functions, most of which act on ROI's, are shown in tables 1 & 2 and illustrated in figure 3.

The next set of functions is to compare two user selected regions of interest from one or more thermal images. To do this algorithms are adapted to estimate the difference between images before and after loss compression [10, 15] (Figure 4). Based on this ROI's can be drawn as a matrix of temperature. Each point inside the compared regions has a value of temperature, each other point has a value "NAN" (non numeric) to make a difference required for the next comparative step.

Two type of comparison are defined: symmetrical and asymmetrical (Figure 4)

After this we can consider ROIs as two images, one before and one after compression. For comparison we used defined and accepted coefficients to find a similarity/difference between them. This means that if region B (Figure 5) is the same as region A .

Tthe images of figure 5 are compressed and decompressed with out loss from the compression process therefore image fidelity=1, average difference=0: A) is the source image B) the reconstructed image, then the difference value will be "0" and image the fidelity value will be "1" in the other case these values will be different from "0" and "1". When this value is near to "0" then comparative regions are completely different, and in the alternative situation the regions will be practically the same (Figure 6).

For indices of comparison we can use especially defined formulae[10]:

A) image fidelity

$$IF = 1 - \left(\sum_{x=1}^{M} \sum_{y=1}^{N} \left[f(x,y) - \hat{f}(x,y) \right]^2 / \sum_{x=1}^{M} \sum_{y=1}^{N} \left[f(x,y) \right]^2 \right)$$

B)normalized cross-correlation

$$NK = \sum_{x=1}^{M} \sum_{y=1}^{N} f(x,y) * \hat{f}(x,y) / \sum_{x=1}^{M} \sum_{y=1}^{N} \left[f(x,y) \right]^2$$

In the formula this represents the value of temperature in the first ROI, and – value of temperature in the second ROI. The final result is presented in Figure 7.

The software has increased function when working with the database. A interesting feature is the search engine. "Image ThermaBase" takes advantage of "*Query by Example*" concept to find data within the database (Figure 8). The user can define a set of images of special interest based on specific knowledge.

"Image ThermaBase" also has an additional module to present data by the CGI [4] Internet interface (Figure 9). This was tested with the Microsoft Internet Information Server. Access to the data is available after login to the system by the WWW interface from Internet or local network.

Figure 7
Comparing regions of interest

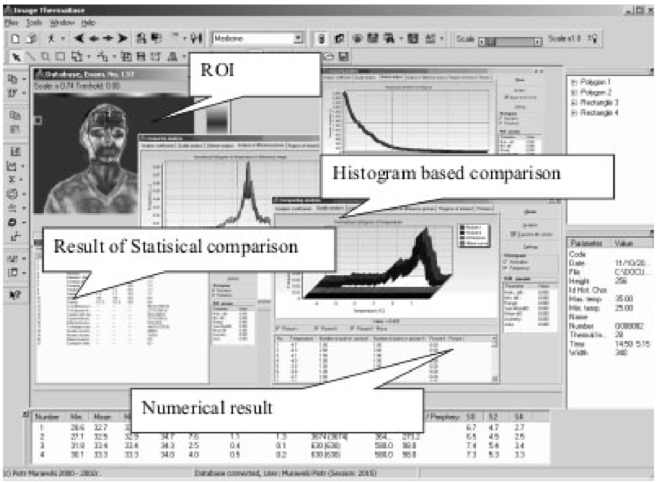


Figure 8
'"Query by Example" Interface

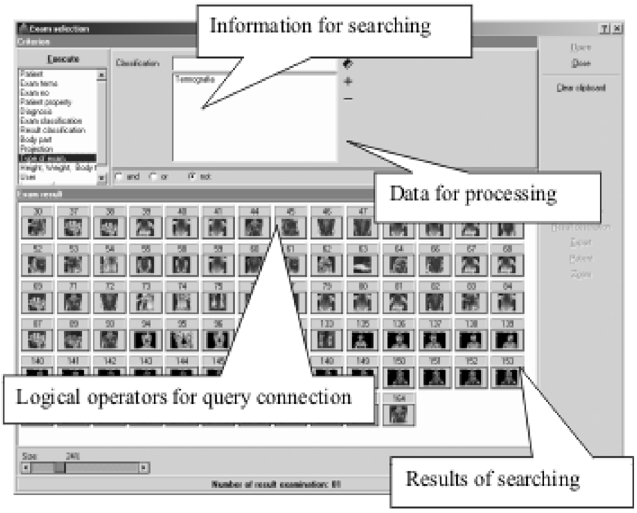
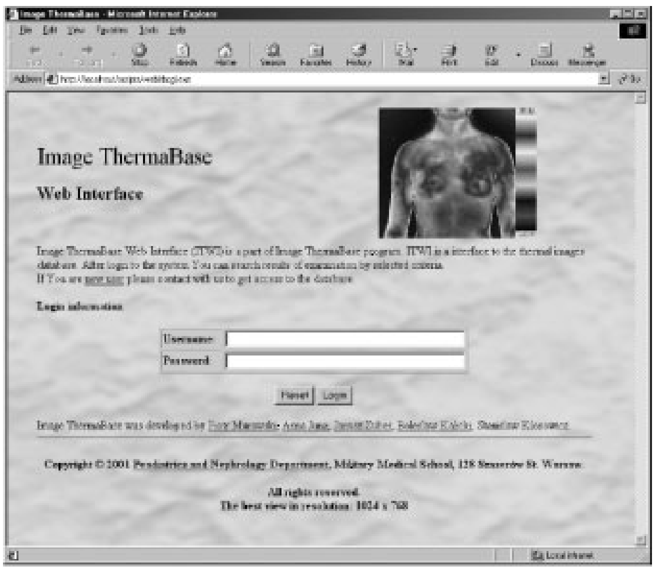


Figure 9
Internet CGI Interface



Summary

"*Image ThermaBase*" has been designed using the Borland Delphi 5 Enterprise RAD Environment and is intended to be an open system that works and exchanges data with a multitude of other software packages. One example may be the export to Microsoft Word (note the Word '*W*' icon on some windows in figure 3). The real power of the system, however, is based on its search capabilities using the SQL language and also techniques such as "*Query By Example*" which enable data access without knowledge of the SQL language. The usual search syntax using Boolean logic applies: and, nor, or.

The system is designed to interface with the user in either Polish or English and can work under Windows 9x/NT/2000 and XP.

Conclusion

The design of this software for analysis of medical thermal images has resulted in a set of special functions for use, which do not exist in standard applications for analysis of infrared images. The use of the database allows us to store medical data together with patient's thermal images. The modular structure of this software provides for future extensions to be readily constructed in the future.

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(Manuscript received 20.07.2002, revision accepted on 8.11,2002)

Citations

Please cite this paper as

Murawski P, Jung A, Ring FEJ, Zuber J, Plassmann P, Kalicki B "Image ThermaBase" - A software programme to capture and analyse thermographic images. Thermology International 2003 13(1) 5-9

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1. Ammer K. Thermology 2003 - – a computer-assisted literature survey with a focus on non medical applications of thermal imaging. Thermology International. 2004; 14(1):5-36

Thermology 2002 – a computer-assisted literature survey

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Summary

This literature survey is based on publications with the keywords "thermograpy" or "thermometry" or "temperature measurements" listed in the databases Medline and HighWire between 1.10.2001 and 31.12.2002. Papers from Thermology international, the Journal of Korean Medical Thermology and the Abstracts of 5 International Thermology Conferences were added to this database. This has resulted in more than 500 references, which is the second highest number of references since this annual literature survey was first published. A high number of publications were related to Biophysics, Petro- logy and Physiology. Thermography was the main subject of 87 papers, but a number of other methods of temperature measurements were used in clinical medicine.

Key words: Temperature measurement, thermography, literature search, Biophysics

Thermology international 2003, 13: 10-27

Thermologie 2001- eine Computer gestützte Literaturübersicht

Diese Liteaturübersicht basiert auf Publikationen, die mit den Schlüssewörtern "thermograpy" oder "thermometry" oder "temperature measurements"in den Datenbanken Medline und HighWire im Zeitraum zwischen 1.10.2001 and 31.12.2002 gefunden wurden. Veröffentlichungen aus den Zeitschriften "Thermology international", Jornal of Korean Medical Thermology" und die Kurzfassungen von fünf internatonalen Thermologiekongressen ergänzten die Daten für diese Übersicht. Diese resultierte in mehr als 500 Literaturzitaten, der größten Zahl von Zitaten seitdem dieser jährliche Literaturüberblick veröffentlicht wird. Viele Publikationen waren dem Themenkreis Biophysik, Gesteinskunde und Physio- logie gewidmet. 87 Veröffentlichungen beschäftigten sich mit der Thermographie, allerdings wurde auch über die Anwendung anderer Methoden der Temperaturmessung in der klinischen Medzin berichtet.

Schlüsselwörter: Temperaturmessung, Thermographie, Literatursuche, Biophysik

Introduction

This literature survey for 2002 is again published in English. The database of this report has been constructed from the succesful hits of a search in the medical database Medline, the database of the internet publisher HighWire, publications in the journals "Thermology international", "Journal of Korean Medical Thermology and the abstracts of five international Thermology Conferences. This survey will provide the reader with a broad overview of the current role of temperature measurements in medicine, biology and related fields.

Methods

A literature search was performed in the medical databases Medline and Highwire using the following keywords: "thermography"; "thermology"; "thermal imaging"; "infrared imaging"; "thermometry" or "temperature measurement". The time period selected was between 01.10.2001 and 31.12.2002. The list was compared with the list of references of last years' survey (1) so that papers already listed in this report are not included in the current references. All articles from volume 12 of Thermology international and from all issues of the Journal of Korean Medical Thermology have been added to the list of references. The database was analysed to show the origin of authors, the language and journal of publication and issue number of the publication.

The abstracts of all presentations of the 15th Thermological Symposium in Vienna, the papers of the Meeting of the Thermology Group of the UK Thermography Association in London, the abstracts of the 3rd Congress of the Asian-Pacific Federation of Thermology in Seoul, the presentations at the 5th Congress of the Polish Society of Thermology in Zakopane and all abstracts of the EMBEC Conference in Vienna related to temperature measurements or Infrared have been analysed in the same way.

Results

Publications from Medline and Highwire

A total of 361 publications, not previously reviewed, were found from both databases, which yielded178 hits in Medline and 183 in HighWire. Compared to last year, the number of publications is less by 30%, because the database Embase includes a higher number of publications than the database HighWire used this year. However, 87 publications, (a similar number to last year), appeared with the key word thermography indicating a relative increase of use of the thermal imaging technique. All other publications were related to temperature measurement.

English is the predominant language for publication (94,5% of publications), followed by Russian (1,4%), French (0.8%) German (0.5%), Japanese (0.5%), Polish (0.5%), Chinese (0.5%), Dutch (0.2%), Ukrainian (0.2%), Hungarian (0.2%) and Hebrew(0.2%).

465 institutes in 37 countries (Argentina 2, Australia 2; Austria 9; Belgium 8; Benin 3, Brazil 6; Bulgaria 1, Canada 10; China 5; Denmark 7; France 21; Germany 30; Greece 1; Hungary 4, India 1; Ireland 1; Israel 2; Italy 13; Japan 28; Malawi 1, Mexico 1, Netherlands 8; Nigeria 1; Norway 7; Poland 3; Portugal 2; Russian Federation 2; Singapore 1; South Africa 2; South Korea 4; Spain 4; Sweden 1; Switzerland 6;Taiwan 6; Turkey 1; United Kingdom 43; United States 118) were involved in temperature measurements.

In total, 184 journals published papers on temperature related matters. The highest number of publications, i.e. 44, were found in The Journal of Petrology, 14 papers related to temperature appeared in the Journal of Applied Physiology, 10 papers were published in the Annals of the New York Academy of Science and 9 in Circulation. Both, Anesthesia & Analgesia and the Journal of Experimental Biology dedicated 8 publications to the issue of this survey, and Science 7 papers. 11 journals published within the given time frame between 4 and 6 papers on temperature measurement. 7 journals were found that had published 3 papers, and 21 journals published two papers on temperature measurement.

16 publications reported clinical trials which were performed either in a controlled (94, 161, 231, 318) or randomised controlled study design (35, 102, 120 ,125, 149,183, 206, 215, 367, 416, 422, 482, 489). 8 papers were dedicated to evaluation studies of equipment (40, 82, 143, 251, 322, 398, 493, 508). 21 review papers and 2 technical reports were related to temperature measurement. 4 editorials and 7 letters also dealt with this issue.

Only Medline allocated their listed citations to distinct fields of medicine. For HighWire the appropriate allocations were performed by the author. The predominant field was Biophysics, Bioengineering and Medical Instrumentation with 129 hits (4, 6, 8, 9, 26, 27, 29, 33, 40, 49, 53, 55, 57, 74, 80, 81, 84, 90, 97, 98, 102, 103, 108, 109, 112, 113, 115, 116, 118, 119, 120, 124, 129, 133, 135, 137, 140, 142, 143, 144, 153, 161, 162, 165, 183, 186, 188, 192, 194, 197, 198, 200, 205, 206, 207, 213, 217, 220, 227, 230, 237, 241, 288, 291, 298, 299, 303, 317, 320, 321, 329, 334, 336, 337, 338, 339, 347, 351, 354, 356, 362, 363, 372, 374, 385, 386, 389, 390, 391, 392, 394, 406, 411, 412, 416, 420, 423, 424, 425, 426, 427, 428, 429, 442, 443, 444, 448, 449, 466, 467, 471, 473, 475, 478, 480, 483, 486, 489, 490, 491, 492, 493, 494, 495, 496, 504, 505, 508, 519). 51papers were related to Geology and Petrology (34, 38, 46, 71,73, 75, 101, 127, 128, 131, 132, 134, 138, 141, 146, 147,148, 166, 170, 171, 172, 187, 195, 222, 232, 234, 235, 238, 275, 295, 296, 319, 330, 331, 341, 344, 364, 365, 382, 388, 395, 403, 405, 407, 419, 446, 455, 456, 506, 507, 508, 513, 514) and Chemistry and Clinical Biochemistry was the allocation for 13 publications (189, 221, 315, 322, 346, 348, 375, 447, 450, 461, 465, 470, 472) Environmental Health and Pollution Control (37, 43, 45, 52, 66, 139, 145, 156, 233, 244, 286, 313, 340, 352, 509), Botany (25, 55, 208, 227, 312, 326, 376, 468). Zoology and Veterinary Medicine (54, 116, 118, 177, 178, 231, 292, 293, 294, 304, 368, 439, 440, 441, 458, 459, 476, 484, 503), Public Health, Social Medicine and Epidemiology (47, 60, 111, 113, 151, 210, 218, 251, 325, 347, 362, 402, 408) and Health Policy, Economics and Management (123) were also addressed. Pharmacology had an allocation of 36 papers (41, 42, 72, 93, 94, 106. 125, 154, 180, 189, 196, 199, 204, 214, 215, 242, 247, 294, 301, 306, 346, 367, 373, 375, 387, 422, 442, 443, 444, 445, 472, 474, 497, 498, 512, 520) and Pharmacy had 1 paper(328),

The allocations for basic medical sciences were in the following fields: Anatomy, Anthropology, Embryology And Histology (120, 322,426, 427,428, 491), Developmental Biology and Teratology (463) General Pathology and Pathological Anatomy (1,51, 77, 79, 89,107, 126, 130, 134, 136, 180, 199, 216, 223, 299, 302, 329, 335, 345, 349, 350, 354, 366, 372, 387, 393, 413, 414, 415, 417, 438, 466, 481, 482, 490), Microbiology (25, 251), Physiology (5, 26, 31, 35, 36, 54, 60, 67, 92, 95, 105, 110, 116, 121, 142, 149, 150, 155, 158, 173, 220, 231, 242, 246, 282, 289, 292, 293, 294, 304, 318, 336, 361, 383, 404, 409, 418, 433, 439, 440, 441, 452, 453 ,454, 458, 459, 460, 462, 477, 479, 480, 488, 503).

Neurology and Neurosurgery (72, 80, 90, 93, 106, 107, 117, 121, 122, 133, 158, 197, 221, 242, 273, 289, 318, 343, 349, 354, 391, 393, 414, 415, 424, 438, 453, 460, 466, 481, 493, 496, 498, 511), Radiology (80, 81, 89, 97, 133, 143, 153, 162, 186, 194, 213, 303, 391, 424, 425, 426, 427,428, 452, 463, 467, 486, 487, 491), and Cardiovascular Diseases and Cardiovascular Surgery (68, 78, 79, 103, 104, 112, 124, 125, 206, 223, 247, 288, 291, 372, 417, 429, 442, 443, 444, 449, 482, 483, 504, 508, 513, 519) were the most frequent allocated specialities of clinical medicine. Pediatrics and Pediatric Surgery (4, 40, 57, 73, 98, 110, 111, 237, 298, 369, 384, 394, 402, 408, 420, 422, 423, 448, 485), Cancer (1, 26, 33, 80, 109, 115, 122, 136, 148, 180, 192, 299, 385, 392, 411, 475, 478, 487), Anaesthesiology (53, 102, 129, 158, 204, 215, 301, 373, 384, 418, 479) and Angiology (6. 29, 84, 94, 183, 214, 218, 350, 367, 413) were the next in frequency of allocation. Orthopedic Surgery (119, 120, 297, 343, 426, 427, 428, 485, 511), Obstetrics and Gynaecology (136, 192, 205, 217, 337, 339, 347, 425), Dermatology and Venereology (130, 196, 216, 298, 350, 366, 421, 497), Urology and Nephrology (126, 184, 385, 458, 478, 489, 494) and Arthritis and Rheumatism (32, 39, 108, 161, 421, 490, 492) were other medical fields related to temperature measurements.

Six or <6 papers were found in Gastroenterology (109, 180, 335, 392, 487, 514), Otorhinolaryngology (35, 36, 233, 345, 361), Physical Medicine and Rehabilitation(6, 92, 149, 161, 297, 497) Surgery (69, 102, 144, 495), Endocrinology (32, 199, 416, 473), Chest Diseases, Thoracic Surgery and Tuberculosis (115, 411, 412), Gerontology and Geriatrics (348, 351, 480), Ophthalmology (150, 198, 334), and Dental medicine (50, 188, 230), Occupational Health and Industrial Medicine (165, 356) Psychiatry, Immunology (462), Serology and Transplantation (69).

In total 1392 authors were found. Of these, 30 authors appeared with two papers, 16 authors with three papers. The American radiologist FG Shellock published eight papers.

Thermology international

12 full papers, 1 editorial and 61 abstracts from 3 major conferences were published in the journal Thermology international. All papers appeared in English. 4 papers were submitted from Austria (12, 21,23, 307), 3 from the United States (152, 360, 380), 2 from Poland (276, 436), and authors from Italy (352), Belgium (76), Germany (245) and Hungary (451) contributed 1 publication. Topics were chronic pain syndromes (352) , vascular disorders (23, 152, 436), osteoarthritis (12), cardiac surgery (451) dental treatment (276), manipulation treatment (23), diabetes (307 and thermoregulation (360). Two papers discussed the use of thermal imaging in botany (76, 245) and one in veterinary medicine (380).

Journal of Korean Medical Thermology

In 2001, the Korean Academy of Medical Thermology started their own print medium for publication. The Editor of this new journal is Prof Zhang from the Yonsei University. At the present time, two issue of the journal are available, 10 of the 14 articles included in this survey appear in English, 4 of them in Korean with an English abstract. All authors are Korean. The topics of the full papers were on monitoring treatment (86, 255, 260, 264, 266, 268), or physiology (252, 256, 257, 259, 515, 517)

Abstracts from conferences

114 abstracts and 23 short papers (24, 48, 56, 88, 157, 164,191, 209, 212, 249, 280, 281, 305, 308, 309, 310, 311, 324, 342, 355, 377, 396, 410, 430) from 5 Meetings on Thermology were included in this review. The authors of these presentations were from 13 countries (Table 1)

Abstracts were allocated to the following fields: Biophysics, Bioengineering and Medical Instrumentation (2, 3, 10, 17, 18, 19, 20, 24, 28, 29, 30, 56, 61, 82, 91, 99, 159, 160, 167, 174, 190, 191, 209, 212, 240, 280, 281, 305, 308, 323, 324, 377, 378, 396, 397, 398, 399, 400, 500, 501, 502), Physiology (13, 15,250), Neurology and Neurosurgery (63, 64, 114, 203, 226, 228, 229, 239, 253, 254,265, 270, 311, 359, 431, 432, 434, 5154, 516, 517), Cardiovascular Diseases and Cardiovascular Surgery (342, 435), Orthopedic Surgery (258, 310,), Occupational Health and Industrial Medicine (65, 271, 316), Obstetrics and Gynaecology including breast diseases (56, 59, 175, 185, 201, 202, 252, 262, 263, 305,358), Arthritis and Rheumatism (105, 182), Surgery (62, 99, 176, 211, 518), Veterinary Medicine (379, 380, 381), Dental Medicine (48, 70, 277, 278, 279, 355), Dermatology (191, 437), Endocrinology (168, 430), Paediatrics (219, 435), Urology and Nephrology (100, 309, 327, 371), Angiology (7, 16, 28, 29, 30, 82, 83, 160, 169,243, 284, 287, 370, 371, 401, 469), Oriental Medicine (85, 87, 225, 236, 256, 257, 259, 261, 333), Physical Medicine (22, 224, 267, 332, 435) and Forensic medicine (499).

Table 1 Origin of abstracts´authors

Origin of author	Reference
Australia	59, 307,
Austria	13, 15, 16, 17, 18, 19, 20,22, 24, 249, 284, 377, 396, 397, 398
Brazil	51, 52, 53, 54, 55, 355,
China	518
Czech Republic	114, 164, 410,
France	56
Italy	48, 157, 308, 309, 310, 311
Japan	283, 316, 327, 430, 437
Poland	70, 88, 100, 105, 191, 201, 211, 212, 219, 250, 277, 278, 279, 314, 323, 324, 342, 370, 435, 500,
South Korea	2, 3 ,85, 86, 87, 163, 193, 202, 203, 224, 225, 226, 229, 236, 239, 252, 253, 254, 258, 261, 262, 263, 265, 267, 270 274, 332, 333, 358,359, 431,432, 510, 515
Taiwan	209, 280, 281,
United Kingdom	10, 28, 30, 82, 83, 91, 99, 159, 160, 167,168, 174, 175,176, 182, 190, 243, 271, 285, 287, 300, 396, 397, 398, 399, 400, 401, 469, 499
United States	179, 185, 272, 305, 378, 379, 381

Discussion

The number of publications found for this survey is 30 % less compared to last years' review. This may be due to the fact that a different database was searched this year resulting in reduced numbers of hits in the fields of chemistry and clinical biochemistry.

The number of publications dedicated to thermography was relatively higher than last year (87 of 370 compared to 83 of 523). However, there is an increased reported use in the fields outside medicine such as botany, petrology and biochemistry. Neurology, radiology, cardiovascular medicine and paediatrics are the main fields of temperature measurements in clinical medicine. This is supported by the number of publications in journals and presentations in conferences. There is also a continuing interest in radiology to obtain temperature values from magnetic resonance images, mainly combined with monitoring tasks in hyperthermal treatment. Breast thermography which was not much mentioned in last years´ survey, appears to be in revival and is again becoming of increasing interest.

Research reported from the United States is reduced compared to last year's data. The influence of European researcher however is increasing in all fields, and the number of of publication is no longer restricted to applications in clinical medicine. The majority of papers dealing with geology and petrology originate from Europe, particularly from Germany. The United Kingdom, Germany, France and Italy combined, had the same number of institutes researching in temperature related matters as the United States, but the average number of publications per institute was higher in Europe than in the USA.

In conclusion, this years' literature survey has demonstrated a high interest in temperature measurement techniques, and the technique of thermal imaging has been increasingly used compared to the previous year. Although Biophysics and Engineering are predominant applications, temperature measurements in clinical medicine remains an important topic. Other fields in biology such as botany, zoology and veterinary medicine have shown an increase of interest in applications related to temperature.

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(Manuscript received on 7.1.2003, accepted on 20.1.2003)

Diagnosis of Raynauds Phenomenon Using a Hand Held Infra-red Scanner Compared to Thermal Imaging

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Summary

Raynaud's phenomenon (RP) is an intermittent abnormal spasm of the arterioles of distal limbs after exposure to cold or emotional stimuli resulting in painful or cold fingers. Average finger to wrist temperature indices <-4 °C acquired from an infrared camera are indicative of RP. However infrared cameras are expensive and inconvenient for use in the outpatient clinic or general practitioner setting.

The aim of this study was to compare the temperature index obtained from a thermal imaging camera with a hand held infrared temperature scanner.

Twenty one patients with suspected RP undergoing thermology examination using an infrared camera (Aga Thermovision® 782) were also assessed using a hand held infra-red temperature scanner (Exogen Dermatemp™). A temperature index before and 10 minutes after a cold challenge was calculated using the average temperature of the fingers minus the dorsum of the hand for the thermal image. The average of 12 finger and 8 dorsum temperature measurements were also taken with the infra-red scanner.

Thirteen out of the twenty patients assessed by the infra-red camera and by the hand held scanner demonstrated index values < -4°C, indicative of RP.

The use of a hand held infrared temperature scanner provides comparable results to thermal imaging for the assessment of RP.

Key words: Raynaud's Phenomenon, Thermography, Infrared, Temperature,

Diagnose des Raynaud Phänomens mit einem tragbaren Radiometer im Vergleich zur Infrarotthermographie

Die kalten und oftmals schmerzhaften Finger, die das Raynaud'sche Phänomen (RP) kennzeichnen, werden durch eine sporadisch auftretende, abnormale Verengung der Arterien in den distalen Extremitäten in Folge von Kälte oder emotionaler Stimuli verursacht.

Mittels Infrarotkamera gemessene Temperaturdifferenzen von mehr als 4°C zwischen Handgelenk und Fingern gelten als Indikatoren für das RP. Infrarotkameras sind jedoch relativ teuer und können außerhalb eines Krankenhauses oder in der ärztlichen Praxis umständlich in der Handhabung sein. Diese Studie hatte daher das Ziel, die Temperaturindizes, die sich mittels einer Infrarotkamera erhalten lassen mit solchen zu vergleichen, die mit einem tragbaren Temperaturmessgerät ermittelt werden können.

21 Patienten mit Verdacht auf RP wurden mittels einer Infrarotkamera (Aga Thermovision® 782) und zusätzlich mit einem kleinen, kontaktlos messenden Thermometer (Exogen Dermatemp™) untersucht.

Der Temperaturindex wurde für zwei Zeitpunkte berechnet: kurz vor und 10 Minuten nach einen Kältereiz. Im Wärmebild wurden dafür die durchschnittlichen Temperaturen der Finger minus der des Handrückens herangezogen. Die Temperaturen diese Regionen wurden auch mit dem Temperaturmessgerät bestimmt, wobei der Mittelwert von jeweils 12 Einzelmessungen an den Fingern und 8 am Hand- gelenk zur Berechnung kam.

13 der 20 Patienten, die mit beiden Geräten vermessen wurden, zeigten Indexwerte < -4°C, die für ein RP typisch sind.. Das kontaktlos messende Thermometer lieferte dabei Werte, die mit denen der Infrarotkamera vergleichbar waren.

Schlüsselwörter: Raynaud-Phänomen, Thermographie. Infrarot, Temperatur

Thermology international 2003; 13: 27-32

Introduction

Raynaud's phenomenon (RP) is characterised by a pathological vasomotor reaction resulting in intermittent abnormal spasm of the digital vasculature. This usually occurs after exposure to cold or emotional stimuli, resulting in cold fingers. The symptoms of RP were first described by M. Raynaud in 1888 (1)

The fingers of patients with RP can often feel cold, patients also describe symptoms of pain, numbness or abnormal sensations such as paraesthesia when suffering an attack.

Many have described patients suffering Raynaud's attacks as having episodic colour changes in the fingers (pallor, cyanosis and or erythrocyanosis) (2, 3, 4). Vasoconstriction and vasodilation which are a normal homeostatic mechanism in response to cold or emotional stimulus can alter the colour of the fingers in a person not suffering from RP. However when this colour change is prolonged it may be considered as a medical condition and the patient registered as suffering from RP (5).

The diagnosis of RP is difficult if it is purely dependent on visual examination of the patient. RP patients can be divided into two groups, those with primary RP and those with secondary RP. Primary RP patients have idiopathic Raynauds symptoms and are diagnosed as having Raynaud's disease. As mentioned above many patients who present with blanching fingers and, or short cold spells can be considered as normal and should not be labelled as suffering from RP (5). Traditionally secondary RP has been described in numerous systemic diseases such as scleroderma, sclerosis and other iatrogenic conditions such as certain toxins and drugs (2-5).

The prevalence of RP in the general population has been estimated to be between 3.8 to 22% (2, 6-10). This estimation largely depends on how the population groups studied were selected and the RP diagnosed. There is a lower prevalence for RP in men compared to women (8-12). RP has also been associated with diseases or other types of environmental factors such as, stroke, heart disease (10) smoking (11, 12) and the type of employment (3).

Treatments for RP are varied; secondary RP can be diagnosis and treatment or prevention of further progress where possible by treating of the underlying disease. Many treatments have been proposed for the reduction of primary RP attacks (13-16). The diagnosis of RP can also be very subjective. This usually consists of a verbal description given by the patient followed by a clinical examination. Many workers have used structured questionnaires of their own or linked with clinical examinations to diagnose RP sufferers in the population (4, 7, 8, 10-13, 17) but these can be very subjective.

There are many objective measurement techniques that have been used in the diagnosis of RP (18), however few if any of these can be considered as reliable methods.

The use of microscopy to examine nailfold capillary loops (capillaroscopy) (18, 19, 20), digital systolic blood pressure measurement (18), Doppler ultrasound (18) and plethysmography (3, 18, 21, 22) may be helpful. However these techniques need the use of specialised equipment, training and at present remain in the research environment where further work is required. Other methods such as blood flow assessment using Laser-Doppler measurements suffer from site to site variation (18, 23).

Within the normal population there is a small temperature difference between the fingers and the proximal part of the hand. However this temperature difference can be greatly increased in patients with RP. This temperature disparity can be in the region of 4-5 ºC or more. Thermal imaging cameras have been used to detect these temperature differences in Raynauds patients (14, 15, 16, 24, 25). It is possible to calculate the average finger to proximal hand temperature index, for both hands and merge these to give the combined thermal gradient (CTG) for patients who have had thermal images taken before and after a thermal challenge to the hands (26, 27). The CTG is calculated from the average finger temperature (AFT) minus the average dorsum temperature (ADT) of the hand before a cold challenge (BCC) added to the average finger temperature minus the average dorsum temperature of the hand 10 minutes post cold challenge (PCC) (Fig3).

If this index is less than -4ºC it is indicative of Raynauds phenomenon. If the index is less than -8ºC this is an indication of scleroderma and other advanced connective tissue disease. Thus with a high resolution thermal imaging camera it is relatively easy to diagnose patients who may possibly have RP. However infra-red cameras and their inherent hardware and software can be expensive (28).

Such detection equipment is not within the reach of the general practitioner (GP) or non specialist clinic. A simple but effective screening instrument resulting in objective methods could significantly improve patient management.

Aim

The aim of this study was to compare the temperature index obtained from a thermal imaging camera with a relatively inexpensive hand held infra-red scanner.

Method

Twenty two patients attending a specialist thermography clinic for the diagnosis of suspected RP underwent thermal examination for the symptoms using a high resolution infra-red camera (Agema Thermavision® 782) (Fig 1). The procedure followed the method described by Ring et al. (26, 27). This involved the patient sitting relaxed with their arms resting on the arm rests off a chair with their hands hanging over the end of the arm rests for 15 minutes to allow for hand temperature stabilisation. The room temperature was maintained at 20 ºC. After temperature stabilisation the patient was asked to place their hands in front of an insulated cushion made from a block of polystyrene, covered in a thin blue cotton cover (approximately 20x20x50 cm). The thermal camera was focused on the hands and the temperature threshold adjusted so that the whole of the patient's hand temperature falls within the selected range. A thermal image was then

Figure 1
Agema Thermavision Thermal Camera

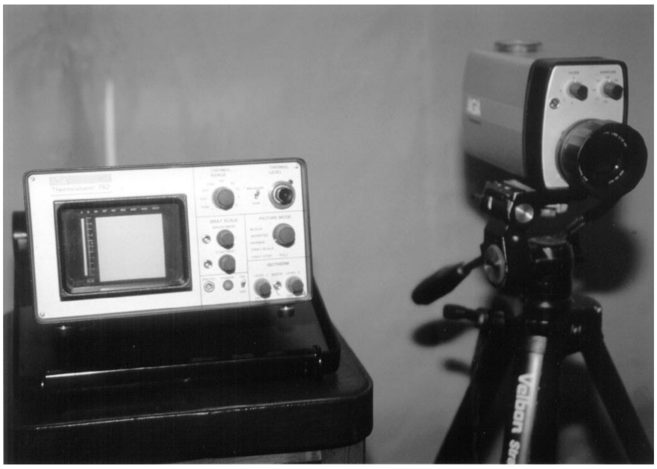


Figure 2
Hand Held Infra-red Scanner

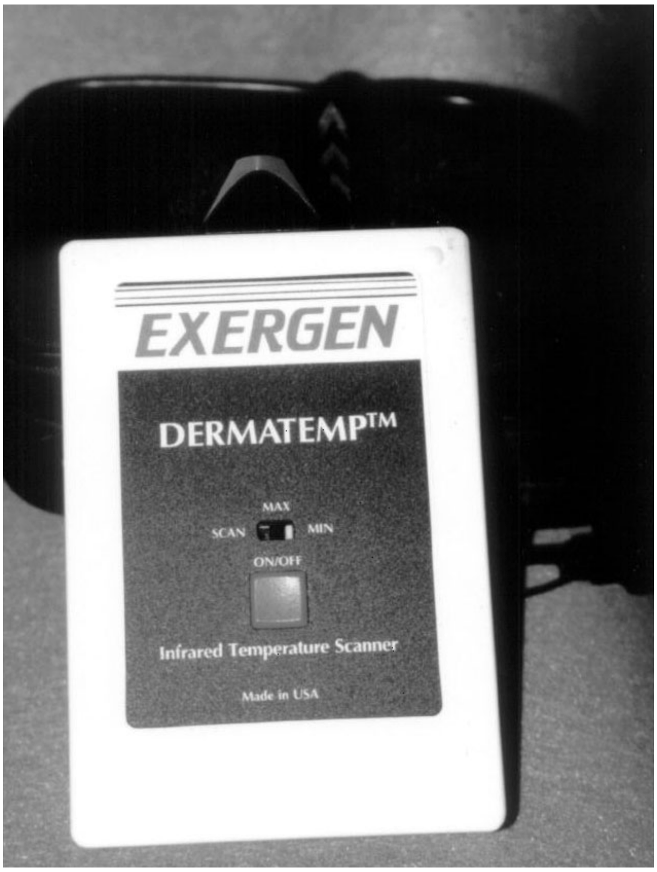


Figure 3
CTG Calculation

$$CTG = (AFT_{BCC} - ADT_{BCC}) + (AFT_{PCC} - ADT_{PCC})$$

CTG: Combined thermal gradient,
AFT: Average finger temperature,
ADT: Average dorsum temperature,
BCC: Before cold challenge
ACC: Post cold challenge

acquired. The patient was then asked to put on a pair of thin surgical gloves (Bodyguards, Peterborough) and their hands subjected to a thermal challenge by immersing them up to the wrists in a bowl of water, at 20ºC, for one minute. The patient then returned to the chair, after 10 minutes stabilisation time a second thermal measurement was taken using the methods described above.

The resultant images were transferred, by cable, to a PC for storage and processing. The software used to affect this is an open system for the acquisition and evaluation of medical thermal images (28). The software is capable of acquisition, storage, editing, and other image based calculations. The resolution of the thermal image is 250 temperature readings per inch (TRI). The combined thermal gradient for the thermal images of the hands taken before and after the cold challenge were then calculated using this software based on the equation of Ring et al. (26, 27), (Fig 3).

The thermal camera was calibrated by reading the temperatures from five thermostatically controlled black-body radiators set at 27.4, 30.5, 33.6, 36.0, 38.4°C (EMI Thermocal), with particular emphasis on the temperature range of interest.

Immediately after the thermal images were acquired by the thermal imaging camera 20 temperature readings were taken from the dorsum of both hands using a hand held infra-red temperature scanner (Exogen, Dermatemp™ Smith and Nephew, Fig 2). Temperatures were recorded over the terminal, middle and proximal phalanx of each finger, and over the dorsum of the hand approximately 2 and 4 cm proximal to the metacarpophalangeal joint of the fingers (Fig 4.). These temperatures were then written on a data sheet which depicted a drawing of a hand, this required approximately 2-3 minutes to record for both hands. This process was repeated immediately after the second thermal image was acquired following the cold challenge and recorded in the same way. The average temperature for the fingers and dorsum of the left hand was calculated before and after the cold challenge. This was repeated for the right hand. The CTG was then calculated for both hands using the same formula as that applied to the thermal images (Fig 3).

The Exogen Dermatemp is a high precision hand held infra-red thermographic scanner designed to detect the subtle skin temperature variations that correlate with the underlying perfusion. The Dermatemp has a temperature resolution of 0.1 °C and has the ability to correct for the variation in the emissivity of human skin. The emissivity of human skin varies depending on colour, texture, moisture etc. having a range between 0.92 and 0.98 (a black body with no reflective heat source has an emissivity of 1.0) (29).

The Exogen instrument has a factory set calibration. Its readings were compared to temperatures measured from the Thermocal black body radiators and skin surface mounted thermister temperature probes (Edale GC203 digital thermometer) on the lower arms of two volunteers.

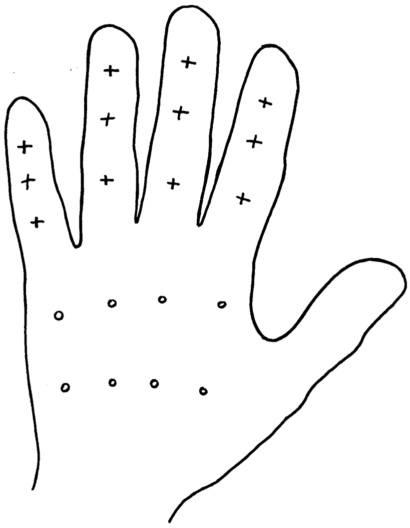


Fig 4
Hand Held Scanner Measurement Positions

Results

The median (Range) age of the 22 patients was 47 (16-71). Of these 5 were males and 17 were females with a median age (Range) of 47 (34-71) for the males and 47 (16-62) for the females.

The mean (standard deviation) temperature of the room in which both the thermographic imaging and infra-red hand scanner measurements were undertaken was 20.9 (1.08) °C. The mean (standard deviation) temperature of the water used for the cold challenge was 19.8 (0.28) °C.

One patient had finger temperatures that were variable and was excluded from the comparison of the thermal camera with the hand held infra-red scanner due to unreliable temperature variations. The patient had two cold fingers on one hand and one cold finger on the other. While individual finger indexes could be calculated it was not in the remit of this study. The patient also had a previous diagnosis of scleroderma.

Of the 21 remaining patients assessed by the thermal imaging camera 13 of the patients had a CTG less than -4ºC for their right hand and 14 of the patients had thermal index ratio of less than -4ºC for their left hand (Fig 5,6). The infra-red hand held scanner identified the same 13 patients with a CTG less than -4ºC for their right hand and the same 14 patients with a CTG of less than -4ºC for their left hand (Fig 5,6). One of the patients had a CTG of less than -4ºC in their left hand only, the right having a CTG of greater than –4ºC. For the thermal camera and hand held infra-red scanner this was between –1 to –2ºC. The CTG tended to have a greater range when calculated from the infra-red scanner measurements (2.05 to –12.90 ºC) as compared to the thermal camera results (1.08 to –7.69 ºC), (Table 1, Figures 5,6). Both the thermal camera and hand held infra-red scanner demonstrated that 13

Table 1.
Comparison of CTG readings between the thermal image camera and the hand held infra-red scanner (C º) for the right and left hand.

Thermal camera	
Left hand	**Right hand**
1.08 to –7.42	**0.74 to 7.69**
Hand Held Infra-red scanner	
Left hand	**Right hand**
2.05 to –11.00	**1.77 to –12.90**

Fig ure 5
CTG for Left Hand, Thermal Camera vs. Hand Held Infra-red Scanner

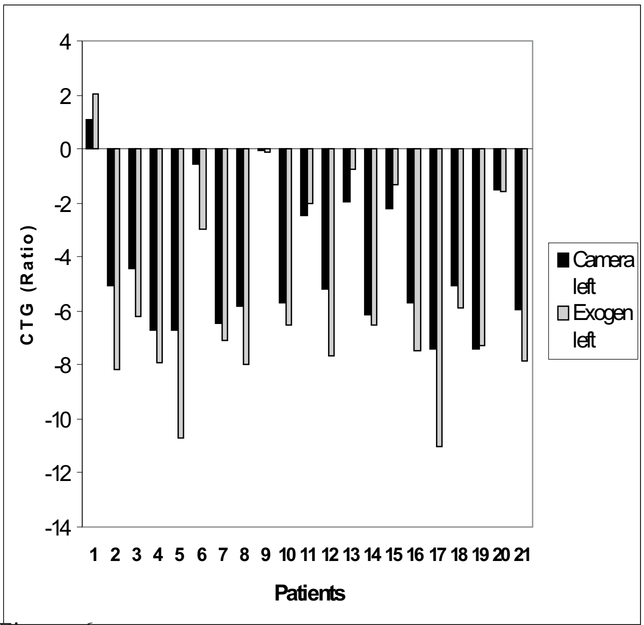
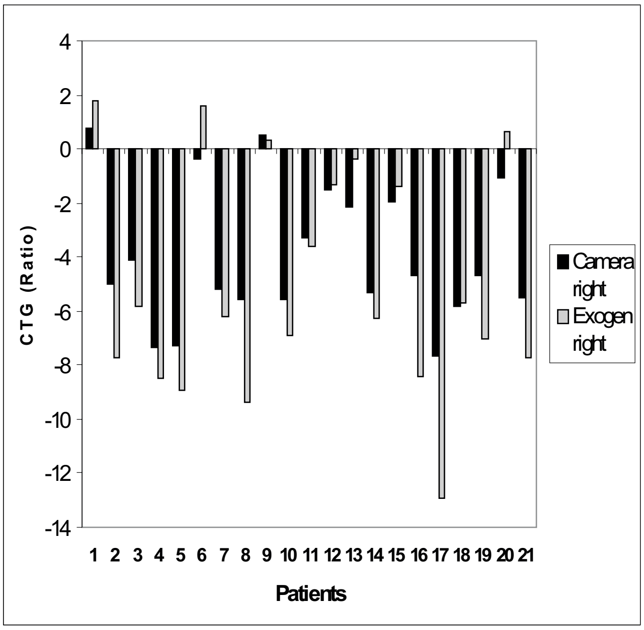


Fig ure 6
CTG for Right Hand, Thermal Camera vs. Hand Held Infra-red Scanner



out of the 21 patients had thermal ratios (< –4 ºC) indicative of RP. The data collected from the hand held infra-red scanner was processed using an Excel spreadsheet (Microsoft 97, XP) where the CTG was automatically calculated. The time to undertake the measurements and perform the calculation was approximately 5 minutes.

The thermal imaging camera's calibration demonstrated agreement to within ± 0.2ºC after adjustment to the 30.5ºC blackbody when compared to the other black body temperatures. The camera remaining within ±0.1ºC of the selected calibration blackbody for the duration of the study period. The calibration of the Exogen hand held infra-red scanner could not be checked, as this is factory set. However the infra-red scanner demonstrated that it was capable of measuring the same temperature as the thermal camera to within ± 0.5ºC from the blackbody Thermocal. Comparisons of skin temperatures between the hand held infra-red scanner and the digital skin thermometer on the two volunteers demonstrated temperature agreement to within ± 0.5ºC.

Discussion

There is a need for a reliable system to help clinicians in non-specialist clinics or GP surgeries in the diagnosis of RP. This could allow for the earlier objective screening of patients, resulting in the elimination of non RF suffers and helping those with RF to gain earlier treatment and hospital appointments. Such a system needs to be cost effective, both to purchase and use. The system should be easy to use, accurate, precise and maintainable. Such a device would help with the early detection, treatment or management of RP patients which would reduce the load on specialist hospital clinics. At present the only methods of diagnosis of RP in the non-specialist clinic or GP practice is external examination of the hands and a number of questions that the patient may not be able to answer correctly (4,7,8,10-13,17).

This study has compared a thermal imaging camera to a hand held infra-red scanner which could be a possible solution to this problem in the future. The device is cheap in comparison to other equipment currently used to look at RP patients in the clinical or research setting. The hand held scanner is capable of accurate and precise measurements when compared to other temperature measurement devices. It is easy to use and maintain. The scanner is suited to a clinical environment being sealed from contamination and can be easily sterilised.

The use of this version of CTG described by Ring et al. (26,27) for the diagnosis of RP patient's may be controversial as there are a number of versions of the cold challenge test. These use different water temperatures to provide the cold challenge, measurement time periods, and locations (2,4,19,22,24,25). The choice of the method used in this study (24,26)) was due to local expertise in this technique for the diagnosis of RP patients.

It has been demonstrated that the hand held scanner is comparable to the thermal camera used in the diagnosis of RP patients. However the hand held scanner has a wider range of calculated CTG values. This may be explained by the reduced number of data points, the variability in the measurement locations, or the time difference between the thermal camera image and the hand held scanner readings which was approximately 2-3 minutes in the study. However this wider range reduces the probability of false negative CTG ratios. During calibration and testing the temperatures measured by the thermal imaging camera, hand held infra-red scanner and the skin surface Edale temperature sensors were closely comparable. The method for calculating the CTG is dependent on the relative temperature differences between the hand locations, so absolute accuracy is not required.

There would be a tendency for any underlying condition that may have an effect on skin surface temperature in the hands to distort the findings by the above method (scleroderma, arthritis, infection, wounds). In this study one patient presented with an abnormal temperature distribution between the fingers and was known to have been diagnosed as having scleroderma. This patient was excluded from the study, but the technique was able to distinguish a difference in this patient, thus abnormal or lower temperature patterns in patients could point to other conditions requiring further investigations.

Conclusion

The use of a hand held infra-red temperature scanner gives comparable results to the thermal imaging camera for the assessment of RP. Both systems demonstrated that 13 out of the 21 patients had thermal ratios indicative of RP. This could allow for the use of hand held infra-red temperature scanners in outpatient or GP settings for the possible early detection or screening of patients with RP.

Acknowledgements

The hand held infrared scanner was kindly donated to the unit by Smith and Nephew Ltd.

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(Manuscript received on 17.12.2002, accepted on 02.01.2003)

Citations

Please cite this paper as

Melhuish JM, Krishnamoorthy L, Harding JR, Wertheim DF, Williams RJ, Harding KG Diagnosis of Raynauds phenomenon using a hand held infra-red scanner compared to thermal imaging. Thermology International 2003; 13(1) 27-32

This paper was cited by

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30th Annual Meeting of the American Academy of Thermology in Orlando, November 7-10, 2002: Abstracts

BREAST THERMAL IMAGING - ANGIOGENESIS OF BREAST DISEASE

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In 1956, Ray Lawson showed increased heat on the breast surface and venous blood of breast cancer. Gros and Guthrie of Strasbourg, France, Pistolesi of Italy and Atsumi of Japan correlated neoplasia and thermal breast skin signal. Because of believing that heat was generated by the tumor, it was thought that the thermal signal would be directly related to the size of the tumor and therefore was not an early signal or good screening tool. Not until 1978 when Jean of Mellon-Carnegie University demonstrated an angiogenesis factor in breast cancer and breast tissue were we able to find TO tumors. British Surgeon, Lloyd Williams of Bath, England, showed survival was directly related to the thermal expression better than any size, tumor marker or other method of calculating survival. This was done once in the late 1960's and again in the mid-80's by the same surgeon.

Judith Folkman from Harvard in 1988 demonstrated that angiogenesis was necessary for neoplasia to move from in situ to invasive disease. She also demonstrated that an enzymatic stimulation of the vasculature took place from this angio-genesis factor. Presently, 300 or more drugs are being tested in stage three FDA trials to halt angiogenesis.

The 21st century paradigm is that when a normal breast thermal study changes, time for antiangiogenesis and expected thermal turn-off as demonstration of tumor regression will be the protocol. This will occur without identifying the tumor.

The thermal signal precedes clinical (including x-ray, ultrasound, dia- phanoscopy, and MRI) by 6-12 months (1). Now, early detection and acceptable nontoxic therapy is available and will be the protocol in the decades ahead for conquering this dreaded disease of women.

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EQUINE THERMAL IMAGING

Kelly Martin

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This presentation will yield a generalized overview of how thermal imaging is incorporated into veterinary medicine. Areas to be covered will include; proper imaging technique of the horse, overcoming artifacts, type of equipment used, suitable applications, as well cases representing normal and abnormal thermal patterns.

EFFICACY OF COMPUTERIZED, DYNAMIC INFRARED IMAGING IN ASSESSING BREAST MASSES UNDERGOING BIOPSY

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Introduction: A computer-aided system, which evaluates infrared (IR) emission, for the differential diagnosis between benign and malignant breast masses was assessed in subjects undergoing biopsy. The IR technique employs a computerized, dynamic imaging scan to capture a series of sequential images that provide an assessment of the obtained IR information in a suspicious area identified by mammography. Unlike present imaging systems, the CTI system uses a proprietary imaging table, software managed cold challenge, and algorithmic data analysis.

Methods: Subjects scheduled for breast biopsy were recruited at five hospitals located throughout the U.S. over a five-year period. Prior to biopsy of suspicious masses, digital IR images were acquired of each breast using CTI's proprietary protocol and algorithm. Three independent radiologists experienced in mammography, but who were blinded regarding the pathology outcome, determined the IR results of these biopsied lesions. The suspicious area was localized for assessment on the IR image by the evaluating radiologists using the subjects' mammography films. A pre-determined threshold resulting in a negative or positive assessment occurred prior to unblinding of the pathology results.

Results: Biopsy of 490 masses resulted in 385 benign outcomes and 105 malignant outcomes. Assessment by IR resulted in excellent sensitivity and negative predictive value. It is quite important to note that malignant masses as small as 0.1cm received a positive IR assessment. This is significantly smaller than the claimed recognition abilities of traditional mammography. It was also demonstrated by regression analyses that increased breast density was associated with accurate IR results in malignant masses ($p=0.02$) whereas breast density in patients with benign masses did not produce statistical evidence of a relationship ($p=0.14$).

Conclusion: Computerized IR imaging assessment with the CTI system offers a non-invasive, safe procedure that shows promise as an adjunctive technology to mammography in determining whether a lesion is benign or malignant. This IR technology provides a dynamic, physiological assessment that complements the anatomical information obtained by mammography. It may be particularly useful in dense breast tissue and could provide physicians with an important new diagnostic tool in the war against breast cancer. When used as an adjunct to mammographic assessment, the IR imaging information should reduce the number of biopsies of benign masses.

COMPUTERIZED THERMAL IMAGING SINGLE VERSUS MULTIPLE AUTONOMIC CHALLENGES IN BREAST THERMAL IMAGING.DOES ADDITIONAL GENERAL AUTONOMIC CHALLENGE CHANGE SPECIFIC AUTONOMIC COLD CHALLENGE FINDINGS?

Dr. Linda A. Fickes

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Introduction Heat produced by organ function does not conduct directly to the surface of the body. Heat is dissipated through the bloodstream to be distributed throughout the circulatory system. This core body heat is cooled by the process of convection through the superficial vascular networks. The regulation of cutaneous blood flow and thus heat loss occurs primarily under the control of the sympathetic division of the autonomic nervous system. It is the radiation of the thermal energy to the external environment that is measured by the infrared camera.

The stimulation of sympathetic dermal receptors via cold water causes vasoconstriction. The cold stress test to the hands was developed in different forms since the 1970's. Other chemical and mechanical tests have been used to induce a response in skin temperature recorded by infrared imaging.

This study examines the question: do multiple autonomic challenges change or intensify post cold challenge findings, thus revealing different, more intense or no change as opposed to single autonomic challenges?

Methodology: The room temperature is standardized to 68 degrees Fahrenheit.

Equipment used is AGA 680, scanning liquid nitrogen cooled long wave system.

Twelve subjects: Age range 21 to 75

Race: Caucasian: 8 Asian: 4

Using hormones: 6

Have a lesion of concern: 9

Exclusion:No history of sunburn, trauma or costochondritis.

Procedure: After a 15-minute cool down with both hands on the head, no clothing from the waist up, no touching of the breast area, no prior consumption of caffeine for the day, thermal images were taken. These include a bilateral frontal, left and right oblique, and left and right unilateral. A cold challenge of having the patient hold a frozen ice pack in each hand for one minute is performed. The same series of pictures is taken. An additional challenge is then performed: asking the patient to "think of something that will bring on an emotion, either positive or negative, whatever will bring on the strongest emotion. Close your eyes and feel it and when you are ready, signal me by raising your hands to your head, and then I will take the picture." Immediately an additional bilateral thermal image was captured. There are three to five minutes between the cold challenge image and the emotional challenge image.

Results and Discussion. Out of the 12 subjects, 10 showed an enhancement of the cold pattern, one degree colder and a slight increase in the area of the increased cold than in the cold challenge images or in the images before any challenge. In one of the 12, who had a diagnosed breast cancer of a large size, the area of the cancer became warmer by one degree and there was a larger area of warmth than in the cold challenge image or in the image before any challenge. In one other of the 12, there was greater warmth than the cold challenge images, but less than that shown in the images before challenge. This subject had difficulty feeling emotion in the emotional challenge, whereas the others did not.

The mechanism causing these results could be that the subject who had the cancer and the increased warmth had dilated blood vessels in the area of increased warmth due to nitric oxide and neoangeogenesis produced by the cancer cells. The blood vessels that could constrict due to the emotional challenge could have shunted their blood to the larger caliber, cancer related blood vessels.

The majority of the subjects showed increased cold after the emotional challenge. This could be because there was no neoangeogenic growth or nitric oxide expanded blood vessels. These may have simply responded to the additional challenge with increased sympathetic caused constriction of blood vessels.

There was one subject that did not follow the patterns above. She was the one who was unable to feel emotion during the emotional challenge. She had less cold/constriction of blood vessels after the attempt at emotional challenge than she had after the cold challenge, but still more cold than there was in the before challenge images. I believe this increased warmth after the attempt at emotional challenge could simply be the diminished sympathetic constriction with time after the cold challenge.

Subjects:: P. M, Age: 23; Asian; Hormones: No; Lesion: Tender lumps felt in both breasts; Result: Increased cold area of right breast in area of tenderness by one degree with a larger area of cold than on cold challenge image. No change in left breast.

J.T.; Age: 30; Caucasian; Hormones: No; Lesion: Tender lumps in left breast; Result: Increased cold at bilateral armpits and nipples.

P.H.; Age: 54; Caucasian; Hormones: No; Lesion: Lump in right breast;Result: Increased area of cold in right breast, especially around area of lump. Increased area of cold by one degree in left breast.

W.W.; Age: 54; Caucasian; Hormones: Triestrogen; Lesion: Tenderness in both breasts around nipples. Bilateral increase in breast size.. Result: Increased area of cold and colder temperature by one degree in both breasts, inferior medial and lateral.

B. B.; Age: 62; Caucasian; Hormones: No; Lesion: Lumpectomy in right breast five months prior, with chemotherapy and radiation therapy to the right breast concluding two months prior to thermogram. Recent mammogram showed calcification in upper lateral left breast.; Result: Decreased heat in the right breast (more area of colder temperature by one degree) and increased area of cold in left areola by one degree and diminished warm pattern in upper left breast (larger area of cold than in the previous images).

K. L.; Age: 39; Asian; Hormones: No; Lesion: None; Result: Slight increase in area of cold in left breast around an apparent fibrocystic area and increase in distribution of end range cold in that area. There is also diminished heat in the upper right chest from the pattern shown by cold challenge, yet more than shown by before cold challenge.

B.A.; Age: 58; Caucasian; Hormones: Natural progesterone; Lesion: None; Results: TH2 rating. Had difficulty eliciting emotion. The cold pattern that was increased in the cold challenge decreased slightly but was still larger than the pre-challenge pattern. There is greater heat in the area of the upper right sternum than after the cold challenge, but less than before challenges.

C.Y.; Age: 50; Caucasian; Hormones: Bi est and natural progesterone; Lesion: Pain and tenderness of left and right breasts in lateral mid breast area; Result: TH4 rating. Increased area of cold in left breast lateral and medial. Increased cold in right breast, upper medial, and lateral at mid breast area.

S. M-M.; Age: 45; Asian; Hormones: Natural progesterone used one time per month; Lesion: None; Result: TH2 rating. There is greater diminishment of the heat pattern seen in the lateral left breast and sub areola area on the left.

J. M.; Age: 21; Asian; Hormones: No; Lesion: Upper, medial right breast is tender and harder than other breast tissue.; Results: TH3 rating. There is greater area of cold and one degree colder in the right breast and left breast after the emotional challenge.

A. C.; Age: 75; Caucasian; Hormones: Pregnenolone for two years and occasional natural progesterone; Lesion: Left breast above nipple has large confirmed cancer; Results: TH5 rating. There is greater heat (one degree) and a larger area of heat in the left breast in the cancer area.

C.T.; Age: 44; Caucasian; Hormones: Orthocycline birth control pills; Lesion: Below right breast a blue bean shaped lump was removed.
Results: A slight increase in cold in the inferior left breast, right armpit and lateral right breast.

SINGLE VERSUS MULTIPLE AUTONOMIC CHALLENGES IN BREAST THERMAL IMAGING PART II HOW DOES GENERAL AUTONOMIC CHALLENGE BEFORE SPECIFIC AUTONOMIC COLD CHALLENGE AFFECT BREAST THERMOLOGY RESULTS?

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In a previous test group we performed the general autonomic challenge after a cold challenge and found generally enhanced results on thermographic images. In order to test if the result was the same with general autonomic challenge before cold challenge, we performed this study.

Methodology: The room temperature is standardized to 68 degrees Fahrenheit.

Equipment used is AGA 680; scanning liquid nitrogen cooled long wave system.

Eight -subjects: Age range 44 to 58

Race: Caucasian: 7, Asian: 1

Using hormones: 4

Has a lesion of concern: 4

Exclusion: No history of sunburn, trauma or costochondritis.

Procedure: After a 15-minute cool down with both hands on the head, no clothing from the waist up, no touching of the breast area, no prior consumption of caffeine for the day, thermal images were taken. These include a bilateral frontal, left and right oblique, and left and right unilateral. The patient is asked to "think of something that will bring on an emotion, either positive or negative, whatever will bring on the strongest emotion. Close your eyes and feel it and when you are ready, signal me by raising your hands to your head, and then I will take the picture." Immediately an additional bilateral thermal image was captured. After these pictures there are three to five minutes between the emotional challenge image and the cold challenge is immediately performed. The patient holds a cold pack in each hand for 1 minute, and then an additional set of images is taken.

Results and Discussion: Out of the eight subjects, two showed a progression pattern of enhanced heat and cold reactions after emotional challenge and still more after cold challenge. Neither of these two was using hormones.

Three of the eight women showed no change at all after emotional challenge, but an increase in cold and heat after the cold challenge. Two of these were using no hormones; one was using birth control pills. These women had difficulty with feeling emotion strongly also.

Three more out of the eight-showed no change after emotional challenge or cold challenge. All three were using natural hormones. It is not clear how much emotion they were feeling.

Taking hormones or not had no effect on the part one study where the emotional challenge was given after the cold challenge. Therefore it is unlikely that it had an effect here, however, the three non-responders to sympathetic challenge were the ones using natural hormones. It could be speculated that the use of hormones may be a sympathetic challenge of its own, due to the effect of these hormones on the hypothalmus, which also mediates sympathetic response. Possibly the hormones stabilized the sympathetic nervous system and made the breast tissue less shockable.

An important influence on this study is the difficulty some women had in eliciting emotion on command. We noticed that the participants who felt deep emotion had more significant heat changes in both studies. In hindsight, it would have been valuable to have the participants rate the amount of emotion they were feeling on a scale of one to ten, so this could be more accurately compared.

Another speculation regarding these results is that stress in the form of the sympathetic challenge may aggravate a previously stressed area. Just as a patient with chronic neck pain feels more neck pain when under emotional stress, a general sympathetic stress may aggravate a pre-existing pain area, one that is perhaps dominant to the nervous system. In the prior study with emotional challenge following cold challenge, the cold caused sympathetic stress visible on the thermogram and the emotional challenge caused additional aggravation to the prior stressed areas, accentuating those heat patterns.

In this study, perhaps the emotional challenge non-responders were actually responding in another more painful area. Possibly the emotional challenge may have caused reaction in areas of body priority, old injury or damage, which may not have been the breasts. We wondered if other more painful areas might show thermal changes with emotion and then cold challenges even if the breasts did not.

Due to a lack of time, we obtained thermal images of only one additional individual in order to investigate this possibility. This Caucasian woman, age , who did not use hormones, was having a migraine headache at the time of her breast imaging. Images were observed of both head and breast areas before any sympathetic challenge, after emotional challenge, and after additional cold challenge. This woman easily felt deep emotion, due to the recent death of her son.

These images showed definite heat changes after the emotional challenge, more cold in the cystic breast areas, more warmth in a shoulder injury area, and more warmth in both the symptomatic area of the head and the non symptomatic area of the head.

The subsequent cold challenge did show a deepened cold pattern in the cystic breast areas and no change in the head and shoulder areas, even a slight diminishment of heat in those areas.

This study did not answer our questions about the non- emotional responders in the breast studies. The images did not support the theory that a dominant pain area would react more to a general sympathetic challenge than the less painful breast area. Here all areas reacted.

What we can say is that emotions do have effects that can be visualized thermographically. We also believe we have found that thermography can verify when a genuine emotion is elicited. Genuine emotions do seem to make thermal findings more obvious in all parts of the body.

Subjects:: P.F.; Age: 50; Caucasian; Hormones: Birth Control Pills; Lesion: No; Result: No change after emotional challenge, but mild increase in cold with cold pack challenge.

E. V; Age: 56; Caucasian; Hormones: No; Lesion: No; Result: No change after emotional challenge. Increased warm pattern after cold challenge.

J. G.; Age: 58; Caucasian; Hormones: No; Lesion: Lump in right breast; Result: No change after emotional challenge. Mild increased cold after cold challenge

R. L.; Age: 44; Caucasian; Hormones: No; Lesion: No; Result: Progression increase in cold after emotional challenge and additional increase after cold challenge.

C. C.; Age: 49; Caucasian; Hormones: No; Lesion: Pain, tenderness and lumps bilaterally; Result: Progression intensification of heat pattern in upper chest and cold in lower breast tissue after emotional and slight increase in cold with cold challenge.

C. M.; Age: 49; Caucasian; Hormones: Natural progesterone, estriol and testosterone; Lesion: No; Result: No change after emotional and cold challenge.

C. D. Age: 45; Asian; Hormones: Natural progesterone.; Lesion: Lumpectomy 9 months prior right breast, no chemotherapy or radiation; Results: No change after emotional and cold challenge.

B.A.; Age: 53; Caucasian; Hormones: Natural progesterone; Lesion: Tenderness and previous TH3 left breast; Result: No change with emotional challenge, small increase in cold with cold challenge.

PRESENTATION ON MEDARRAY™

Ben Lamfers

EIC Inc., 120 Old M-21, Jenison, MI 49428

MedArray is a new and powerful thermographic software program that enables medical professionals to take patient views up to 25 views of a patient into an array, which is saved and displayed as a group for analysis and trending. It has been proven with more than a year of clinical trials and actual use for the past 7 months. This has application to many kinds of medical practices. MedArray™ is unique to the software industry.

MedArray description

1.Introduction – Moves the software into the concept of the taking of views. For Breast Cancer – for example 3 views are taken of the patient – right, frontal, and left. This is repeated for a second row of 3 views with a cold challenge taken by placing the patients hands in cold water. A total of 9 images are then taken

2.Views are given a row description, Patient identification and description with time and date. Taking of images is facilitated by a single click of a mouse and captured by another click. MedArray displays patient view as live views at the frame rate of the supported camera, which can be up to 60 frames per second to facilitate positioning of the patient.

3.MedArray™ saves captured images automatically with correct information. It allows the making of reports by capturing individual views to Windows Clipboard, and many file formats such as BMP, JPG, BMP, and TMF. The entire MedArray™ is saved as one file and can be sent to other facilities by e-mail, placing onto CD. Editing, changing, at a later date or by other agencies, is easy with all the temperature, palettes, level set information saved into the file.

4. MedArray™ supports all the tools of ThermoSoft II as an application within ThermoSoft II so that the user can use as much or as little as they wish.

THERMOGRAPHY: THE FUTURE OF THE INDUSTRY

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From liquid crystal thermography to sophisticated infrared cameras, technology has certainly evolved. Considering the roller coaster ride of political economics, what lies ahead for the thermographic industry?

As a newcomer to the industry, I have found that one tremendous task is in melding several decades of history with current conditions to predict a future. Logically, history should go unrepeated… but will it? Intuitively, the thermographic proposition is long overdue… so why isn't it more available? What's getting in the way?

Indeed it's a perplexing situation. Technology has advanced, but the industry has back-stepped. That is, thermography was once more accepted by insurance providers, but now is not. Every technology provider says, "our system is the best". "Well, I guess that depends on your criterion", I reply. And every thermographic service provider has a story to tell about the value of thermography: "Yeah, it's a great technology, but…" Apparent judgments based on history. And from the public I hear, "I wish that my insurance provider covered thermography". "Oh, but the potential for litigation," I think. Then there are the many associations… each with their own reasons for being, moving in different directions and speeds.

So what's the crux? Is there a reason that the industry hasn't moved forward? Well, consider the opposite: "What if?". What if there were no more than a few associations? And what if these associations, or at least their boards, met with some frequency to agree on how best to expend their energies, developing ***synergy***, towards common goals?

- What if a goal was to create national standards and protocols?
- What if those standards and protocols include training and certification requirements?
- What if those standards and protocols are enforceable by medical/government agencies?
- What if those standards and protocols are accepted by insurance providers?

If it were so:

- it seems plausible that the past would not be repeated,
- that thermography could approach a "standard of care" criterion,
- that untrained and uncertified service providers would be eliminated,
- that fraud and litigation would be reduced,
- that a fair and objective playing field for technology providers would exist,
- and that the abundance of patients would have access and availability. What if it were simple?

HISTORICAL PERSPECTIVES OF THERMAL PHYSIOLOGY AND THERMOGRAPHY

Pascoe D.D.[1], Molloy J.M.[1], Smith J.W.[1], Purohit R.C.[2];

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The purpose of this presentation is to provide a historical perspective that clarifies the importance of thermal measures in the study of physiological functions. This perspective affirms the thermography practitioners role in providing a valuable source of information for diagnosis, screening, and evaluation of medical pathologies that are expressed in neural and vascular cutaneous changes in temperature. The infrared technology has also been an effective investigative tool for re searchers who seek a better understanding of thermoregulation. Alterations in skin temperature and blood flow are tightly regulated in order to manipulate and control the heat transfers between the body's core temperature and external environment. In both medical and physiological applications, the development of thermographic imaging provides a non-invasive, no contact technique by which skin temperature can be quantified. The latest generation of infrared thermography machines are capable of capturing the dynamic changes in cutaneous temperature for measuring acute dynamic responses to stimuli or stressors.

STANDARDS FOR THERMOGRAPHY DATA COLLECTION AND INTERPRETATION FOR HUMANS

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Infrared thermography provides an image of the thermal patterns of the skin surface. Changes in skin temperature are the result of dynamic physiological responses that include both the neural and vascular systems. Due to the dynamic responsiveness of skin to internal and external stimuli or stress, thermal temperatures and patterns can and will be altered. The validity of an image is dependent upon the conditions under which this thermal image was obtained. Therefore, the conditions under which images are recorded need to be controlled and standardized when possible. Factors that influence the thermal response of the skin and are extraneous to the pathology or thermoregulatory response should be accounted for or eliminated. In all cases, accurate documentation needs to be taken regarding the subject/patient, testing conditions, and image (thermal scale- sensitivity, mid range) for proper interpretation of the thermogram. When challenge testing is used, the procedures and time sequence need to be clearly stated in all publications.

INTERACTIVE CASE STUDY: INFRARED THERMOGRAPHY AS A CLINICAL DIAGNOSTIC AID

Molloy J.M.[1], Smith J.W.[1], Goodlett M.[2], Purohit R.C.[3], Pascoe D.D.[1]

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The non-invasive, diagnostic technique of infrared (IR) thermography was used to evaluate a 62 year old male who presented for photonic stimulation treatment of chronic left shoulder, knee and heel pain. The individual demonstrated asymmetrical surface temperatures of as much as 2.0° C. Serial IR imaging demonstrated decreased surface temperatures along the left thigh and right foot. Thigh temperature asymmetries ranged from 0.5° C. posteriorly and laterally to approximately 1° C. at the knee. Mean dorsal foot temperature asymmetry was 1.7° C. Within twenty minutes after cold water immersion testing, dorsal left foot temperatures were within 0.1° C. of pre-immersion temperatures. The right foot remained 0.5° C. colder at thirty minutes' post-testing. Lower body strength was bilaterally normal. Vascular supply and deep tendon reflexes were normal on both sides. However, vibratory and pinprick testing demonstrated sensory impairment in the left foot. The individual's fasting blood glucose level was within normal limits. Preliminary physical diagnoses have included calcific bursitis, tarsal tunnel syndrome and plantar fasciitis of the left shoulder and foot respectively. Thermographic screening and cold water challenge testing demonstrated a slow recovery response in the asymptomatic right foot. The individual awaits further evaluation.

INFRARED THERMOGRAPHY IN SPORTS MEDICINE

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The purpose of this presentation is to demonstrate the efficacy of infrared thermography in sports medicine. Infrared thermography provides the sports medicine physician and staff with a technique for the screening, diagnosis, and evaluation of sports related injuries. Athletic populations may experience multiple traumatic injuries or repetitive injuries to the same area. Additionally the thermogram can show the altered thermal patterns and temperatures of these athletes. This is helpful in examining acute and chronic problems as well as changes in the thermal image as a result of previous injuries.

As a screening tool, infrared thermography can aid the medical staff in determining if a region of interest needs further examination prior to participation. As a diagnostic tool thermography can be used to improve injury diagnosis. Further infrared monitoring will help sports medicine personnel to monitor the progression of rehabilitation post surgery and the efficacy of therapeutic modality treatment.

THE USE OF THERMOGRAPHY TO PREDICT SPREAD OF RSD/CRPS

Phillip Getson, D.O.

Cherry Hill, New Jersey

In a study of twenty patients with RSD/CRPS whose symptoms were Limited to one limb, a complete thermographic study was done from head to plantar feet. In addition, dedicated TOS views were taken irrespective of whether or not the patient had upper body symptoms.

In eighteen of the twenty patients identified and studied, the thermographic study was positive in another part of the body, one in which the patient had no symptoms. In fifteen of these eighteen patients, the disease progressed with the patient developing symptoms in the "predicted" limb in a time frame from several weeks to five months after the thermographic study. This allowed us to recognize symptoms that were clearly related to the disease at their first presentation, thereby initiating treatment in a rapid fashion. By doing so, we were able to get better symptom relief because of the rapidity of administered sympathetic blockade. The long-term benefits of such early recognition and reatment cannot be minimized in the approach to this disorder. Further study is ongoing to verify this limited patient population but the early results are most encouraging.

RSD/CRPS I; VASCULAR ABNORMALITIES, PAIN AND HYPERALGESIA

Srini Govindan,

Wheeling WV.

Patients with painful syndromes of neurological origin may express abnormal cutaneous temperature in the symptomatic part of the body (1)

Deviations of cutaneous thermal emission are conveniently documented by thermography, a technique that sensitively detects and precisely displays temperature patterns of chosen regions of the body surface (2). In the skin where most of the blood is used for thermoregulation and only a small fraction goes through the nutritional capillaries. Blood may enter the subpapillary vascular network through AV Shunts and bypass the nutritional skin capillaries (3). A specific structure of the skin vascular bed is the arterio-venous anatomoses (or) A-V Shunts, through these A-V Shunts the skin blood flow may vary enormously from time to time, mainly depending on the skin temperature (4). Wasner G documented complete functional loss of cutaneous sympathetic vasoconstrictor nerve activity in the early stages of RSD/CRPS I with recovery (5). The origin of this autonomic dysfunction is in the central nervous system. He used 1) Laser Doppler flowmetry for measuring cutaneous blood flow, 2) Infrared thermography for skin temperature and 3) Sympahtetic vasoconstrictor function (phasic induced by deep inspiration and tonic induced by controlled thermoregulation). Baron R studied Capsaicin evoked pain, hyperalgesia and vasodilatation and concluded cutaneous sympathetic vasoconstrction activity does not influence spontaneous pain and mechanical hyperalgesia after Capsaicin induced C- nociceptor sensitization (6)

Laser Doppler and thermography can measure and image skinblood flow. These finding can be correlated clinically with changes in pain and mechanical hyperalgesia in RSD/CRPS I patients.

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COLD STRESS TEST FOR THE DIAGNOSIS OF COLD HYPERSENSITIVITY ON HANDS

Ji-Young Han, Yong-Suk Kim, Kyung-Sub Lee

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Purpose: The cold hypersensitivity is a subjective symptom and it is very difficult to evaluate the severity. It is possible to detect cold hypersensitivity by measuring the skin temperature on DITI, but there is limitation only using DITI to find the objective grade of the symptom. To set a new objective standard for the diagnosis of cold hypersensitivity, we examined the relationship between the Visual Analogue Scale (VAS) score for the cold hypersensitivity and the change of skin temperature on hands by cold stress test

Method: 23 patients with symptom of cold hypersensitivity were participated as subjects who visited the women medical center of Kangnam Kyung Hee Korean Hospital, Kyung Hee Univ. from May 1, 2002 to August 31, 2002. There were all carefully examined to rule out other disease such as obesity, skin diseases, spinal nerve lesions and external wounds. Thermographic observations for this study were made using DITI. We performed cold stress test three times to compare with the results from thermographic observations by DITI; first, after 15 minutes-resting, second, right after 1 minutes soak in 20? water, the third for last, 10 minutes after the soak. VAS score was chosen to determine the severity of cold hypersensitivity.

Re sult: 1 male and 22 female patients were participated ranging in age from 22.17 to 45.21. There was a significant negative correlation between the recovery rate of finger skin temperature after cold stress test and the VAS score. And there was a significant positive correlation between the difference of finger skin temperature and the back and palm of hands after cold stress test and the VAS score. Conclusion

In cold hypersensitivity patients, the cold stress test combined with DITI could be an accurate method for the objective evaluation of cold hypersensitivity, especially good at deciding the severity by numeric values. Using a more strict criterion, as diagnosing of cold hypersensitivity, and longer follow-up may improve the validity of the results attained in clinical trials.

STANDARDS FOR THERMOGRAPHY DATA COLLECTION AND INTERPRETATION FOR ANIMAL SPECIES

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2 Department of Health and Human Performance, Auburn University, Alabama 36849

In most mammalian species the body temperature is normally well controlled by its own metabolic state. The skin temperature is normally lower than that of internal tissues and depends not only on the metabolic state of the animal, but also various factors such as thermal conduction from heat sources within the body's vascular activity, and just beneath the surface heat losses due to evaporation, convection by air currents, or exchange of infrared radiation energy to the surroundings. Heat lost from the body by the exchanges of IR radiation with the surrounding is the basis of thermography. For this to occur, there must be a temperature gradient. Thus, to obtain a reliable and meaningful thermogram having diagnostic value, one should follow well established standards.

First, the environmental factors which interfere with the quality of thermo- graphy should be minimized. The room temperature should be maintained between 21 and 26 degrees C, and room temperature should always be cooler than body temperature and free from air drafts. Thermograms obtained outdoors under conditions of direct air drafts, sunlight, and extreme variations in temperature provide unreliable thermograms in which thermal patterns are altered. Such observations are meaningless. When a person or an animal is brought into a temperature controlled room, it should be equilibrated at least 20 minutes or more, depending on the external temperature from which a subject was brought in.

Other factors affecting the quality of thermograms in various animal species are hair coat, exercise, sweating, body position and angle, body covering, systemic or topical medications, regional and local blocks, sedatives, tranquilizers, and anesthetics, vasoactive drugs, skin lesions such as scars, surgically altered areas, etc. The value of thermography is its extreme sensitivity to changes in heat and its ability to detect changes. Therefore, it is important to have well documented, normal thermal patterns and gradients in a species prior to making any claims or detecting pathological condition.

THERMOGRAPHY AS A GUIDE IN PAIN MANAGEMENT Part I of II

Hooshang Hooshmand, M.D., Masood Hashmi, M.D., and Eric M. Phillips

Neurological Associates Pain Management Center , 1255 37 Street Suite B, Vero Beach, Florida

The value of Thermography is limited to evaluation of neurovascular dysfunction. It provides indispensable information regarding neuropathic pain due to perivascular micro-circulatory sympathetic dysfunction. Thermography records superficial, and deep temperature changes. The bilateral cervical cord temperature modulation demands careful clinical correlation. Thermography is an objective guide helping the clinician to choose a proper and harmless treatment protocol, especially avoiding unnecessary surgery.

Introduction: This is a study of the role of Thermography as a guide in pain management. The results were compared with the information in medical literature. The anatomical tests such as magnetic resonance imaging (MRI), computed tomography (CT), and physiological tests such as electromyography (EMG) and nerve conduction velocity (NCV) tests have been the main diagnostic tools applied in the management of somesthetic (somatic) pain. The above tests usually are not informative in the diagnosis of neuropathic pain. The neurovascular involvement in neuropathic pain requires tests such as Thermography and Quantitative sudomotor axon reflex test (QSART) that address autonomic (e.g., thermal) changes for a more accurate diagnosis and treatment

Methods: Bales Scientific Thermal Processor and Agema Cameras were used for this study of 3,265 successive patients. A review of our experience with Thermography and its role in pain management was conducted, and compared with the recent medical literature. The study was limited to the role of Thermography in the management of complex chronic pain

Discussion: Sloppy technique, and poor background in basic neurophysiologic training, have contributed to poor utilization and interpretation of thermographic images. For thermography to be accurate and clinically useful, proper technique, standardization, and proper clinical correlation are the minimal requirements. The basic physiology of autonomic thermoreg ulation is outlined in detail to help the clinician to properly understand and interpret the test. The dysfunction of thermal sensory nerves in the wall of arterioles cannot be detected by EMG or NCV and excluding the Thermography test may mislead the clinician to diagnose the condition as "psychogenic" or "functional." Our results were compatible with the review of current medical literature.

Results:Thermography provides useful clinical information when applied with proper technique. It provides diagnostic and therapeutic information limited to diseases involving autonomic, neurovascular, and neuroinflammatory changes. Conversely, it cannot be expected to help diagnose nerve injuries with no microvascular involvement such as somesthetic nerve injuries. Proper teaching and understanding of thermoregulation helps the clinician to obtain indispensable information from this test.

THERMOGRAPHY AS A GUIDE IN PAIN MANAGEMENT. Part II

Hooshang Hooshmand, M.D., Masood Hashmi, M.D., and Eric M. Phillips

Neurological Associates Pain Management Center , 1255 37 Street Suite B, Vero Beach, Florida

Thermography is a neurophysiological tool providing diagnostic and therapeutic information in patients suffering from neuropathic pain with neurovascular involvement. This information cannot be obtained from anatomical tests (e.g.,MRI or CT).

Methods: Bales Scientific Thermal Processor (Bales Scientific, Walnut Creek, CA)(762 patients) and Agema Cameras (Flir)(2,503 patients) were used for this study of 3,265 successive patients. A review of our experience with Thermography and its role in pain management was conducted, and compared with the recent medical literature. The study was limited to the role of Thermography in the management of complex chronic pain.

Discussion: Thermography is helpful in proper localization of hyperthermic foci due to iatrogenic permanent damage to thermosensory nerves, such as seen after repetitive sympathetic ganglion blocks; or due to sympathectomy or prolotherapy. As the result, the physician stays out of harms way by not causing further permanent damage. In addition, Thermography identifies the spread of Complex regional pain syndrome (CRPS), pointing to the need for treatment of such spread. It helps differentiate migraine from neuropathic occipital neuralgia - two diseases requiring to contrasting treatments.

Results: Thermography has not been proven useful in evaluation of cervical and lumbar radiculopathies, stroke, and transient ischemic attacks. Thermography can differentiate cervicogenic headaches from migraine - each requiring opposite forms of treatment. Thermography is a useful prognosticator for diabetic foot pain, sparing some patients from amputation. Thermography can spare patients from unnecessary carpal tunnel, spinal disc, and TMJ surgeries by identifying the original source of neuropathic pain. If Thermo- graphy shows diffuse hyperthermia in the extremity already treated with repeated sympathetic ganglion blocks (virtual sympathectomy), such patients should be spared from undergoing further ganglion blocks. The hypothermic extremity after sympathectomy proves the futility of this and other ablative treatments such as chemical sympathectomy, or neurolytic blocks.

MEDICAL INFRARED IMAGING– LOOKING BEYOND THE PRIMARY SYMPTOM

Pip McCahon

Medical Infrared Digital Imaging Pty Ltd, Unit 6 Southern Cross House, 9 McKay Street, TURNER ACT 2612 AUSTRALIA

Many patient present to my clinic for IR examination with the primary symptom of Pain. This pain is usually of a Chronic nature. The area (s) of Pain are defined by the patient, with negative findings from X Ray, CT Scan and/or MRI evaluations.

It has been my experience that scanning a 'region of interest', as reported by the patient, may result in an incomplete assessment of the pathology causing or contributing to the patients' condition.

As a result I have adopted the approach of scanning the whole body when a patient presents with long term undiagnosed pain.

All patients are provided with a Full Body study, a minimum of 27 scans. This protocol has enabled me to establish a considerable database of studies showing thermal abnormalities in regions of the body not reported by the patient. In many cases the body appears to prioritise pain awareness by the patient - i.e. more distinct thermal asymmetries/ patterns will be evident in regions of the body not reported as painful. A number of case studies will be presented to illustrate the benefits of such a protocol. A full body study provides additional useful information about the patient, such as:

1.uneven weight bearing

2.compensatory over use of alternate limb

3.areas of pathology not reported by the patient

4.in some cases, tumors not sufficiently advanced enough for detection by other modalities. The patient is thus given the best opportunity to address all factors contributing to their disease state, leading to a more complete health outcome than by addressing the Primary Symptom alone.

NERVE BLOCKS FOR NEUROPATHIC PAIN

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Neurological Associates Pain Management Center , 1255 37 Street Suite B, Vero Beach, Florida

Introduction: Sympathetic ganglion blocks are the standard nerve blocks for neuropathic pain. However, these blocks are not consistently successful [1-5]. According to Bonica, in the hands of experts, these blocks are technically successful in no more than 75% of patients [1]. Such blocks usually last for a short period of time (from hours to days). As such, these blocks are more diagnostic than therapeutic.

Methods: Comparative study of the diagnostic and analgesic values of nerve blocks was done. Four groups of 100 patients were studied for the efficacy of sympathetic, epidural, regional (BIER), and plexus blocks. The regional temperature was measured with Bales Scientific Infrared Imaging Thermography.

Results: Sympathetic nerve blocks: These nerve blocks were effective in the first few months post- injury lasting an average of 11 days. The technical success of sympathetic blocks was rated at 72%. The success rate of warming up of the extremity (Fig) and pain relief was reduced by an average of 11???days in 41% of patients. This is in contrast to the other types of blocks lasting more than nine weeks (Table). Epidural blocks containing Depo-Medrol® were successful in 89% of patients. The regional BIER blocks showed an average success rate of 32%. The brachial plexus blocks showed 63% success in regards to analgesia and hyperthermia.

Conclusion: The sympathetic nerve blocks are more diagnostic than therapeutic in nature. Epidural, regional, and plexus blocks containing corticosteroids provide more effective and longer lasting pain relief.

Table Comparison of Nerve Blocks

Type of Nerve Block	Duration of Pain Relief
Sympathetic Ganglion Block	2-11 days
Epidural Steroid Block	5-9 weeks
Regional Bier Block	1-2 weeks
Brachial Plexus Block	2-8 weeks

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THERMOLOGY AS A TOOL IN THE DIFFERENTIAL DIAGNOSIS OF MALIGNANT AND FIBRO-CYSTIC BREAST DISEASE

Philip P. Hoekstra, III, Ph.D.

Therma-Scan, 6711 Woodward Ave. Huntington Woods, MI 48070 USA

There are more than three hundred and fifty thousand (350,000) breast biopsies done during a typical year in the United States. Though the core biopsy technique is less invasive and stereo-tactic methods have improved the ability to sample tissue in question than open excision; biopsy is a major expense to the health care system and traumatic to both breast tissue and women. Approximately eighty percent (80%) of all breast biopsies prove to be benign fibro-cystic disease and thus unnecessary. The high frequency of breast biopsies is the result of a high prevalence of both benign fibro-cystic and malignant disease and dependence on anatomically-based methods of evaluating breast disease.

Our laboratory evaluated the thermal features of a group of fifty (50) randomly selected women that presented newly-discovered breast masses from clinical examination or mammography. Each of these patients had subsequent biopsies with definitive histologic results. We discerned significant differences in what would prove to be benign fibro-cysts from malignant disease in the proximity of these masses based on the thermal features and response of these features to a standardized autonomic challenge. We also characterized a typical evolution in the thermal features of benign fibro-cysts as we monitored these women over time.

UPDATE ON THERMOGRAPHY IN SPORTSMEDICINE

Richard T. Herrick, MD, FAAOS, FACSM, Adjunct Associate Professor,

Auburn University, Auburn, AL

Thermography has been used in sportsmedicine for many years, especially in Europe and Asia. It is slowly being accepted in the USA as a premier imaging process for athletic injuries, their diagnosis and progress of treatment. This update is a review of what has been reported over the past 10 years and provides suggestions for future utilization. Prevention of sports injury and rapid, safe, return to play are our primary goals, ones which may be advanced through the use of Thermography and should be fostered by members of our Organization.

NEUROGENIC INFLAMMATION IN CHRONIC REGIONAL PAIN SYNDROME.

Srini Govindan.

Wheeling. West Virginia.

In 1920 Lewis hypothesized that several inflammatory symptoms commonly observed in RSD (Reflex Sympathetic Dystrophy) patients result from release of pain producing vasodialator substances at the endings of sensory nerve fibres as a result of excitation of these nerve fibres some where at axonal leve (l). Studies have demonstrated that not only mechanical but also chemical (2) and electrical (3) excitation of sensory nerve fibres somewhere at axonal level may provoke neurogenic inflammation. Sensitization of unmyelinated nociceptive afferents has been hypothesized to play a pivotal role in the induction of CRPS. In addition to their sensory function, nociceptive C-fibers have an efferent neurosecretory role. Upon stimulation they release neuropeptides within their innervation territory, which causes vasodilatation (mainly CGRP) and protein extravasation (mainly Substance P) in redents (neurogenic inflammation), the latter could be prevented by selective neurokinin 1 (NK-1) receptor antagonism (4). Weber's data suggest that either neuropeptides are released from the nociceptive nerve ending in large amounts, their inactivation is im- paired or that there is an enhanced expression or sensitivity of receptors (4).Noxious stimulation of the skin of man leads not only to a flare response (redness of the skin), but also to edema and reduced pain threshold both locally and more widespread. Neuropeptides are considered to be the cardinal mediators of neurogenic inflammation resulting in vasodialator effect on the microvasculature, increased excitability of primary sensory nerve fibres, increased vascular permeability and release of inflammatory mediators like histamine (5).

The sequence of events induced by excitation of sensory nerve fibres is referred to as neurogenic inflammation and includes the triple response:

1)The red reaction due to local dilatation of skin microvessels.

2)The flare, a widespread dilatation of neighbouring arterioles brought about by a local axon reflex and accompanied by hyperalgesia.

3)The wheal ie, local increased permeability of skin microvessels.

In neuropathic patients the alleged release of neuropeptides may be involved not only in vasomotor disturbances but also in altered nociception and edema formation.

CGRP acting via CGRP 1 receptors is the principal transmitter of neurogenic dilatation of arterioles . Whereas SP and neurokinin A (NK A) acting via NK1 receptors mediate the increase in vascular permeability (6). Edema and the increase of skin blood flow found in early stages of CRPS resemble the two major features of neurogenic inflammation (7).

CRPS (Chronic Regional Pain Syndrome) is characterized by a variety of clinical features including spontaneous pain and hyperalgesia. Increased neuropeptide release from peripheral nociceptors has been suggested as a possible pathphysiologic mechanism triggering the combination of trophic changes, edema, vasodilatation and pain. Awarness of neurogenic inflammation can help in the diagnosis, treatment and follow up of the patients with CRPS/neuropathic pain syndromes.

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PRACTICAL CONSIDERATIONS IN EVALUATING THERMAL IMAGES FOR PERIPHERAL SYMPATHETIC NERVE DYSFUNCTION

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Roswell, New Mexico 88202

In publications about infrared thermography (IRT) as practiced in relation to human medicine, we find many references to the syndrome Reflex Sympathetic Dystrophy or "RSD". Although an identical syndrome has not been clinically recognized in veterinary medicine, we do see thermal patterns that appear to have many similarities to those seen in RSD. This thermal patterning is most commonly associated with Peripheral Sympathetic Nerve Dysfunction or "PSND". Horses are the animal species that are most commonly presented for thermal evaluation, and that may explain why practitioners are most likely to see these thermal patterns in that species. For a thermographer working under field conditions, there are several important considerations in evaluating the thermal images of a horse suspected of have PSND.

The first consideration relates to the physical location and environmental factors associated with that location and subsequently, the images taken there. A second consideration is the patient's physical presentation and history. In addition to environmental and physical factors, one needs to perform a test of the horse's alpha receptor response as previously described by Drs. Purohit and Pascoe.

When all of these factors are considered together, a reasonable assessment of the abnormal thermal patterns, exhibited by an individual horse, can be made. The outcome may be a true PSND or conversely, be found to be primarily associated with other physical and/or environmental factors.

News in Thermology

9th European Congress of Thermology

Prof.Dr.Anna Jung is preparing the organisation of the 9th European Congress of Thermo- logy, which will take place in Krakow May 30 to June 1, 2003. The conference will be combined with 6th National Congress of the Polish Association of Thermology and the 16th Thermo- logical Symposium of the Austrian Society of Thermology.

The **international scientific board** of this major thermology conference is headed by Prof Dr. Anna Jung, Poland. She is assisted by

Prof. Francis Ring, U.K,
Kevin Howell, U.K
Prof. Pors Nielsen, Danmark
Prof. J. Mercer, Norway,
Prof. H.Tauchmanova, Slovak Republik
Prof. I.Benkö, Hungary
Dr. G.Dalla Volta, Italy
Prof. K.Ammer, Austria
Dr.H.Mayr, Austria
Prof. Ram C. Purohit, USA
Prof.K.Mabuchi, Japan
Prof. Sang Chul Lee, Korea
Prof. M.Brioschi, Brasil

Local organising Committee

Chair: Prof.Anna Jung

Deputy Chairman: Dr. Janusz Zuber

Members: Dr. Boleslaw Kalicki
Dr. Alina Goszcyk
Mgr Ewa Moszumanska
Mgr inz. Piotr Murawaski

Krakow

the European City of Culture for 2000, is one of the most visited cities in Poland. This former capital city has a wealth of preserved buildings and culture over many centuries. It is a major centre of science and learning, its renowned Jagellonian University is one of the oldest in Europe from 1466. The University Museum contains many items dating back to Copernicus, who received his degree there. The main square is the largest medieval market square in Europe. In the centre is the famous Cloth Hall from the 12th century, which today is a centre for local arts, crafts and souvenirs. A few hundred meters away stands the Royal Castle commanding a view of the whole city. The origins of this historic building date back to the year 1000 AD.

The Conference Centre is a pleasant building in the old town district belonging to the Polish Military. It has art deco styling typical of the early 20th Century, with a conference hall and exhibition area on the first floor.

Campanile Hotel is conveniently located a few minutes walk away and is less than 5 minutes walk to the old city square, with its abundance of restaurants etc.

Krakow Airport Balice is near the city, and can be reached by bus and taxi. Good International connections include Chicago, London, Paris, and Rome. Regular daily flights link to Warsaw's International Airport.

Polish National Tourist Websites

Austria	polska@netway.at
Belgium	www.polska-be.com
Germany	www.polen-info.de
Italy	www.polonia.it
UK	www.visitpoland.org
USA	www.polandtour.org

Topics of the Conference

Thermal physiology, skin temperature, thermo- regulation, clinical applications of thermal imaging and related techniques (LDI, U/S, MIR), Raynaud's phenomenon, hand-arm syndrome, complex regional pain syndrome, neuromuscular conditions, peripheral vascular diseases, deep vein thrombosis, haemodialysis, skin graft monitoring, paediatric diseases, rheumatology, Image quantitation, Developments in Infra red camera systems, Software and image processing, databases and normal thermograms, standards of IR imaging

Outline programme

Thursday 29th May

14.00-17.00	Registration at The Cultural Institute Zyblikiewicza 1.
Evening	Welcome reception party

Friday 30th

I-V Human Body Temperature, Physiology and technical developments

9.00-9.15 - Opening

9.15-11.00 - Session 1, Invited lectures: Basis of thermography

11.00-11.15 - coffee

11.15-12.15 - Session 2,
Thermal Physiology, Skin temperature, thermoregulation,

12.15-13.30 - lunch

13.30-14.30 - Commercial presentations
(FLIR, InterTech, Medicore, Moore Instr.)

14.30-15.30 - Session 3,
Software and image processing

15.30-15.45 -coffee

15.45-16.45 - Session 4,
Thermal imaging and related techniques (LDI, U/S, MRI)

16.45-17.30 - Session 5,
Standards of IR imaging,
Databases and normal thermograms

Saturday 31st May

V-IX Clinical applications of thermal imaging

8.30-10.00 - Session 6
Peripheral vascular diseases, deep vein thrombosis

10.00-10.30 - coffee and posters/exhibition

10.30-12.00 - Session 7,
Raynaud's phenomenon, hand-arm syndrome,
Complex Regional Pain Syndrome

120.00 -13.30 lunch

13.30-15.00 - Session 8,
Paediatric diseases, rheumatology

15.00-15.30 - coffee

15.30 - 17.00 - Session 9, Neuromuscular conditions,

17.00 - 17.30 - EAT Business Meeting (Election of new President, Thermology International Journal, Proposal for International Federation)

19.30 - Conference dinner & folk music

Sunday 1st June

X - XI Clinical applications & Future trends

8.30 - 9.30 - Session 10,
Future trends,
Invited lecture (European Thermography Network)

9.30 - 12.00 - Royal Castle and Cathedral

12.30-13.30 - lunch

13.30-14.30 - Session 11, Clinical applications

14.45 - Closing by the President

15.00 - Krakow sightseeing

Presentation takes 15 min. with discussion,
invited lectures - 30 min.

An exhibition of equipment and related subjects will be held throughout the conference. Interested companies should contact Prof. Jung without delay
ajung@cskwam.mil.pl

ABSTRACT DEADLINE FEBRUARY 1st 2003

Abstract form in Thermology International (page 48) or conference website
thermo.cskwam.mil.pl/krakow2003/index.htm

REGISTRATION FEE

before Feb.1st 350 USD/ 350Euros

After Feb.1st. 450USD/ 450 Euros

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Make sure that your name is shown on the documentation and registration form.

Registration form from: **ajung@cskwam.mil.pl**
in Thermology International (page 47) or website.
thermo.cskwam.mil.pl/krakow2003/index.htm

Accommodation

The Conference Hotel is Campanile Krakow in the Old City and close to the Congress Centre,Sw.Tomasza 34 Str
Single room 75USD , Double 85USD (incl. breakfast)

13TH THERMO in Budapest

The Scientific Society of Measurement, Automation and Informatics (MATE) has the honour to invite you to the **13th International Conference on Thermal Engineering and Thermogrammetry (THERMO)**

from the 18th to 20th of June, 2003 in the OSSKI Center (Törley Palace), Budapest, XXII.
(Budafok), Anna u. 5.

Preliminary Programme

A. Bilgin, S. Caran, A. Bolatturk (Suleyman Demirel Univ., Fac. of Engn. and Arch., Isparta, Turkey): Geothermal resurces and minaral waters in Isparta and surrounding area

A. Liazid, M. Guen, B. Kerboua (Labor.L.T.E.-ENSET Oran, Algeria): Mathematical model of unsteady mechanical characteristics of a diesel engine

B. O. Kashani (Univ. of Birjand, Birjand, Iran): Consideration of the valve timing effect on performance and pollutants emission in dual-fuel Diesel engines

M. M. Abu-Khader (Al-Balqa Applied University, Amman, Jordan): Mathematical expressions of temperature disturbances through two heat exchangers in series

M.R. Modaress-Razavi (Ferdowsi Univ. of Mashhad, Mashhad, Iran): The effect of spark plug position on combustion of spark ignition engine

M.R. Modaress-Razavi (Ferdowsi Univ. of Mashhad, Mashhad, Iran): Examination of the dual-fuel engine performance using low BTU gaseous fuels

V.V. Ghia (Inst. of thermal engines, Univ. Politechnica of Bucharest, Romania): Burning improvement of water-in heavy oil emulsion using combustion simulation

Z. Hrytskiv, V. Hoy, P. Kondratov (Lviv Polytechnic National University, Lviv, Ukraine): Optimization of scannig mode for pyroelectric vidicon based thermal imaging cameras

A.Galovic, M. Zivic, B. Halasz (Univ. of Zagreb,Fac. of M.E. and Naval Arch., Croatia): The analysis of the entropy production and heat transfer efficiency of a crossflow heat exchanger

M.Zivic*, Z. Virag, A. Galovic (*Univ. of Osijek, Slavonski Brod, Croatia; Univ. of Zagreb, Fac. of M.E. and Naval Arch., Croatia):Melting driven by natural convection of the ice in an enclosure filled with water

B.Halasz, M. Tadic, S. Mudrinic (Univ. of Zagreb,Fac. of M.E. and Naval Arch., Croatia): Analysis of the entropy production in a counterflow cooling tower

E.A. Pieczyska (Inst. of Fundamental Techn. Res. of PAS, Warsaw, Poland): Polymers – interesting aspects of thermomechanical couplings during relaxation processes

S.P. Gadaj, W. K. Nowacki, E. A. Pieczyska (Inst. of Fundamental Techn. Res. of PAS, Warsaw, Poland): Thermal and mechanical characteristics during simple shear of materials

G. Kurilenko (Novosibirsk State Technical University, Novosibirsk, Russia): Non-destructive check up of fatigue durability on the basis of thermal phenomena

A. Can*, E. Buyruk**, Y. Can*** (*Trakya Univ., Edirne; **Cumhuriyet Univ., Sivas; ***Istanbul Techn. Univ., Istanbul, Turkey): Heat bridges effects on heat loss and heat gain at buildings

K.-D. Gruner , U. Kienitz (Raytek GmbH, Berlin, Germany): Modern infrared thermometers – trends and applications

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E.F.J. Ring (School of Computing, Univ. of Glamorgan, Pontypridd, U.K.): History of quantitation of thermo- graphy

I. Benkö (Budapest Univ. of Technology and Economics, Hungary): Analysis of thermal bridges of building structures through infrared thermograms

K. Ammer, P. Melnizky (LBF Physical Doagnostics, Vienna, Austria) Temperature of hot packs for medical treatment

Exhibition

During the conference an exhibition of scientific and industrial instrumentation will be organised. Exhibitors from the field of tempera- ture measurement and control, thermal properties, IR-imaging, anemometry, industrial energy control, heat loss detection equipment etc. are welcomed.

Venue

The conference is hosted by the OSSKI Center (Törley Palace, Budapest, XXII. (Budafok), Anna u. 5.) located in the vicinity of the famous Budafok wine cellars. More information about the conference place and hotel accommodation will be sent after the arrival of the Registration Form.

Information

Application Forms and papers should be sent to:

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H-1372 Budapest, POB. 451., Hungary.

Fax: +361-353-1406 Phone: +361-332-9571.

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4th Instructional Course on Thermal Imaging in Medicine

After three successful courses on Thermal Imaging in Medicine in 2001and 2002, a further course will held on theory and practice of Infra red Imaging in Medicine. The 4th Short Course will be held on April 9-11, 2003 at the School of Computing of the University of Glamorgan in Pontypridd, Wales, UK. Prof K Ammer, Prof F Ring and Dr P Plassmann will lecture on the theoretical and historical basis of thermal imaging in medicine, clinical applications and future developments of thermal imaging in medicine. A supervised practical session is included which focuses on the capture and analysis of images.

Registration Fee is £300. Cheques should be made payable to The University of Glamorgan. The Fee includes lunch and refreshment breaks, the hardback book -The Thermal image In Medicine and Biology, and a CD of Archived IR Imaging in Medicine publications,

The course is recognized by The University and certificates will be issued to all who complete the short course.

Further information can be obtained from
Prof Francis Ring
(01443 483717 , e-mail efring@glam.ac.uk) or

Dr Peter Plassmann
(01443 483486, e-mail pplassma@glam.ac.uk)

School of Computing, University of
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Biomedical Engineering Handbook (Third Edition)

Dr. Nicholas Diakides has been invited by Professor Joseph Bronzino, Editor in Chief of the Biomedical Engineering Handbook, to participate in the third edition of this publication. The plan is to have a series of ten volumes, one of which will be dedicated to infrared imaging.. This will require the setting up of an advisory board, and a panel for reviewing, a panel to solicit the best work in your areas and to ensure that we seize this opportunity to propel infrared imaging worldwide. We need to commit to this work by the end of February..

As background, I would like to tell you that these Handbooks will be published by CRC Press in collaboration with IEEE Press. The first edition consisting of one volume was published in 1994; the second edition was two volumes published in 1999; The third edition is projected to be 10 volumes to be published in 2005. One of these will be dedicated to infrared. imaging.

Need your inputs, recommendations in soliciting the right papers, articles and chapters, and a suggested approach. If you wish to be a contributing author or to produce a chapter, please forward us a title, authors and affiliations, etc.

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Call for papers: "TTM- 21st Century Health"

1st International Conference of Thermal Texture Mapping (TTM), Technology in Medicine and Engineering

9-11 April 2003, Westin Galleria Hotel, Houston, Texas, U.S.A

The TTM Technology in Medicine and Engineering Society will celebrate its 1st annual international conference in Texas, U.S.A in 2003. This is the first time that a TTM Evaluation Technology Meeting will be held in America. This conference is designed to bring together scientists, engineers, medical researchers, biomedical engineers, physicians and educators to further examine and explore the TTM concept. The 1st TTM Conference gathers together the broad multidisciplinary topics of TTM technology, and is the largest Conference of its kind in the world. Houston is proud to host this meeting, and we sincerely hope that it will be a successful and rewarding experience for everyone.

This conference will focus on the application of the science and technology involved in TTM . Its scope ranges from IT technology to health monitoring, and from fundamental physics of TTM to medical treatment evaluation, and food and medicine. As a special feature, all of our oral platform sessions will include presentations by physicians, medical researchers and engineers working in medical centers, universities and industry.

The conference committee cordially invites you to attend and submit papers addressing the following themes:

- Imaging and Image Processing
- Cancer Early Detection
- TTM medical Information Engineering
- Medical Treatment Monitoring and Evaluation
- Health Screen Systems Modeling
- Instrumentation, Sensors and Measurements
- TTM Evaluation Technology Education
- Clinical Engineering and Technology Assessment

The venue for the meeting is the Westin Galleria Hotel and Entertainment Complex with its entertainments and shopping, and many other attractions, but we also hope that you will be interested in exploring the city, with its restaurants, theater and culture. Houston is home to the largest energy companies in the world, the Johnson Space Center (NASA), and the Texas Medical Center, which is the largest medical research and healthcare complex in the world serving 4.2 million patients annually.

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