



International Academy of Clinical Thermology Quality Assurance Guidelines

*Standards and Protocols in Clinical Thermographic Imaging
Current Revision July 2015*

Introduction –

The following document is issued as a quality assurance guideline for the clinical use of thermal imaging. The process of establishing standards and protocols was guided by the board of the International Academy of Clinical Thermology and represents a consensus from experts in the field of clinical thermology and consultants in relevant fields of expertise.

The foundation of the methodological approach to the development of any guideline must be grounded in scientific evidence. In the guideline and development process, all available scientific evidence must be considered. This requires an extensive literature search followed by a critical review of all the relevant publications. To the extent possible, recommendations made in the guidelines should be based on the results of well-designed studies.

The information in these guidelines is based primarily on a review of the current and past peer-reviewed indexed literature. Consultation with authorities in relevant fields of expertise, standards and guidelines issued by other qualified organizations, and clinical experience concerning the application of thermal imaging was also considered.

It is not the purpose of this organization to regulate clinical thermography, but rather to promote scientific validity and quality imaging. The information that follows has been compiled to insure the highest standards in clinical thermal imaging and patient safety.

Committee Chair –

William Amalu, DC, DABCT

Committee Members –

Jerome Block, MD, PhD, FACP

Anand Chaudhry, DC, DABCT

James Christiansen, PhD

William Dudley, DC, DABCT

Robert Elliot, MD, PhD

Stephen Elliott, MD

William Hobbins, MD, FACS

Scott Miles, MD, FACOG

Maria Papakyriacou, PhD

Valerie Quijano, DC, BCCT

Charles Solano, DC, DABCT

Liezl Voshol, MD

Internationally Peer Reviewed

Annual review January 2025 – No revisions

GUIDELINE SECTIONS –

- Definition of Clinical Thermography
- Statement of Need
- Laboratory Requirements
- Imaging System Guidelines
- Other Thermal Detection Devices
- Patient Management Protocols
- Imaging Protocols
- Image Interpretation and Reporting
- Clinical Thermography Education Guidelines

DEFINITION OF CLINICAL THERMOGRAPHY –

Thermography, when used in a clinical setting, is an adjunctive imaging procedure that detects, records, and produces an image (thermogram) of a patient's skin surface temperatures and/or thermal patterns. The procedure uses equipment that can provide both qualitative and quantitative representations of these temperature patterns.

Thermography does not entail the use of ionizing radiation, venous access, or other invasive procedures; therefore, the examination poses no harm to the patient.

There are two currently recognized methods of clinical thermographic imaging: electronic infrared telethermography and liquid-crystal thermography. The following terminology is commonly used interchangeably for clinical thermographic analysis and computer interfaced infrared thermography systems: thermal imaging, thermography, infrared imaging, digital infrared imaging, digital infrared thermal imaging, computed thermal imaging, computerized infrared imaging, and medical infrared imaging among others.

Ref: 1, 2-4, 65, 12-19

STATEMENT OF NEED –

Clinical thermography is appropriate and germane to health care practice whenever a clinician feels a physiologic imaging test is needed for differential diagnostic purposes. Clinical thermography is a physiologic imaging technology that provides important information on the normal and abnormal functioning of the sensory and sympathetic nervous systems, vascular system, musculoskeletal system, and local inflammatory processes. The procedure also provides valuable diagnostic information with regard to dermatologic, endocrine, and breast conditions. Other imaging technologies such as radiography, mammography, ultrasonography, CT, and MRI do not provide the neurological, vascular, and metabolic information provided by thermography.

Clinical thermography may contribute to the diagnosis and management of the patient by assisting in determining the location and degree of irritation, the type of functional disorder, and treatment prognosis. The procedure may also aid the clinician in the evaluation of the case, in determining the most effective treatment, and improving patient outcomes.

Clinical thermography is an acceptable analytical procedure that may be performed by a doctor or technician who has been adequately trained and certified by a recognized organization. However, it is strongly recommended that the interpretation of the thermal images be made only by health care providers who are formally trained in clinical diagnosis and hold credentials as board certified clinical thermographers from a recognized organization. This is meant to insure that directed care and proper follow-up recommendations will be made available to the patient if warranted by the interpretation of the images.

Ref: 1, 12-19, 65

GUIDELINE 1: LABORATORY REQUIREMENTS

1.1 Imaging Room Design: As part of image quality control, the design and environmental conditions of the imaging room should conform to the thermodynamic attributes required in thermal image acquisition. The room itself should be of adequate size to maintain a homogenous temperature. There must be sufficient space for the placement of equipment and freedom of movement for both the technician and patient. It should also be large enough to allow for patients of all sizes to be positioned adequately for each anatomic image. A room approximately 8' x 10', or dimensions similar in square footage, is adequate to meet these requirements. Larger rooms may also be used as long as a steady homogenous ambient temperature can be maintained (see Environmental Controls section below). During the examination, the patient should be able to be placed relatively equidistant and adequately spaced from each wall. The room should be carpeted. If this is not possible, a well-insulated area rug will suffice.

1.2 Environmental Controls: The temperature of the room should be such that the patient's physiology is not altered to the point of shivering or perspiring. The temperature range should be maintained between 18 and 23 degrees C. Room temperature changes during the course of an examination must be gradual so that steady state physiology is maintained and all parts of the body can adjust uniformly. The temperature of the room should not vary more than one degree Celsius during the course of a study. The humidity of the room must also be controlled such that there is no air moisture build-up on the skin, perspiration, or vapor levels that can interact with radiant infrared energy. The examining room must have an ambient temperature thermometer to accurately monitor the temperature of the room.

A complete infrared survey of the room should be performed to inspect for any infrared sources and leakage (e.g. windows, heating/AC ducts, light fixtures, hot water pipes). Any significant findings need to be remedied. All windows must be covered or shielded to prevent outside infrared radiation from entering the room. Shades or blinds may be adequate for this purpose depending on the amount of direct infrared radiation. The room must be free from drafts. Windows and doors should be adequately sealed to prevent airflow in the area where the patient is positioned. Heat and air conditioning sources must be minimized in the room and kept well away from the patient. Vents should be directed away from the patient and thoroughly diffused or turned off during the examination. Incandescent lighting should not be used during the examination due to the amount of infrared radiation produced. Standard fluorescent lighting is adequate.

Ref: 1, 4, 7, 9, 10, 12-19, 20, 22-26, 27-38, 41-42, 50-51, 57, 65, 66, 68-73

GUIDELINE 2: IMAGING SYSTEM REQUIREMENTS

In order to provide for quality image production and accurate clinical interpretations, certain minimum equipment standards should be maintained. There are two currently recognized types of thermographic imaging equipment: electronic infrared telethermography (IRT) and liquid-crystal thermography (LCT).

2.1 Liquid Crystal Thermography: LCT utilizes a range of interchangeable "screens" or "pillows" impregnated with cholesteric methyl-ester derivatives that change color as a function of their temperature. The "screens" or "pillows" are touched to the anatomic surface for development. A standard picture of the image is taken for later analysis and archive. The thermal precision and resolution of the equipment is well within accepted limits for clinical interpretation.

2.2 Electronic Infrared Telethermography: IRT equipment incorporates single or multiple infrared detectors that sample the field-of-view in two directions simultaneously. The process does not involve contact with the surface of the skin. A current review of the literature suggests that in order to produce accurate and reproducible diagnostic images the following minimum specifications should be incorporated in the design of clinical IRT hardware and software systems for image-capture, display, and analysis:

- Detector(s) response greater than 5 microns and less than 15 microns with the spectral bandwidth encompassing the 8-10 micron region.

- System temperature range set to cover temperatures over the range of human emissions.
- Emissivity set to 0.98 (human skin).
- Absolute resolution of at least 19,200 temperature points per image frame with an appropriate lens. The largest lens applicable to the detector is desired.
- Spatial resolution of 1 sq. mm at 40 cm from the detector(s) (2.5 mRad IFOV).
- Thermal sensitivity of less than 80 mK NEDT.
- Repeatability and precision of 0.1 degree C detection of temperature difference.
- Thermal drift strictly controlled with corrective calibration to as close to 0.00 degrees C as possible at system equilibration to ambient temperature guidelines.
- Maintenance of detector uniformity to within 0.20 degree C Delta-T across 80% of the central field.
- Absolute temperature accuracy of +/- 2 degree C or +/- 2% of reading or less.
- Manual adjustment of temperature span.
- Manual adjustment of level settings.
- Manual adjustment of focus.
- Minimum focus distance capable of close-up views of selected sectional anatomy.
- Capture frame-rate set to allow for live image focusing and capture.
- Ability to capture images in high-resolution grayscale.
- High-resolution image display for interpretation.
- Imaging software capable of accurate quantitative analysis.
- Ability to perform accurate quantitative differential temperature analysis with a precision of 0.1 degree C.
- Ability to annotate areas of interest with accurate temperature values.
- Software manipulation of the images (both live and post-image processing) should be maintained within strict parameters to insure that the diagnostic qualities of the original images are not compromised.
- Ability to archive images for future reference and image comparison. Proprietary formatting with an image convertible format such as JPEG or DICOM is acceptable.

Due to the natural progression of technical advancements in the field of thermal imaging, infrared imaging systems for clinical use typically exceed these requirements. However, there is no evidence (Class 1 or Class 2) in the current research literature to support the need of using imaging systems that surpass the above minimum standards.

Ref: 1, 5, 7, 8, 11, 12-19, 38, 64, 65, 106, 351, 354, 377, 393, 422, 427, 430-433, 445-459

GUIDELINE 3: OTHER THERMAL DETECTION DEVICES

As previously mentioned, certain minimum equipment standards should be maintained in order to produce infrared images that are diagnostic. There are many different types of thermal detection devices available that may be used for specific purposes (e.g. temporal and tympanic thermometers), but may not be suitable for body or breast examinations. A brief summary is given below regarding some of these devices.

3.1 Dual Sensor Paraspinal Devices: Since the early 1920's, thermal detection devices have been used in the examination of the paraspinal region. These devices are designed to be hand-held and moved by the operator up or down the spine over the paraspinal surfaces. The equipment is composed of a linear array of two spot radiometers (infrared sensors) spaced adequately to straddle the spine and interfaced to a hard-copy readout device or computer. This creates a system best defined as surface thermometry or computerized surface thermometry if a computer interface is used. If enough plotted data is displayed for analysis (e.g. scan distance for anatomic location, direct and differential temperature displays) the system may be defined as paraspinal thermography. Earlier contact devices using thermocouples or thermistors have been replaced with infrared sensors to avoid the inherent errors produced when instruments of this type are used.

These infrared devices are limited in their use to the evaluation of conditions arising from the area of the spine and paraspinal tissues. If the device is manufactured to the strict minimum standards imposed on all quality clinical infrared devices (e.g. accuracy, repeatability, and thermal stability), then the information yielded will be of diagnostic value.

A review of the literature concerning infrared sensor instruments of this type suggests that in order to produce accurate, reproducible, and clinically relevant thermal data the following minimum specifications should be incorporated in their design:

- An infrared detector response greater than 5 microns and less than 15 microns with the spectral bandwidth encompassing the 8-10 micron region.
- System temperature range set to cover temperatures over the range of human emissions.
- Emissivity set to 0.98 (human skin)
- Accurate data repeatability in temperature value and location.
- A direct linear correspondence between the distance traveled, anatomic location, and the displayed temperature values.
- Controlled infrared sensor collimation to prevent sensor cross-talk.
- Within a reasonable range of distance from the skin, the recorded temperature, and the spot size being measured, should not vary.
- The skin surface covered by the sensor must be controlled within a small enough area to yield data with which a sufficiently detailed graph can be produced.
- A sufficient number of infrared samples must be taken in order to maintain an adequately detailed graph resolution. The number of samples taken should be equivalent to the minimum standards of acceptable clinical infrared camera systems.
- Repeatability and precision of 0.1 degree C detection of temperature difference.
- Absolute temperature accuracy of +/- 2 degree C or +/- 2% of reading or less.
- Ability to perform accurate quantitative differential temperature analysis.
- High-resolution image display for interpretation.
- Ability to archive images and graphs for future reference and image comparison.
- Software manipulation of the images and graphs should be maintained within strict parameters to insure that the diagnostic qualities of the images and graphs are not compromised.

3.2 Microwave Thermography: Past research has determined that microwave thermography has some limited value in the evaluation of the breast. Studies have demonstrated that certain inherent problems exist with this technology. Concerns raised include: introduction of errors from surface contact, depth of analysis, area coverage,

and low spatial and thermal resolution. Research on this technology suggests that infrared telethermography or liquid crystal thermography is better suited for clinical use.

3.3 Single Sensor Devices: The devices in this category are usually designed to be hand-held and moved by the operator over a particular area of the skin or to areas of the body where single spot temperature readings are taken (e.g. tympanic thermometers, skin surface thermometry). Thermal detection devices that fall into this category are best described as surface thermometry. Most of these devices are designed using a single spot radiometer (infrared sensor). If the device incorporates the need for surface contact, certain inherent problems can cause significant errors when a thermal analysis is performed. Incorporation of a computer interface to the sensor creates a system best defined as computerized surface thermometry. We are unaware of any acceptable level of peer-reviewed research in the body of literature to support the use of this type of equipment for body or breast analysis. Single sensor devices are not considered suitable for clinical use as they suffer from many data acquisition problems, notably of which is an extreme lack of absolute and spatial resolution. Devices of this type are considered obsolete.

Ref: 1, 45, 62, 65, 421

GUIDELINE 4: PATIENT MANAGEMENT PROTOCOLS

Proper management of the patient, both before and during the examination, decreases the chance of thermal artifacts and increases the accuracy of the images. It is the technician's responsibility to ensure that all pre-imaging preparation and laboratory protocols are followed.

4.1 Pre-examination Preparation: Pre-examination preparation instructions are of great importance in decreasing thermal artifacts. The following is a minimal list of instructions that should be given to the patient prior to the examination:

- No sunbathing of the area to be imaged 5 days prior to the exam.
- No use of lotions, oils, creams, powders, or makeup on the body area to be imaged the day of the exam.
- For upper body and breast imaging, no use of deodorants or antiperspirants the day of the exam.
- If any body areas included in the images are to be shaved, this should be done the day before the exam.
- No physical therapy, EMS, TENS, ultrasound treatment, acupuncture, chiropractic, physical stimulation, sauna or steam room use, hot or cold pack use for 24 hours before the exam.
- No exercise the day of the exam.
- If showering, it must be no closer than 1 hour before the exam. No baths for 24 hours prior to the exam.
- If not contraindicated by the patient's doctor, avoid the use of pain medications and vasoactive drugs the day of the exam. The patient must consult with their doctor before changing the use of any medications.
- For breast imaging, if the patient is nursing they should try to nurse as far from 1 hour prior to the exam as possible. The last breast nursed should be identified (e.g. right or left).
- If the patient has had any surgical procedure (e.g. any type of biopsy) within the last 12 weeks, the imaging office should be notified and the surgical procedure cleared before an appointment is made.

4.2 Intake Forms: Intake forms should be used and formatted to cover the areas of complaint along with specific pain diagrams, precise location of scars, previous tests and examinations, and a current and past history of any diagnoses, surgeries, and traumas. Intake forms for breast imaging should include additional questions pertaining to anatomic and physiologic changes noted in the breast along with breast diagrams for determining the precise locations of clinical and imaging findings. All of these forms should be designed to be thorough and specific to the body area(s) being imaged.

4.3 Informed Consent: Informed consent is a process, not just a form. Information must be presented in such a manner that enables persons to voluntarily decide whether or not to participate in imaging. Each patient must sign the consent form in the presence of office personnel. The form needs to acknowledge that they have been provided with information applicable to informed consent that reflects expert consensus of the strengths and weaknesses of clinical infrared imaging. Informed consent forms must also contain clear wording that infrared imaging is an adjunctive procedure; and as such, is not a replacement for mammography, ultrasonography, CT, MRI, or any other form of imaging.

4.4 Patient Acclimation: Prior to imaging, the patient's body must be given sufficient time to equilibrate with the ambient conditions of the laboratory such that an approximate steady physiologic state of thermodynamic equilibrium can be reached. A minimum equilibration period of 15 minutes should be observed; further equilibration results in minimal surface temperature changes. During the equilibration period, and the subsequent examination, the area to be imaged should remain completely uncovered of clothing or jewelry. To provide a level of modesty prior to certain examinations, a loose fitting gown may be worn during the equilibration period provided that it does not restrict airflow or constrict the skin surface in any way that would produce an artifactual result on the thermogram. Special gowning procedures, specific to the clinic or examination, may be required and are permitted as long as the above stipulations are observed.

The only exception to gowning is in breast imaging where the breasts should remain uncovered during the entire equilibration period, and subsequent examination, in order to avoid contact artifacts. Due to the individual anatomy of each patient, special positioning during the equilibration period and examination may be needed. If the patient is seated or standing, the last 5 minutes of the equilibration period should be spent with the patient placing their hands over their head in order to lift the breasts for adequate surface area exposure. Depending on the individual patient's anatomy, this posture may need further modification during the acclimation period. This posture is also to be maintained throughout the examination.

4.5 Clinical Examination: When appropriate to the individual case, a clinical examination may be performed after thermal imaging to correlate specific findings. The examination may include visual inspection, palpation, neurologic, orthopedic or other forms of analyses as deemed necessary by the patient's doctor or the interpreting clinician if attending. Visual observation for skin changes and irregularities (e.g. scars, redness) should also be part of the normal imaging process for the attending technician.

Ref: 1, 2-4, 8, 11, 22, 26, 30-32, 35, 37-51, 54-55, 57-65, 70-72, 74-404

GUIDELINE 5: IMAGING PROTOCOLS

The guidelines given for strict laboratory environmental controls and patient preparation provide for a subject that is physiologically ready for thermal imaging.

Note: It is absolutely essential that the capturing of thermal images for health care purposes be made only by personnel who hold credentials as certified clinical thermographic technicians or board certified clinical thermographers from a recognized organization.

5.1 Imaging Series: A thermographic series consists of one or more images, captured on archival media, which permit the evaluation of the body surface area relevant to the purpose of the examination. Each thermographic series should include all or as many body surfaces as possible that are relevant to the patient's complaint and symptomatology, along with any anatomically and physiologically related areas. Standardized views of each body part have been established in order to provide adequate viewing of the skin surface for qualitative and quantitative analysis. A single thermographic series is considered clinically valid if performed under the conditions previously outlined.

5.2 Patient Positioning: The use of both electronic infrared and liquid crystal thermographic systems incorporate basic standardized patient and equipment positioning for each area of the body imaged. Typically, the entire upper

body or lower body is imaged in sections in order to adequately analyze the physiology related to these areas. Specialized or limited views may be added, or taken as an individual study, as needed.

When positioning for breast imaging, multiple views from different angles are necessary to provide adequate imaging of the differing surface aspects of the breast and relevant anatomic areas. The minimum set of images taken should include the bilateral frontal, right oblique, and left oblique. In order to provide for an adequate view of the lateral aspect of the breast, the angle of the oblique views will vary depending on the patient's presenting anatomy. It is highly recommended that the unilateral "bullseye" close-up view of each breast be included on every series taken. This view provides optimal use of the detector by dedicating the greatest number of infrared sensors to each individual breast; thus, providing for an image with the highest absolute and spatial resolution. With certain patients, additional views may be necessary to image specific surface areas that are obscured due to the individual's anatomy (e.g. inferior quadrant lift views).

5.3 Imaging: Combined positioning of the equipment and the patient is critical to accurate imaging. Electronic infrared telethermography studies should be performed with the detector(s) as perpendicular as possible to the surface to be viewed. If other than perpendicular views are required, the angle must be kept exactly the same for comparable bilateral views. To maintain adequate spatial resolution and interpretation accuracy, the body part(s) of interest should be brought close enough to the detector(s) to fill the viewable image area. When multiple views are required for bilaterally equivalent areas of the body, the equipment settings (or temperature scale "screen" selection with LCT) must not be altered for the two views. Liquid crystal thermography studies should be performed using the proper temperature scale "screen" for the body area imaged along with an adequate number of images to cover the surface area(s) of interest. The screens must also be allowed to cool/equilibrate between views of the opposite sides of the body.

5.4 Additional Studies: Any additional studies and/or images may be requested and are up to the discretion of the interpreting thermologist. Stress studies involving symptom exacerbation or a thermoregulatory challenge may be performed following a baseline thermographic series.

The use of a thermoregulatory challenge (a.k.a. cold challenge) is defined as dynamic thermography. The thermoregulatory challenge may be added to an examination to clarify the extent of the nervous system's involvement in a suspected pathologic process (e.g. Raynaud's disease, CRPS). The procedure entails the use of a cold stimulus (ice water or equivalent temperature stimulus) applied to the hands, feet, or lower half of the central thoracic spine. The test is commonly performed via hand or feet immersion in an ice water bath for a minimum of 45 seconds (or until pain tolerance) followed by repeated imaging (a single duplicate study or a timed cooling/warming series may be used) of the body area(s) under study. Warmer water (e.g. tap water in temperate climate zones) may not provide a strong enough stimulus to the sympathetic nervous system and is considered questionable as to its reliability. The addition of a thermoregulatory challenge test is up to the discretion of the interpreting thermologist and not the technician.

With regard to breast imaging, both direct airflow to the breast (fans) and ice water (hand, feet, or thoracic spine area stimulus) have been used as a thermoregulatory challenge in many thermal imaging studies. Studies have shown that the use of fans directed at the breast(s) generally produces an unreliable superficial effect while ice water (hand, feet, or thoracic spine area stimulus) assures a central nervous system mediated sympathetic reflex. The use of fans may also introduce many variables that cannot be controlled for which could adversely affect the quality of the images. The addition of a thermoregulatory challenge test is up to the discretion of the interpreting thermologist and not the technician. Studies have shown that the addition of the thermoregulatory challenge to the standard set of infrared breast images is not necessary to provide for accurate and reliable imaging.

5.5 Documentation: Each thermographic image, captured on archival media, should contain an indication of the anatomic view along with the following minimum information; either included with the original image or immediately traceable to the patient's individual database:

- 1.) The patient's name or identification code and imaging date
- 2.) The imaging facility name and address

GUIDELINE 6: IMAGE INTERPRETATION AND REPORTING

Note: It is absolutely essential that the interpretation of thermal images for health care purposes be made only by health care providers who are formally trained in clinical diagnosis (e.g. MD, DC, DO) and hold credentials as board certified clinical thermographers from a recognized organization. Health care providers with specific specialties may also be included (e.g. DDS), with the use of thermography limited to the specialty.

6.1 Thermogram Interpretation: Interpretation of thermal images is based on a knowledge of thermography and its relation to human physiologic systems and processes. Interpretation provides information on the normal and abnormal functioning of the sensory and sympathetic nervous systems, vascular system, musculoskeletal system, endocrine system, and local inflammatory processes. Combining the information gained from the thermal images with clinical data allows for the formation of a clinical impression.

6.2 Breast Thermogram Interpretation: Standardized interpretation guidelines in thermal breast imaging have been utilized since the adoption of the 20 point TH (Thermobiological) interpretation and classification system in the early 1980's. This system has been continually updated as ongoing research has dictated. Many large-scale studies, encompassing well over 300,000 women participants, confirm the objectivity and accuracy of this interpretation and classification system. This system of interpretation is the most up-to-date method for use in the analysis of thermal breast images. The 20 point TH interpretation and classification system is the accepted standard in thermal breast imaging analysis.

The TH grading system was devised in order to provide a method for the universal interpretation of both qualitative and quantitative thermal data and to use this data to convey the level of risk and concern. The grading system allows for the objective monitoring of the progression of possible pathology and to provide an objective indicator of improvement of the health of the breasts under care. The TH classification system is as follows:

- TH 1** Normal Symmetrical Non-Vascular
- TH 2** Normal Symmetrical Vascular
- TH 3** Questionable
- TH 4** Abnormal
- TH 5** Very Abnormal

Depending on the patient's recent clinical examination and imaging status, images that fall into the TH3 range and higher classification should be referred for further evaluation. This may include clinical examination, mammography, ultrasonography, magnetic resonance imaging (MRI) and/or a combination of these tests depending on the TH grading.

6.3 Written Reporting: The format for reporting should include as a minimum the following information:

- Imaging facility
- Patient name and age
- Date of examination
- Clinical data
- Symptomatology
- Relevant thermographic findings
- Impression

- Recommendations (if appropriate)
- Signature of qualified thermologist

6.4 Follow-up Thermographic Studies: The clinical need for follow-up thermograms is ultimately up to the discretion of the interpreting thermologist and is based on the pathophysiology of the presenting images and the clinical presentation of the patient. The need for and/or timing of thermographic follow-up will also be predicated on the patient's recent examination procedures and/or imaging.

With regard to breast thermograms, follow-up evaluations are generally done on an annual basis if the images are normal (TH1 or TH2). The following recall recommendations are based on the average doubling time of malignant mammary neoplasms. Depending on the patient's conventional risk factors, and other pertinent clinical data, the following recall times may be varied by the interpreting thermologist.

Patients who fall into the TH3 classification upon initial evaluation should be recalled at 6 months. If at the 6 month re-evaluation the thermogram remains stable as a TH3, or improves to a TH2 or TH1, the patient should be recalled once more at 6 months. If after 1 year of observation the patient remains stable as a TH3, or improves to a TH2 or TH1, a return to annual thermograms would be recommended.

Patients with an initial thermogram in the TH4 or TH5 classification should be recalled at 3 months. If at the 3 month re-evaluation the thermogram remains stable as a TH4 or TH5 (no increase to a higher classification), or improves to a lower classification, the patient should be recalled once more at 6 months. If at the 6 month re-evaluation the thermogram remains at a stable TH4 or TH5, thermograms should be performed at 6 month intervals until improvement to a TH3 or lesser classification or a pathology is discovered.

All imaging and recalls should be accompanied by the recommendation that the patient should be seeing their doctor and maintaining their regularly scheduled health examinations. Recommendations for treatment must be made by the patient's doctor.

Ref: 1, 11, 37, 49, 57, 59, 62, 63, 65, 95, 139, 142, 144, 146, 156, 195, 265, 276, 387-388, 405-411, 413-420, 422-425

GUIDELINE 7: CLINICAL THERMOGRAPHY EDUCATION GUIDELINES

Adequate training in thermographic imaging is a necessity to insure quality image acquisition, accurate interpretation, and patient safety.

7.1 Certified Clinical Thermographic Technicians: Training courses leading to certification are comprised of both formal classroom hours and practical imaging experience. Courses typically cover basic thermal imaging principles, patient management, laboratory and imaging protocols, and a time period of supervised practical field experience. Technicians are not trained in the interpretation of thermographic images. Candidates that complete a recognized course of study, and successfully pass the required examination(s), hold credentials as certified clinical thermographic technicians.

7.2 Board Certified Clinical Thermologist: Educational courses at this level are comprised of both formal classroom hours and practical imaging experience. The course material typically covered includes: a review of relevant anatomy and physiology, pathophysiologic processes and their relation to thermographic presentations, laboratory and imaging protocols, patient management, thermal imaging principles, image analysis and interpretation, and a time period of closely supervised practical field experience. Candidates that complete a recognized course of study, and successfully pass the required examinations, hold credentials as board certified clinical thermologists.

7.3 Breast Thermologist: It is essential that extended training in breast thermography be completed by doctors who are intending on interpreting thermal breast images. This level of education exceeds the thermal breast imaging information covered in courses leading to general board certification. A typical course of study includes: a review of breast anatomy and physiology, pathophysiologic breast processes and their relation to thermographic

presentations, laboratory and imaging protocols, patient management, thermal imaging principles, image analysis and interpretation, and a time period of closely supervised practical field experience.

7.4 Certifying Organizations: Educational courses in clinical thermography are provided through recognized organizations. Due to the many non-clinical uses of thermographic imaging, only organizations specifically founded to serve the educational needs in clinical thermography are recognized.

Quality educational courses have been offered by the International Academy of Clinical Thermology since its beginnings as the California Thermographic Society in the early 1980's. The Academy provides training courses for both technicians and health care providers. The courses have been continually updated to meet the ongoing changes and advancements in the field of clinical thermology.

SUMMARY –

The guidelines in this document are designed to assist practitioners in the use of clinical thermal imaging and to provide outside agencies with knowledge in the application of the procedure. The guidelines, however, should not be considered permanent. Research in this field is ongoing internationally within private practices, hospitals, and universities. This research can be expected to impact the utilization of thermal imaging on a continuous basis ensuring that there is progression and growth in knowledge and understanding of the benefits and role of thermal imaging in the health care delivery system. As the results of such research begin to have a practical impact, the utilization of thermal imaging will change and future guidelines will have to take such changes into account. The guidelines in this document are reviewed annually by the guidelines committee with revisions made as research dictates.

REFERENCES –

- 1) ACTA Thermographica: Vol 1-6, 1976-1982.
- 2) E.F.J. Ring, Pioneering progress in infrared imaging in medicine, *Quant. InfraRed Thermogr. J.* (2014) 1–9.
- 3) E.Y.K. Ng, A review of thermography as promising non-invasive detection modality for breast tumor, *Int. J. Therm. Sci.* 48 (2009) 849–859.
- 4) E. Ring, K. Ammer, The technique of infra red imaging in medicine, *Thermol. Int.* 10 (2000) 7–14.
- 5) J.-H. Tan, E.Y.K. Ng, U. Rajendra Acharya, C. Chee, Infrared thermography on ocular surface temperature: a review, *Infrared Phys. Technol.* 52 (2009) 97–108.
- 6) Amalu WC. Nondestructive Testing of the Human Breast: The Validity of Dynamic Stress Testing in Medical Infrared Breast Imaging. Presented at the 26th Annual International Conference of the IEEE Engineering in Medicine and Biology Society. Published in the proceedings of the IEEE – EMBS Conference 2004.
- 7) G. Gaussorgues, *Infrared Thermography*, Springer, Netherlands, 1993.
- 8) B.F. Jones, P. Plassmann, Digital infrared thermal imaging of human skin, *IEEE Eng. Med. Biol. Mag.* 21 (2002) 41–48.
- 9) N.A. Taylor, M.J. Tipton, G.P. Kenny, Considerations for the measurement of core, skin and mean body temperatures, *J. Therm. Biol.* 46 (2014) 72–101.

- 10) I. Campbell, Body temperature and its regulation, *Anaesth. Intens. Care Med.* 12 (2011) 240–244.
- 11) N. Zaproudina, V. Varmavuo, O. Airaksinen, M. Narhi, Reproducibility of infrared thermography measurements in healthy individuals, *Physiol. Meas.* 29 (2008) 515–524.
- 12) K. Ammer, Thermology 2013 – a computer-assisted literature survey, *Thermol. Int.* 24 (2014) (2013) 93–130.
- 13) K. Ammer, Thermology 2002 – a computer assisted literature search, *Thermol. Int.* 13 (2003) (2002) 10–26.
- 14) K. Ammer, Published Papers on Thermology or Temperature Measurement Between 2011 and 2012, 2013. <[http://www.uhlen.at/thermologyinternational/archive/Volume 4.pdf](http://www.uhlen.at/thermologyinternational/archive/Volume%204.pdf)>.
- 15) K. Ammer, Published Papers on Thermology or Temperature Measurement Between 2007 and 2010, 2011. <[http://www.uhlen.at/thermologyinternational/archive/therlit 2007-2010.pdf](http://www.uhlen.at/thermologyinternational/archive/therlit%202007-2010.pdf)>.
- 16) K. Ammer, Published Papers on Thermology or Temperature Measurement Between 2005 and 2006, 2007. <[http://www.uhlen.at/thermologyinternational/archive/therlit 2005-2006.pdf](http://www.uhlen.at/thermologyinternational/archive/therlit%202005-2006.pdf)>.
- 17) K. Ammer, Published Papers on Thermology or Temperature Measurement Between 1989 and 2004, 2005. <[http://www.uhlen.at/thermologyinternational/archive/therlit 2004.pdf](http://www.uhlen.at/thermologyinternational/archive/therlit%202004.pdf)>.
- 18) M. Abernathy, T.B. Abernathy, International bibliography of medical thermology, *Thermology* 2 (1987) 117–533.
- 19) K. Ammer, Thermology on the Internet – an update, *Thermol. Int.* 19 (2009) 15–28.
- 20) Conwell, T.D., et al., Sensitivity, specificity and predictive value of infrared cold water autonomic functional stress testing as compared with modified IASP criteria for CRPS. *Thermology International*, 20-2, 60, 2010.
- 21) K. Ammer, E.F.J. Ring, Standard procedures for Infrared Imaging in Medicine, in: N.A. Diakides, J.D. Bronzino (Eds.), *Medical Infrared Imaging*, Taylor & Francis, United States, 2007, pp. 22.1–22.14.
- 22) N. Harada, M. Iwamoto, M.S. Laskar, I. Hirosawa, M. Nakamoto, S. Shirono, T. Wakui, Effects of room temperature, seasonal condition and food intake on finger skin temperature during cold exposure test for diagnosing hand-arm vibration syndrome, *Ind. Health* 36 (1998) 166–170.
- 23) D.D.F. Pascoe, J. Llanos, J.M. Molloy, J.W. Smith, W.A. Kramer, Influence of environmental temperature on the calculations of mean skin temperature, *Med. Sci. Sports Exerc.* 33 (5 Suppl.) (2001) S222.
- 24) K. Ammer, E.F. Ring, Influence of the field of view on temperature readings from thermal images, *Thermol. Int.* 15 (2005) 99–103.
- 25) G.R. Ivanitsky, E.P. Khizhnyak, A.A. Deev, L.N. Khizhnyak, Thermal imaging in medicine: a comparative study of infrared systems operating in wavelength ranges of 3–5 and 8–12 micron as applied to diagnosis, *Dokl. Biochem. Biophys.* 407 (2006) 59–63.
- 26) IACT, Thermology guidelines, standards and protocols in clinical thermography imaging, in: *International Academy of Clinical Thermology IACT*, 2002, pp. 1–9.
- 27) M.F. Chiang, P.W. Lin, L.F. Lin, H.Y. Chiou, C.W. Chien, S.F. Chu, W.T. Chiu, Mass screening of suspected febrile patients with remote-sensing infrared thermography: alarm temperature and optimal distance, *J. Formos. Med. Assoc.* 107 (2008) 937–944.
- 28) K. Mabuchi, O. Kanbara, H. Genno, T. Chinzei, S. Haeno, M. Kunimoto, Automatic control of optimum ambient thermal conditions using feedback of skin temperature, *Biomed. Thermol.* 16 (1997) 6–13.

- 29) J.H. Veghte, *Infrared Thermography of Subjects in Diverse Environments*, Artic Aeromedical Laboratory Tech., 1965, p. 18.
- 30) S.D. Livingston, R.W. Nolan, J. Frim, L.D. Reed, R.E. Limmer, A thermographic study of the effect of body composition and ambient temperature on the accuracy of mean skin temperature calculations, *Eur. J. Appl. Physiol. Occup. Physiol.* 56 (1987) 120–125.
- 31) G. Fisher, E.B. Foster, D.D. Pascoe, Equilibration period following exposure to hot or cold conditions when using infrared thermography, *Thermol. Int.* 18 (2008) 95–100.
- 32) D.D. Pascoe, G. Fisher, Comparison of measuring sites for the assessment of body temperature, *Thermol. Int.* 19 (2009) 35–42.
- 33) W. Liu, Z. Lian, Q. Deng, Y. Liu, Evaluation of calculation methods of mean skin temperature for use in thermal comfort study, *Build. Environ.* 46 (2011) 478–488.
- 34) L.D. Montgomery, B.A. Williams, Effect of ambient temperature on the thermal profile of the human forearm, hand, and fingers, *Ann. Biomed. Eng.* 4 (1976) 209–219.
- 35) S. Bagavathiappan, T. Saravanan, J. Philip, T. Jayakumar, B. Raj, R. Karunanithi, T.M. Panicker, M.P. Korath, K. Jagadeesan, Infrared thermal imaging for detection of peripheral vascular disorders, *J. Med. Phys./Assoc. Med. Physicists India* 34 (2009) 43–47.
- 36) U. Garagiola, E. Giani, Use of telethermography in the management of sports injuries, *Sports Med.* 10 (1990) 267–272.
- 37) P.M. Gomez Carmona, *Influencia de la informacion termografica infrarroja en el protocolo de prevencion de lesiones de un equipo de futbol profesional espanol*, Sports Department, Faculty of Sciences for Physical Activity and Sport (INEF), Universidad Politecnica de Madrid, Madrid, 2012.
- 38) Z.S. Deng, J. Liu, Mathematical modeling of temperature mapping over skin surface and its implementation in thermal disease diagnostics, *Comput. Biol. Med.* 34 (2004) 495–521.
- 39) E. Akimov, V. Son'kin, Skin temperature and lactate threshold during muscle work in athletes, *Hum. Physiol.* 37 (2011) 621–628.
- 40) E.F. Ring, A.J. Collins, P.A. Bacon, J.A. Cosh, Quantitation of thermography in arthritis using multi-isothermal analysis. II. Effect of nonsteroidal anti-inflammatory therapy on the thermographic index, *Ann. Rheum. Dis.* 33 (1974) 353–356.
- 41) N. Zaproudina, Z. Ming, O.O. Hanninen, Plantar infrared thermography measurements and low back pain intensity, *J. Manipulative Physiol. Ther.* 29 (2006) 219–223.
- 42) M. Chudecka, A. Lubkowska, Temperature changes of selected body's surfaces of handball players in the course of training estimated by thermovision, and the study of the impact of physiological and morphological factors on the skin temperature, *J. Therm. Biol.* 35 (2010) 379–385.
- 43) M. Abate, L. Di Carlo, L. Di Donato, G.L. Romani, A. Merla, Comparison of cutaneous termic response to a standardised warm up in trained and untrained individuals, *J. Sports Med. Phys. Fitness* 53 (2013) 209–215.
- 44) M. Chudecka, A. Lubkowska, Thermal maps of young women and men, *Infrared Phys. Technol.* 69 (2015) 81–87.
- 45) R. Roy, J.P. Boucher, A.S. Comtois, Validity of infrared thermal measurements of segmental paraspinal skin surface temperature, *J. Manipulative Physiol. Ther.* 29 (2006) 150–155.

- 46) T.J. Malkinson, Calf skin temperature during ergometer exercise: effect of intensity, in: Proceedings of the Second Joint Engineering in Medicine and Biology, 24th Annual Conference and the Annual Fall Meeting of the Biomedical Engineering Society EMBS/BMES Conference, 2002, vol. 1292, pp. 1297–1298.
- 47) D.L. Roberts, P.H. Goodman, Dynamic thermoregulation of back and upper extremity by computer-aided infrared Imaging, *Thermology* 2 (1987) 573–577.
- 48) B.B. Lahiri, S. Bagavathiappan, T. Jayakumar, J. Philip, Medical applications of infrared thermography: a review, *Infrared Phys. Technol.* 55 (2012) 221–235.
- 49) E.S. Kolosovas-Machuca, F.J. Gonzalez, Distribution of skin temperature in Mexican children, *Skin Res. Technol.* 17 (2011) 326–331.
- 50) A. Merla, P.A. Mattei, L. Di Donato, G.L. Romani, Thermal imaging of cutaneous temperature modifications in runners during graded exercise, *Ann. Biomed. Eng.* 38 (2010) 158–163.
- 51) C. Hildebrandt, C. Raschner, K. Ammer, An overview of recent application of medical infrared thermography in sports medicine in Austria, *Sensors* 10 (2010) 4700–4715.
- 52) Head, JF, Amalu WC., Elliot, RL., Hobbins, WB: Infrared Imaging of the Breast – A Review. Chapter 9: Medical Infrared Imaging. Ed. Nicholas Diakides and Joseph Bronzino. CRC Press – Taylor and Francis. 2013
- 53) N. Bouzida, A. Bendada, X.P. Maldague, Visualization of body thermoregulation by infrared imaging, *J. Therm. Biol.* 34 (2009) 120–126.
- 54) D.M. Savastano, A.M. Gorbach, H.S. Eden, S.M. Brady, J.C. Reynolds, J.A. Yanovski, Adiposity and human regional body temperature, *Am. J. Clin. Nutr.* 90 (2009) 1124–1131.
- 55) K. Ammer, Temperature changes after manual examination of the cervical spine, *Thermol. Int.* 12 (2002) 147–152.
- 56) B.M. Gratt, M. Anbar, Thermology and facial telethermography: Part II. Current and future clinical applications in dentistry, *Dentomaxillofac. Radiol.* 27 (1998) 68–74.
- 57) S. Uematsu, D.H. Edwin, W.R. Jankel, J. Kozikowski, M. Trattner, Quantification of thermal asymmetry. Part 1: Normal values and reproducibility, *J. Neurosurg.* 69 (1988) 552–555.
- 58) M.D. Devereaux, G.R. Parr, D.P. Thomas, B.L. Hazleman, Disease activity indexes in rheumatoid arthritis; a prospective, comparative study with thermography, *Ann. Rheum. Dis.* 44 (1985) 434–437.
- 59) F. Feldman, E.L. Nickoloff, Normal thermographic standards for the cervical spine and upper extremities, *Skeletal Radiol.* 12 (1984) 235–249.
- 60) J. Gershon-Cohen, J.D. Haberman, Thermography of smoking, *Arch. Environ. Health* 16 (1968) 637–641.
- 61) P. Branemark, S. Fagerberg, L. Langer, J. Save-Soderbergh, Infrared thermography in diabetes mellitus a preliminary study, *Diabetologia* 3 (1967) 529–532.
- 62) E.F. Owens Jr., J.F. Hart, J.J. Donofrio, J. Haralambous, E. Mierzejewski, Paraspinal skin temperature patterns: an interexaminer and intraexaminer reliability study, *J. Manipulative Physiol. Ther.* 27 (2004) 155–159.
- 63) R.A. Roy, J.P. Boucher, A.S. Comtois, Digitized infrared segmental thermometry: time requirements for stable recordings, *J. Manipulative Physiol. Ther.* 29 (2006). 468.e461–468.e410.

- 64) J.C. Bouzas Marins, D. Gomes Moreira, S. Pinonosa Cano, M. Sillero-Quintana, D. Dias Soares, A. de Andrade Fernandes, F. Sousa da Silva, C.M. Amaral Costa, P.R. dos Santos Amorim, Time required to stabilize thermographic images at rest, *Infrared Phys. Technol.* 65 (2014) 30–35.
- 65) *Journal of Thermology*: Vol 1-3, 1985-1991.
- 66) L.M. Reinikainen, J.J. Jaakkola, Significance of humidity and temperature on skin and upper airway symptoms, *Indoor Air* 13 (2003) 344–352.
- 67) W.C. Amalu, W.B. Hobbins, J.F. Head, R.L. Elliott, Infrared imaging of the breast: a review, in: N.A. Diakides, J.D. Bronzino (Eds.), *Medical Infrared Imaging*, Taylor & Francis, United States, 2007, pp. 9-1–9-22.
- 68) Marins, JC, Fernandes, AA, Cano, SP, et al: Thermal Body Patterns for Healthy Brazilian Adults (male and female). *J Therm Biol.* 2014 May;42: 1-8.
- 69) M. Torii, M. Yamasaki, T. Sasaki, H. Nakayama, Fall in skin temperature of exercising man, *Br. J. Sports Med.* 26 (1992) 29–32.
- 70) J.J. Ferreira, L.C. Mendonca, L.A. Nunes, A.C. Andrade Filho, J.R. Rebelatto, T.F. Salvini, Exercise-associated thermographic changes in young and elderly subjects, *Ann. Biomed. Eng.* 36 (2008) 1420–1427.
- 71) A. Zontak, S. Sideman, O. Verbitsky, R. Beyar, Dynamic thermography: analysis of hand temperature during exercise, *Ann. Biomed. Eng.* 26 (1998) 988–993.
- 72) T. Nakayama, Y. Ohnuki, K. Kanosue, Fall in skin temperature during exercise observed by thermography, *Jpn. J. Physiol.* 31 (1981) 757–762.
- 73) I. Atmaca, A. Yigit, Predicting the effect of relative humidity on skin temperature and skin wettedness, *J. Therm. Biol.* 31 (2006) 442–452.
- 74) C. Hildebrandt, K. Zeilberger, E.F.J. Ring, C. Raschner, The application of medical Infrared Thermography in sports medicine, in: K.R. Zaslav (Ed.), *An International Perspective on Topics in Sports Medicine and Sports Injury*, InTech, 2012, pp. 257–274.
- 75) J.D. Hardy, E.F. Du Bois, Differences between men and women in their response to heat and cold, *Proc. Natl. Acad. Sci. USA* 26 (1940) 389–398.
- 76) J.M. Chamberlain, T.E. Terndrup, D.T. Alexander, F.A. Silverstone, G. Wolf-Klein, R. O'Donnell, J. Grandner, Determination of normal ear temperature with an infrared emission detection thermometer, *Ann. Emerg. Med.* 25 (1995) 15–20.
- 77) N. Hashiguchi, Y. Feng, Y. Tochihara, Gender differences in thermal comfort and mental performance at different vertical air temperatures, *Eur. J. Appl. Physiol.* 109 (2010) 41–48.
- 78) A.M.J. van Ooijen, W.D. van Marken Lichtenbelt, K.R. Westerterp, Individual differences in body temperature and the relation to energy expenditure: the influence of mild cold, *J. Therm. Biol.* 26 (2001) 455–459.
- 79) F.C. Baker, J.I. Waner, E.F. Vieira, S.R. Taylor, H.S. Driver, D. Mitchell, Sleep and 24 hour body temperatures: a comparison in young men, naturally cycling women and women taking hormonal contraceptives, *J. Physiol.* 530 (2001) 565–574.
- 80) R. Grucza, H. Pekkarinen, E.K. Titov, A. Kononoff, O. Hanninen, Influence of the menstrual cycle and oral contraceptives on thermoregulatory responses to exercise in young women, *Eur. J. Appl. Physiol. Occup. Physiol.* 67 (1993) 279–285.

- 81) M.D. Coyne, C.M. Kesick, T.J. Doherty, M.A. Kolka, L.A. Stephenson, Circadian rhythm changes in core temperature over the menstrual cycle: method for noninvasive monitoring, *Am. J. Physiol. Regul. Integr. Comp. Physiol.* 279 (2000) R1316–R1320.
- 82) M. Sund-Levander, C. Forsberg, L.K. Wahren, Normal oral, rectal, tympanic and axillary body temperature in adult men and women: a systematic literature review, *Scand. J. Caring Sci.* 16 (2002) 122–128.
- 83) M.L. Bartelink, H. Wollersheim, A. Theeuwes, D. van Duren, T. Thien, Changes in skin blood flow during the menstrual cycle: the influence of the menstrual cycle on the peripheral circulation in healthy female volunteers, *Clin. Sci. (Lond.)* 78 (1990) 527–532.
- 84) K. Cankar, Z. Finderle, Gender differences in cutaneous vascular and autonomic nervous response to local cooling, *Clin. Auton. Res.: Off. J. Clin. Auton. Res. Soc.* 13 (2003) 214–220.
- 85) N. Charkoudian, Skin blood flow in adult human thermoregulation: how it works, when it does not, and why, *Mayo Clinic proceedings, Mayo Clinic* 78 (2003) 603–612.
- 86) A. Karki, P. Karppi, J. Ekberg, J. Selfe, A thermographic investigation of skin temperature changes in response to a thermal washout of the knee in healthy young adults, *Thermol. Int.* 14 (2004) 137–141.
- 87) M. Chudecka, A. Lubkowska, A. Kempin´ska-Podhorodecka, Body surface temperature distribution in relation to body composition in obese women, *J. Therm. Biol.* 43 (2014) 1–6.
- 88) D. Fournet, L. Ross, T. Voelcker, B. Redortier, G. Havenith, Skin temperature mapping in the cold: the role of subcutaneous fat, in: XIV ICEE, ICEE, Nafplio, Greece, 2011.
- 89) D. Fournet, L. Ross, T. Voelcker, B. Redortier, G. Havenith, Body mapping of thermoregulatory and perceptual responses of males and females running in the cold, *J. Therm. Biol.* 38 (2013) 339–344.
- 90) J. Christensen, M. Vaeth, A. Wenzel, Thermographic imaging of facial skin gender differences and temperature changes over time in healthy subjects, *Dentomaxillofac. Radiol.* 41 (2012) 662–667.
- 91) Y. Shapiro, K.B. Pandolf, B.A. Avellini, N.A. Pimental, R.F. Goldman, Physiological responses of men and women to humid and dry heat, *J. Appl. Physiol.: Respir., Environ. Exerc. Physiol.* 49 (1980) 1–8.
- 92) G. Havenith, Human surface to mass ratio and body core temperature in exercise heat stress – a concept revisited, *J. Therm. Biol.* 26 (2001) 387–393.
- 93) F. Haas, A. Rebecca, A.O. Kruczek, L. Haas, J.M. Cohen Downing, M.H.M. Lee, Use of infrared imaging to evaluate sex differences in hand and finger rewarming patterns following cold water immersion, *Thermol. Int.* 17 (2007) 147–153.
- 94) N. Zaproudina, Methodological Aspects of use of Infrared Thermography in Healthy Individuals and Patients with Nonspecific Musculoskeletal Disorders, Faculty of Health Sciences, University of Eastern Finland, Kuopio, 2012, p. 66.
- 95) H.H. Niu, P.W. Lui, J.S. Hu, C.K. Ting, Y.C. Yin, Y.L. Lo, L. Liu, T.Y. Lee, Thermal symmetry of skin temperature: normative data of normal subjects in Taiwan, *Zhonghua Yi Xue Za Zhi (Taipei)* 64 (2001) 459–468.
- 96) J.S. Petrofsky, E. Lohman 3rd, H.J. Suh, J. Garcia, A. Anders, C. Sutterfield, C. Khandge, The effect of aging on conductive heat exchange in the skin at two environmental temperatures, *Med. Sci. Monit.: Int. Med. J. Exp. Clin. Res.* 12 (2006) CR400–CR408.
- 97) M.E. Symonds, K. Henderson, L. Elvidge, C. Bosman, D. Sharkey, A.C. Perkins, H. Budge, Thermal Imaging to assess age-related changes of Skin Temperature within the supraclavicular region co-locating with Brown Adipose Tissue in healthy children, *J. Pediatr.* 161 (2012) 892–898.

- 98) W.L. Kenney, C.G. Armstrong, Reflex peripheral vasoconstriction is diminished in older men, *J. Appl. Physiol.: Respir., Environ. Exerc. Physiol.* 80 (1996) 512–515.
- 99) L.A. Holowatz, W.L. Kenney, Peripheral mechanisms of thermoregulatory control of skin blood flow in aged humans, *J. Appl. Physiol.: Respir., Environ. Exerc. Physiol.* 109 (2010) 1538–1544.
- 100) D. Weinert, Circadian temperature variation and ageing, *Ageing Res. Rev.* 9 (2010) 51–60.
- 101) R.P. Clark, J.K. Stothers, Neonatal skin temperature distribution using infrared color thermography, *J. Physiol. London* 302 (1980) 323–333.
- 102) L. Hanssler, H. Breukmann, Measuring skin temperature in premature infants. Comparison of infrared telethermography and electric contact thermometry, *Klin. Padiatr.* 204 (1992) 355–358.
- 103) I. Christidis, H. Zotter, H. Rosegger, H. Engele, R. Kurz, R. Kerbl, Infrared thermography in newborns: the first hour after birth, *Gynakol. Geburtshilfliche Rundsch.* 43 (2003) 31–35.
- 104) R.B. Knobel, B.D. Guenther, H.E. Rice, Thermoregulation and thermography in neonatal physiology and disease, *Biol. Res. Nurs.* 13 (2011) 274–282.
- 105) L.K. Rasmussen, J.B. Mercer, A comparison of thermal responses in hands and feet of young and elderly subjects in response to local cooling as determined by infrared imaging, *Thermol. Int.* 14 (2004) 71–76.
- 106) E. Boerner, J. Bauer, B. Ratajczak, E. Deren´, H. Podbielska, Application of thermovision for analysis of superficial temperature distribution changes after physiotherapy, *J. Therm. Anal. Calorim.* (2014) 1–7.
- 107) J.C. Bouzas Marins, A.d. Andrade Fernandes, D. Gomes Moreira, F. Souza Silva, C. Magno A. Costa, E.M. Pimenta, M. Sillero-Quintana, Thermographic profile of soccer players' lower limbs, *Rev. Andaluza Med. Deporte* 7 (2014) 1–6.
- 108) E.L. Glickman-Weiss, C.M. Hearon, A.G. Nelson, J. Kime, Relationship between thermoregulatory parameters and DEXA-estimated regional fat, *Wild. Environ. Med.* 7 (1996) 19–27.
- 109) J. LeBlanc, Subcutaneous fat and skin temperature, *Can. J. Biochem. Physiol.* 32 (1954) 354–358.
- 110) A. Reinberg, Circadian changes in the temperature of human beings, *Bibl. Radiol.* (1975) 128–139.
- 111) S.D. Bianchi, G.G. Gatti, B. Mecozzi, Circadian variations in the cutaneous thermal map in normal subjects, *Acta Thermogr.* 4 (1979) 95–98.
- 112) A. Binder, G. Parr, P.P. Thomas, B. Hazleman, A clinical and thermographi study of lateral epicondylitis, *Br. J. Rheumatol.* 22 (1983) 77–81.
- 113) R.S. Salisbury, G. Parr, M. De Silva, B.L. Hazleman, D.P. Page-Thomas, Heat distribution over normal and abnormal joints: thermal pattern and quantification, *Ann. Rheum. Dis.* 42 (1983) 494–499.
- 114) [108] E.F. Ring, Quantitative thermal imaging, *Clin. Phys. Physiol. Meas.* 11 (Suppl. A) (1990) 87–95.
- 115) J. Waterhouse, B. Drust, D. Weinert, B. Edwards, W. Gregson, G. Atkinson, S.Y. Kao, S. Aizawa, T. Reilly, The circadian rhythm of core temperature: origin and some implications for exercise performance, *Chronobiol. Int.* 22 (2005) 207–225.
- 116) G.S. Kelly, Body temperature variability (Part 1): a review of the history of body temperature and its variability due to site selection, biological rhythms, fitness, and aging, *Altern. Med. Rev.* 11 (2006) 278–293.

- 117) K. Krauchi, A. Wirz-Justice, Circadian rhythm of heat production, heart rate, and skin and core temperature under unmasking conditions in men, *Am. J. Physiol.* 267 (1994) R819–R829.
- 118) N. Miyakoshi, E. Itoi, K. Sato, K. Suzuki, H. Matsuura, Skin temperature of the shoulder: circadian rhythms in normal and pathologic shoulders, *J. Shoulder Elbow Surg./Am. Shoulder Elbow Surg.* 7 (1998) 625–628.
- 119) T. Reilly, J. Waterhouse, Circadian aspects of body temperature regulation in exercise, *J. Therm. Biol.* 34 (2009) 161–170.
- 120) T. Reilly, R. Garrett, Effects of time of day on self-paced performances of prolonged exercise, *J. Sports Med. Phys. Fitness* 35 (1995) 99–102.
- 121) C. Morris, G. Atkinson, B. Drust, K. Marrin, W. Gregson, Human core temperature responses during exercise and subsequent recovery: an important interaction between diurnal variation and measurement site, *Chronobiol. Int.* 26 (2009) 560–575.
- 122) H. Aldemir, G. Atkinson, T. Cable, B. Edwards, J. Waterhouse, T. Reilly, A comparison of the immediate effects of moderate exercise in the late morning and late afternoon on core temperature and cutaneous thermoregulatory mechanisms, *Chronobiol. Int.* 17 (2000) 197–207.
- 123) M.G. Arnett, Effects of prolonged and reduced warm-ups on diurnal variation in body temperature and swim performance, *J. Strength Cond. Res.* 16 (2002) 256–261 (National Strength & Conditioning Association).
- 124) M. Torii, H. Nakayama, T. Sasaki, Thermoregulation of exercising men in the morning rise and evening fall phases of internal temperature, *Br. J. Sports Med.* 29 (1995) 113–120.
- 125) R.B. Barnes, Thermography of the human body, *Science* 140 (1963) 870–877.
- 126) T. Togawa, H. Saito, Non-contact imaging of thermal properties of the skin, *Physiol. Meas.* 15 (1994) 291–298.
- 127) W.M. Smith, Applications of thermography in veterinary medicine, *Ann. N. Y. Acad. Sci.* 121 (1964) 248–254.
- 128) T.A. Turner, Diagnostic thermography, the veterinary clinics of North America, *Equine Pract.* 17 (2001) 95–113.
- 129) E. Autio, R. Neste, S. Airaksinen, M.L. Heiskanen, Measuring the heat loss in horses in different seasons by infrared thermography, *J. Appl. Anim. Welf. Sci.* 9 (2006) 211–221.
- 130) J.D. Hardy, C. Muschenheim, The radiation of heat from the human body. IV. The emission, reflection, and transmission of infra-red radiation by the human skin, *J. Clin. Investig.* 13 (1934) 817–831.
- 131) J.D. Hardy, The radiating power of human skin in the infra-red, *Am. J. Physiol.* 127 (1939) 454–462.
- 132) J. Steketee, Spectral emissivity of skin and pericardium, *Phys. Med. Biol.* 18 (1973) 686–694.
- 133) T. Togawa, Non-contact skin emissivity: measurement from reflectance using step change in ambient radiation temperature, *Clin. Phys. Physiol. Meas.* 10 (1989) 39–48.
- 134) F.J. Sanchez-Marin, S. Calixto-Carrera, C. Villasenor-Mora, Novel approach to assess the emissivity of the human skin, *J. Biomed. Opt.* 14 (2009) 024006.
- 135) J. Thiruvengadam, M. Anburajan, M. Menaka, B. Venkatraman, Potential of thermal imaging as a tool for prediction of cardiovascular disease, *J. Med. Phys.* 39 (2014) 98–105.

- 136) P. Rochcongar, M. Schmitt, Thermographic study of muscular lesions in sport (author's transl), J. Belge. Med. Phys. Rehabil. 2 (1979) 335–342.
- 137) E. Lambiris, H. Stoboy, Thermographie bei Osteosynthesen und Totalendoprothesen des Kniegelenkes mit und ohne Infektion, Z. Orthop. Unfall 119 (1981) 521–524.
- 138) P. Vecchio, A. Adebajo, M. Chard, P. Thomas, B. Hazleman, Thermography of frozen shoulder and rotator cuff tendinitis, Clin. Rheumatol. 11 (1992) 382–384.
- 139) P.H. Goodman, M.W. Heaslet, J.W. Pagliano, B.D. Rubin, Stress fracture diagnosis by computer assisted thermography, Phys. Sportsmed. 13 (1985) 114.
- 140) M.D. Devereaux, G.R. Parr, S.M. Lachmann, P. Page-Thomas, B.L. Hazleman, The diagnosis of stress fractures in athletes, JAMA 252 (1984) 531–533.
- 141) E. Sanchis-Sanchez, R. Salvador-Palmer, P. Codoner-Franch, J. Martin, C. Vergara-Hernandez, J. Blasco, E. Ballester, E. Sanchis, R. Gonzalez-Pena, R. Cibrian, Infrared thermography is useful for ruling out fractures in pediatric emergencies, Eur. J. Pediatr. (2014) 1–7.
- 142) E. Ismail, A. Capo, P. Amerio, A. Merla, Functional-thermoregulatory model for the differential diagnosis of psoriatic arthritis, Biomed. Eng. 13 (2014) 162.
- 143) A. Arfaoui, M.A. Bouzid, H. Pron, R. Taiar, G. Polidori, Application of infrared thermography as a diagnostic tool of knee osteoarthritis, J. Therm. Sci. Technol. 7 (2012) 227–235.
- 144) G. Varju, C.F. Pieper, J.B. Renner, V.B. Kraus, Assessment of hand osteoarthritis: correlation between thermographic and radiographic methods, Rheumatology (Oxford) 43 (2004) 915–919.
- 145) A.J. Collins, E.F. Ring, J.A. Cosh, P.A. Bacon, Quantitation of thermography in arthritis using multi-isothermal analysis. I. The thermographic index, Ann. Rheum. Dis. 33 (1974) 113–115.
- 146) S.J. Spalding, C.K. Kwok, R. Boudreau, J. Enama, J. Lunich, D. Huber, L. Denes, R. Hirsch, Three-dimensional and thermal surface imaging produces reliable measures of joint shape and temperature: a potential tool for quantifying arthritis, Arthritis Res. Ther. 10 (2008) R10.
- 147) U. Snehalatha, M. Anburajan, T. Teena, B. Venkatraman, M. Menaka, B. Raj. Thermal image analysis and segmentation of hand in evaluation of rheumatoid arthritis, in: International Conference on Computer Communication and Informatics (ICCCI), 2012, pp. 1–6.
- 148) R. Lasanen, E. Piippo-Savolainen, T. Remes-Pakarinen, L. Kroger, A. Heikkila, P. Julkunen, J. Karhu, J. Toyras, Thermal imaging in screening of joint inflammation and rheumatoid arthritis in children, Physiol. Meas. 36 (2015) 273–282.
- 149) M. Schmitt, Y. Guillot, Thermography and muscular injuries in sport medicine, in: E.F.J. Ring, B. Phillips (Eds.), Recent Advances in Medical Thermology, Plenum Press, New York, 1984, pp. 439–445.
- 150) F. Bandeira, E. Borba Neves, M.A. Muniz de Moura, P. Nohama, A termografia no apoio ao diagnostico de lesao muscular no esporte, Rev. Bras. Med. Esporte 20 (2014) 59–64.
- 151) L.M. Katz, V. Nauriyal, S. Nagaraj, A. Finch, K. Pearlstein, A. Szymanowski, C. Sproule, P.B. Rich, B.D. Guenther, R.D. Pearlstein, Infrared imaging of trauma patients for detection of acute compartment syndrome of the leg, Crit. Care Med. 36 (2008) 1756–1761.
- 152) S. Pinonosa, M. Sillero-Quintana, L. Milanovic´, J. Coteron, J. Sampedro, Thermal evolution of lower limbs during a rehabilitation process after anterior cruciate ligament surgery, Kinesiology 45 (2013) 121–129.

- 153) J. Allen, K. Howell, Microvascular imaging: techniques and opportunities for clinical physiological measurements, *Physiol. Meas.* 35 (2014) R91–R141.
- 154) E.D. Cooke, M.F. Picher, Deep vein thrombosis: preclinical diagnosis by thermography, *Br. J. Surg.* 61 (1974) 971–978.
- 155) R.B. Perelman, D. Adler, M. Humphreys, Reflex sympathetic dystrophy: electronic thermography as an aid in diagnosis, *Orthop. Rev.* 16 (1987) 561–566.
- 156) S. Bruehl, T.R. Lubenow, H. Nath, O. Ivankovich, Validation of thermography in the diagnosis of reflex sympathetic dystrophy, *Clin. J. Pain* 12 (1996) 316–325.
- 157) K. Ammer, Diagnosis of Raynaud's phenomenon by thermography, *Skin Res. Technol.* 2 (1996) 182–185.
- 158) L.F. Cherkas, L. Carter, T.D. Spector, K.J. Howell, C.M. Black, A.J. MacGregor, Use of thermographic criteria to identify Raynaud's phenomenon in a population setting, *J. Rheumatol.* 30 (2003) 720–722.
- 159) S. Clark, G. Dunn, T. Moore, M.t. Jayson, T.A. King, A.L. Herrick, Comparison of thermography and laser Doppler imaging in the assessment of Raynaud's phenomenon, *Microvasc. Res.* 66 (2003) 73–76.
- 160) E. Ismail, G. Orlando, M.L. Corradini, P. Amerio, G.L. Romani, A. Merla, Differential diagnosis of Raynaud's phenomenon based on modeling of finger thermoregulation, *Physiol. Meas.* 35 (2014) 703–716.
- 161) G.A. Orlov, V.F. Pil'nikov, Infrared thermography of wounds, *Vestn. Khir. Im. I. I. Grek.* 113 (1974) 56–61.
- 162) B.R. Mason, A.J. Graff, S.P. Pegg, Colour thermography in the diagnosis of the depth of burn injury, *Burns* 7 (1981) 197–202.
- 163) K. Ammer, E.F.J. Ring, Application of thermal imaging in forensic medicine. *Imaging Sci. J.* 53 (2005) 125–131.
- 164) W.P. Zhu, X.R. Xin, Study on the distribution pattern of skin temperature in normal Chinese and detection of the depth of early burn wound by infrared thermography, *Ann. N. Y. Acad. Sci.* 888 (1999) 300–313.
- 165) R. Pochaczewsky, Thermography in posttraumatic pain, *Am. J. Sports Med.* 15 (1987) 243–250.
- 166) G.S. Kelly, Body temperature variability (Part 2): masking influences of body temperature variability and a review of body temperature variability in disease, *Altern. Med. Rev.* 12 (2007) 49–62.
- 167) M. Sillero-Quintana, T. Fernandez Jaen, I. Fernandez-Cuevas, P.M. Gomez Carmona, J. Arnaiz, M.-D. Perez, P. Guillen, Infrared thermography as a support tool for screening and early diagnosis of sport injuries, in: A. Jung (Ed.), 18th Congress of the Polish Association of Thermology, EAT, Zakopane, Poland, 2014.
- 168) B.F. Jones, A reappraisal of the use of infrared thermal image analysis in medicine, *IEEE Trans. Med. Imaging* 17 (1998) 1019–1027.
- 169) R.A. Sherman, A.L. Woerman, K.W. Karstetter, Comparative effectiveness of videothermography, contact thermography, and infrared beam thermography for scanning relative skin temperature, *J. Rehabil. Res. Dev.* 33 (1996) 377–386.
- 170) R.A.N. Littlejohn, Thermographic Assessment of the Forearm during Data Entry Tasks: A Reliability Study, Industrial and Systems Engineering, Virginia Tech., 2008.
- 171) E.F. Ring, K. Ammer, Infrared thermal imaging in medicine, *Physiol. Meas.* 33 (2012) R33–R46.

- 172) N. Rosenberg, A. Stefanides, Thermography in the management of varicose veins and venous insufficiency, *Ann. N. Y. Acad. Sci.* 121 (1964) 113–117.
- 173) G. Vermiglio, M.G. Tripepi, V. Vermiglio, C. Sansotta, B. Testagrossa, Thermographic analysis of short and long term modifications due to the application of tattoos and body piercing, in: R. Magjarevic, J.H. Nagel (Eds.), *IFMBE Proceedings on World Congress on Medical Physics and Biomedical Engineering 2006*, Springer, Berlin, 2007, pp. 2468–2471.
- 174) M. Chudecka, Use of thermal imaging in the evaluation of body surface temperature in various physiological states in patients with different body compositions and varying levels of physical activity, *Centr. Eur. J. Sport Sci. Med.* 2 (2013) 15–20.
- 175) D.K. Smith, L. Ovesen, R. Chu, S. Sackel, L. Howard, Hypothermia in a patient with anorexia nervosa, *Metab.: Clin. Exp.* 32 (1983) 1151–1154.
- 176) A. Wakeling, G.F. Russell, Disturbances in the regulation of body temperature in anorexia nervosa, *Psychol. Med.* 1 (1970) 30–39.
- 177) A. Faje, A. Klibanski, Body composition and skeletal health: too heavy? Too thin?, *Curr Osteoporosis Rep.* 10 (2012) 208–216.
- 178) P. Luck, A. Wakeling, Altered thresholds for thermoregulatory sweating and vasodilatation in anorexia nervosa, *Br. Med. J.* 281 (1980) 906–908.
- 179) L. Bock, Body temperature in persons with anorexia nervosa, *J. Am. Diet. Assoc.* 93 (1993) 976.
- 180) L.J. Jiang, E.Y. Ng, A.C. Yeo, S. Wu, F. Pan, W.Y. Yau, J.H. Chen, Y. Yang, A perspective on medical infrared imaging, *J. Med. Eng. Technol.* 29 (2005) 257–267.
- 181) M. Shuran, R.A. Nelson, Quantitation of energy expenditure by infrared thermography, *Am. J. Clin. Nutr.* 53 (1991) 1361–1367.
- 182) A.K. Adams, R.A. Nelson, E.F. Bell, C.A. Egoavil, Use of infrared thermographic calorimetry to determine energy expenditure in preterm infants, *Am. J. Clin. Nutr.* 71 (2000) 969–977.
- 183) M. Gautherie, C.M. Gros, Breast thermography and cancer risk prediction. *Cancer* 45 (1980) 51–56.
- 184) E.Y. Ng, Y. Chen, L.N. Ung, Computerized breast thermography: study of image segmentation and temperature cyclic variations, *J. Med. Eng. Technol.* 25 (2001) 12–16.
- 185) N. Arora, D. Martins, D. Ruggerio, E. Tousimis, A.J. Swistel, M.P. Osborne, R.M. Simmons, Effectiveness of a noninvasive digital infrared thermal imaging system in the detection of breast cancer, *Am. J. Surg.* 196 (2008) 523–526.
- 186) V. Umadevi, S.V. Raghavan, S. Jaipurkar, Framework for estimating tumour parameters using thermal imaging, *Indian J. Med. Res.* 134 (2011) 725–731.
- 187) G. Jiang, Z. Shang, M. Zhang, Metabolism parameter analysis of diabetics based on the thermography, in: *Proceedings of the Second Joint 24th Annual Conference and the Annual Fall Meeting of the Biomedical Engineering Society EMBS/BMES Conference on Engineering in Medicine and Biology*, 2002, vol. 2223, pp. 2226–2227.
- 188) S. Sivanandam, M. Anburajan, B. Venkatraman, M. Menaka, D. Sharath, Medical thermography: a diagnostic approach for type 2 diabetes based on non-contact infrared thermal imaging, *Endocrine* 42 (2012) 343–351.

- 189) T. Yoneshiro, S. Aita, M. Matsushita, T. Kameya, K. Nakada, Y. Kawai, M. Saito, Brown adipose tissue, whole-body energy expenditure, and thermogenesis in healthy adult men, *Obesity* 19 (2011) 13–16.
- 190) P. Lee, K.K. Ho, P. Lee, J.R. Greenfield, K.K. Ho, J.R. Greenfield, Hot fat in a cool man: infrared thermography and brown adipose tissue, *Diabetes Obes. Metab.* 13 (2011) 92–93.
- 191) P. Lee, J.R. Greenfield, K.K. Ho, M.J. Fulham, A critical appraisal of the prevalence and metabolic significance of brown adipose tissue in adult humans, *Am. J. Physiol. Endocrinol. Metab.* 299 (2010) E601–E606.
- 192) H.H. Pennes, Analysis of tissue and arterial blood temperatures in the resting human forearm, *J. Appl. Physiol.: Respir., Environ. Exerc. Physiol.* 1 (1948) 93–122.
- 193) J. Petrofsky, D. Paluso, D. Anderson, K. Swan, J.E. Yim, V. Murugesan, T. Chindam, N. Goraksh, F. Alshammari, H. Lee, M. Trivedi, A.N. Hudlikar, V. Katrak, The contribution of skin blood flow in warming the skin after the application of local heat; the duality of the Pennes heat equation, *Med. Eng. Phys.* 33 (2011) 325–329.
- 194) A.M. Knab, R.A. Shanely, K.D. Corbin, F. Jin, W. Sha, D.C. Nieman, A 45-minute vigorous exercise bout increases metabolic rate for 14 hours, *Med. Sci. Sports Exerc.* 43 (2011) 1643–1648.
- 195) I. Fernandez-Cuevas, Effect of Endurance, Speed and Strength Training on Skin Temperature Measured by Infrared Thermography, Sports Department, Faculty of Sciences for Physical Activity and Sport (INEF), Universidad Politecnica de Madrid, Spain, 2012.
- 196) U. Garagiola, E. Giani, Thermography: Description, Uses in Sports Medicine, Unpublished article by Encyclopedia of Sports Medicine and Science, Milano, 1991, p. 13.
- 197) A. Merla, G.L. Romani, Functional infrared imaging in medicine: a quantitative diagnostic approach, in: 28th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2006, EMBS '06, 2006, pp. 224–227.
- 198) A.M. Seifalian, G. Stansby, A. Jackson, K. Howell, G. Hamilton, Comparison of laser Doppler perfusion imaging, laser Doppler flowmetry, and thermographic imaging for assessment of blood flow in human skin, *Eur. J. Vasc. Surg.* 8 (1994) 65–69.
- 199) J.T. Costello, C.D. McInerney, C.M. Bleakley, J. Selfe, A.E. Donnelly, The use of thermal imaging in assessing skin temperature following cryotherapy: a review, *J. Therm. Biol.* 37 (2012) 245–274.
- 200) E.B. Akimov, R.S. Andreev, Y.N. Kalenov, A.A. Kirdin, V.D. Son'kin, A.G. Tonevitsky, The human thermal portrait and its relations with aerobic working capacity and the blood lactate level, *Hum. Physiol.* 36 (2010) 447–456.
- 201) T. Wu, H. Snieder, E. de Geus, Genetic influences on cardiovascular stress reactivity, *Neurosci. Biobehav. Rev.* 35 (2010) 58–68.
- 202) M.I. Lambert, T. Mann, J.P. Dugas, Ethnicity and temperature regulation, *Med. Sport Sci.* 53 (2008) 104–120.
- 203) L.E. Hauvik, J.B. Mercer, Thermographic mapping of the skin surface of the head in bald-headed male subjects, *J. Therm. Biol.* 37 (2012) 510–516.
- 204) A. Gatt, C. Formosa, K. Cassar, K.P. Camilleri, C. De Raffaele, A. Mizzi, C. Azzopardi, S. Mizzi, O. Falzon, S. Cristina, N. Chockalingam, Thermographic patterns of the upper and lower limbs: baseline data, *Int. J. Vasc. Med.* 2015 (2015) 9.
- 205) T.T. Seeley, P.R. Abramson, L.B. Perry, A.B. Rothblatt, D.M. Seeley, Thermographic measurement of sexual arousal: a methodological note, *Arch. Sex. Behav.* 9 (1980) 77–85.

- 20) P.R. Abramson, E.H. Pearsall, Pectoral changes during the sexual response cycle: a thermographic analysis, *Arch. Sex. Behav.* 12 (1983) 357–368.
- 207) P.R. Abramson, L.B. Perry, T.T. Seeley, D.M. Seeley, A.B. Rothblatt, Thermographic measurement of sexual arousal: a discriminant validity analysis, *Arch. Sex. Behav.* 10 (1981) 171–176.
- 208) J.G. Beck, D.H. Barlow, D.K. Sakheim, Abdominal temperature changes during male sexual arousal, *Psychophysiology* 20 (1983) 715–717.
- 209) T. Kukkonen, Y. Binik, R. Amsel, S. Carrier, An evaluation of the validity of thermography as a physiological measure of sexual arousal in a nonuniversity adult sample, *Arch. Sex. Behav.* 39 (2010) 861–873.
- 210) H. Zenju, A. Nozawa, H. Tanaka, H. Ide, Estimation of unpleasant and pleasant states by nasal thermogram, *IEEJ Trans. Electron., Inform. Syst.* 124 (2004) 213–214.
- 211) N. Koji, A. Nozawa, H. Ide, Evaluation of emotions by nasal skin temperature on auditory stimulus and olfactory stimulus, *IEEJ Trans. Electron., Inform. Syst.* 124 (2004) 1914–1915.
- 212) R. Nakanishi, K. Imai-Matsumura, Facial skin temperature decreases in infants with joyful expression, *Infant Behav. Develop.* 31 (2008) 137–144.
- 213) F.D. Legrand, W.M. Bertucci, A. Arfaoui, Relationships between facial temperature changes, end-exercise affect and during-exercise changes in affect: a preliminary study, *Eur. J. Sport Sci.* 15 (2014) 161–166.
- 214) T. Mizuno, N. Nakategawa, Y. Kume, Color influences on human beings evaluated by nasal skin temperature, *Artif. Life Robot.* 16 (2012) 519–522.
- 215) S. Jenkins, R. Brown, N. Rutterford, Comparing thermographic, EEG, and subjective measures of affective experience during simulated product interactions, *Int. J. Des.* 3 (2009) 53–65.
- 216) S.J. Ebisch, T. Aureli, D. Bafunno, D. Cardone, G.L. Romani, A. Merla, Mother and child in synchrony: thermal facial imprints of autonomic contagion, *Biol. Psychol.* 89 (2012) 123–129.
- 217) B. Manini, D. Cardone, S. Ebisch, D. Bafunno, T. Aureli, A. Merla, Mom feels what her child feels: thermal signatures of vicarious autonomic response while watching children in a stressful situation, *Front. Hum. Neurosci.* 7 (2013).
- 218) A. Naemura, K. Tsuda, N. Suzuki, Effects of loud noise on nasal skin temperature, *Shinrigaku kenkyu: Jpn. J. Psychol.* 64 (1993) 51–54.
- 219) S. Ioannou, S. Ebisch, T. Aureli, D. Bafunno, H.A. Ioannides, D. Cardone, B. Manini, G.L. Romani, V. Gallese, A. Merla, The autonomic signature of guilt in children: a thermal infrared imaging study, *PLoS ONE* 8 (2013) e79440.
- 220) A. Merla, G.L. Romani, Thermal signatures of emotional arousal: a functional infrared imaging study, in: *Conference on the Proceedings of IEEE Engineering and Medicine and Biology Society, 2007, 2007*, pp. 247–249.
- 221) A. Di Giacinto, M. Brunetti, G. Sepede, A. Ferretti, A. Merla, Thermal signature of fear conditioning in mild post traumatic stress disorder, *Neuroscience* 266 (2014) 216–223.
- 222) K. Mizukami, N. Kobayashi, T. Ishii, H. Iwata, First selective attachment begins in early infancy: a study using telethermography, *Infant Behav. Develop.* 13 (1990) 257–271.
- 223) C.K.L. Or, V.G. Duffy, Development of a facial skin temperature-based methodology for non-intrusive mental workload measurement, *Occup. Ergon.* 7 (2007) 83–94.

- 224) V. Engert, A. Merla, J.A. Grant, D. Cardone, A. Tusche, T. Singer, Exploring the use of thermal infrared imaging in human stress research, *PLoS ONE* 9 (2014) e90782.
- 225) A. Merla, L. Di Donato, G.L. Romani, P.M. Rossini, Recording of the sympathetic thermal response by means of infrared functional imaging, in: *Proceedings of the 25th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, 2003, vol. 1082, 2003, pp. 1088–1090.
- 226) S. Ioannou, V. Gallese, A. Merla, Thermal infrared imaging in psychophysiology: potentialities and limits, *Psychophysiology* 51 (2014) 951–963.
- 227) E.F. Ring, J.M. Engel, D.P. Page-Thomas, Thermologic methods in clinical pharmacology-skin temperature measurement in drug trials, *Int. J. Clin. Pharmacol., Therapy, Toxicol.* 22 (1984) 20–24.
- 228) P.A. Bacon, E.F.J. Ring, A.J. Collins, Thermography in the assessment of anti rheumatic agents, in: J.L. Gordon, B.L. Hazleman (Eds.), *Rheumatoid Arthritis*, Elsevier/North Holland Biomedical Press, Amsterdam, 1977, p. 105.
- 229) H.O. Handwerker, Assessment of the effect of ibuprofen and other nonsteroidal anti-rheumatic drugs in experimental algometry, *Z. Rheumatol.* 50 (suppl. 1) (1991) 15–18.
- 230) E. Giani, L. Rochi, A. Tavoni, M. Montanari, U. Garagiola, Telethermographic evaluation of NSAIDs in the treatment of sports injuries, *Med. Sci. Sports Exerc.* 21 (1989) 1–6.
- 231) T. Uematsu, Y. Takiguchi, A. Mizuno, K. Sogabe, M. Nakashima, Application of thermography to the evaluation of the histamine skin test in man, *J. Pharmacol. Meth.* 18 (1987) 103–110.
- 232) D.G. Gubin, G.D. Gubin, J. Waterhouse, D. Weinert, The circadian body temperature rhythm in the elderly: effect of single daily melatonin dosing, *Chronobiol. Int.* 23 (2006) 639–658.
- 233) J. Henahan, Thermography finds multitude of applications, *JAMA* 247 (3296) (1982) 3293–3301.
- 234) P. Caramaschi, D. Biasi, S. Canestrini, N. Martinelli, L. Perbellini, A. Carletto, S. Pieropan, A. Volpe, L.M. Bambara, Evaluation de la temperature cutanee des patients atteints de sclerodermie traites periodiquement par iloprost, *Rev Rhum.* 73 (2006) 53–57.
- 235) E.F. Ring, L.O. Porto, P.A. Bacon, Quantitative thermal imaging to assess inositol nicotinate treatment for Raynaud's syndrome, *J. Int. Med. Res.* 9 (1981) 393–400.
- 236) H. Lecerof, S. Bornmyr, B. Lilja, G. De Pedis, U.L. Hulthen, Acute effects of doxazosin and atenolol on smoking-induced peripheral vasoconstriction in hypertensive habitual smokers, *J. Hypertens. Suppl.* 8 (1990) S29–S33.
- 237) T.C. Tham, B. Silke, S.H. Taylor, Comparison of central and peripheral haemodynamic effects of dilevalol and atenolol in essential hypertension, *J. Hum. Hypertens.* 4 (suppl. 2) (1990) 77–83.
- 238) R.S. Bruning, J.D. Dahmus, W.L. Kenney, L.M. Alexander, Aspirin and clopidogrel alter core temperature and skin blood flow during heat stress, *Med. Sci. Sports Exerc.* 45 (2013) 674–682.
- 239) J.H. Hughes, R.E. Henry, M.J. Daly, Influence of ethanol and ambient temperature on skin blood flow, *Ann. Emerg. Med.* 13 (1984) 597–600.
- 240) K.L. Ewing, T.W. Davison, J.L. Fergason, Effects of activity, alcohol, smoking, and the menstrual cycle on liquid crystal breast thermography, *Ohio J. Sci.* 73 (1973) 55–58.
- 241) G. Mannara, G.C. Salvatori, G.P. Pizzuti, Ethyl alcohol induced skin temperature changes evaluated by thermography. Preliminary results, *Boll. Soc. Ital. Biol. Sper.* 69 (1993) 587–594.

- 242) R. Wolf, B. Tuzun, Y. Tuzun, Alcohol ingestion and the cutaneous vasculature, *Clin. Dermatol.* 17 (1999) 395–403.
- 243) P. Melnizky, K. Ammer, The influence of alcohol and smoking on the skin temperature of the face, hands and knees (Author translation), *Thermol. Int.* 10 (2000) 191–195.
- 244) K. Ammer, P. Melnizky, O. Rathkolb, Skin temperature after intake of sparkling wine, still wine or sparkling water, *Thermol. Int.* 13 (2003) 99–102.
- 245) M.B. Finch, S. Copeland, W.J. Leahey, G.D. Johnston, Short-term effects of alcohol on peripheral blood flow, platelet aggregation and noradrenaline output in normal man, *Int. J. Tissue React.* 10 (1988) 257–260.
- 246) S. Harada, D.P. Agarwal, H.W. Goedde, Aldehyde dehydrogenase deficiency as cause of facial flushing reaction to alcohol in Japanese, *The Lancet* 318 (1981) 982.
- 247) A. Risbo, J.O. Hagelsten, K. Jessen, Human body temperature and controlled cold exposure during moderate and severe experimental alcohol intoxication, *Acta Anaesthesiol. Scand.* 25 (1981) 215–218.
- 248) W.G. Maddock, F.A. Coller, Peripheral vaso-constriction by tobacco demonstrated by skin temperature changes, in: *Proceedings of the Society for Experimental Biology and Medicine*, vol. 29, Society for Experimental Biology and Medicine, New York, NY, 1932, pp. 487–488.
- 249) S. Bornmyr, H. Svensson, Thermography and laser-Doppler flowmetry for monitoring changes in finger skin blood flow upon cigarette smoking, *Clin. Physiol.* 11 (1991) 135–141.
- 250) J. Gershon-Cohen, A.G. Borden, M.B. Hermel, Thermography of extremities after smoking, *Br. J. Radiol.* 42 (1969) 189–191.
- 251) K. Usuki, T. Kanekura, K. Aradono, T. Kanzaki, Effects of nicotine on peripheral cutaneous blood flow and skin temperature, *J. Dermatol. Sci.* 16 (1998) 173–181.
- 252) A. Tagliabue, D. Terracina, H. Cena, G. Turconi, E. Lanzola, C. Montomoli, Coffee induced thermogenesis and skin temperature, *Int. J. Obes. Relat. Metab. Disord.* 18 (1994) 537–541.
- 253) P. Koot, P. Deurenberg, Comparison of changes in energy expenditure and body temperatures after caffeine consumption, *Ann. Nutr. Metab.* 39 (1995) 135–142.
- 254) P. Quinlan, J. Lane, L. Aspinall, Effects of hot tea, coffee and water ingestion on physiological responses and mood: the role of caffeine, water and beverage type, *Psychopharmacology* 134 (1997) 164–173.
- 255) R.P. Clark, M.R. Goff, B.J. Mullan, Skin temperatures during sunbathing and some observations on the effect of hot and cold drinks on these temperatures [proceedings], *J. Physiol.* 267 (1977) 8P–9P.
- 256) A. Tremblay, J. Cote, J. LeBlanc, Diminished dietary thermogenesis in exercisetrained human subjects, *Eur. J. Appl. Physiol. Occup. Physiol.* 52 (1983) 1–4.
- 257) G. Federspil, E. La Grassa, F. Giordano, C. Macor, D. Presacco, C. Di Maggio, Studio della termogenesi indotta dalla dieta mediante teletermografia nel soggetto normale e nell'obeso, *Recenti Prog. Med.* 80 (1989) 455–459.
- 258) M. Shuran, *Direct Quantitation of Heat Loss in Human Subjects Using Infrared Thermography*, University of Illinois, Urbana–Champaign, 1987. p. 115.
- 259) G.K. Shlygin, L.D. Lindenbraten, M.M. Gapparov, L.S. Vasilevskaia, L.I. Ginzburg, A.I. Sokolov, Radiothermometric research of tissues during the initial reflex period of the specific dynamic action of food, *Med. Radiol. (Mosk)* 36 (1991) 10–12.

- 260) M.J. Dauncey, C. Haseler, D.P. Thomas, G. Parr, Influence of a meal on skin temperatures estimated from quantitative IR-thermography, *Experientia* 39 (1983) 860–862.
- 261) F.J. Prokoski, R.B. Riedel, J.S. Coffin, Identification of individuals by means of facial thermography, in: *Proceedings of the Institute of Electrical and Electronics Engineers 1992 International Carnahan Conference on Security Technology, 1992, Crime Countermeasures, 1992*, pp. 120–125.
- 262) D. Thomas, G. Siahamis, M. Marion, C. Boyle, Computerised infrared thermography and isotopic bone scanning in tennis elbow, *Ann. Rheum. Dis.* 51 (1992) 103–107.
- 263) L.S. Chan, G.T.Y. Cheung, I.J. Lauder, C.R. Kumana, Screening for fever by remote-sensing infrared thermographic camera, *J. Travel Med.* 11 (2004) 273–279.
- 264) R.G. Schwartz, Guidelines for neuromusculoskeletal thermography, *Thermol. Int.* 16 (2006) 5–9.
- 265) J. Selfe, N. Hardaker, D. Thewlis, A. Karki, An accurate and reliable method of thermal data analysis in thermal imaging of the anterior knee for use in cryotherapy research, *Arch. Phys. Med. Rehabil.* 87 (2006) 1630–1635.
- 266) J.V.C. Vargas, M.L. Brioschi, F.G. Dias, M.B. Parolin, F.A. Mulinari-Brenner, J.C. Ordonez, D. Colman, Normalized methodology for medical infrared imaging, *Infrared Phys. Technol.* 52 (2009) 42–47.
- 267) B.G. Vainer, Treated-skin temperature regularities revealed by IR thermography, in: A.E. Rozlosnik, R.B. Dinwiddie (Eds.), *Thermosense XXIII*, SPIE, Orlando, FL, USA, 2001, pp. 470–481.
- 268) J. Steketee, The influence of cosmetics and ointments on the spectral emissivity of skin, *Phys. Med. Biol.* 21 (1976) 920–930.
- 269) S. Webb, *The Physics of Medical Imaging*, Taylor & Francis, 1988.
- 270) J.M. Engel, Physiological influence of Medical ointments of infrared thermography, in: E.F.J. Ring, B. Phillips (Eds.), *Recent Advances in Medical Thermology*, Plenum Press, New York, 1984, pp. 177–184.
- 271) K. Ammer, The influence of antirheumatic creams and ointments on the infrared emission of the skin, in: I. Benko, A. Balogh, I. Kovacsics, I. Lovak (Eds.), *Abstracts of the 10th International Conference on Thermogrammetry and Thermal engineering in Budapest 18–20th June 1997*, MATE, Budapest, 1997, pp. 177–181.
- 272) C. Villasenor-Mora, F.J. Sanchez-Marin, M.E. Garay-Sevilla, Contrast enhancement of mid and far infrared images of subcutaneous veins, *Infrared Phys. Technol.* 51 (2008) 221–228.
- 273) A.M. Hug, T. Schmidts, J. Kuhlmann, D. Segger, G. Fotopoulos, J. Heinzerling, Skin hydration and cooling effect produced by the Voltaren vehicle gel, *Skin Res. Technol.* 18 (2012) 199–206.
- 274) V. Bernard, E. Staffa, V. Mornstein, A. Bourek, Infrared camera assessment of skin surface temperature – effect of emissivity, *Physica Med.* 29 (2013) 583–591.
- 275) J.M. Sefton, C. Yarar, J.W. Berry, D.D. Pascoe, Therapeutic massage of the neck and shoulders produces changes in peripheral blood flow when assessed with dynamic infrared thermography, *J. Altern. Complement. Med.* 16 (2010) 723–732.
- 276) D. Rodrigues-Bigaton, A.V. Dibai Filho, A.C.d.S. Costa, A.C. Packer, E.M. de Castro, Accuracy and reliability of infrared thermography in the diagnosis of arthralgia in women with temporomandibular disorder, *J. Manipulative Physiol. Ther.* 36 (2013) 253–258.

- 277) E.F.J. Ring, K. Ammer, Thermal Imaging in sports medicine, *Sport Med. Today* (1998) 108–109.
- 278) S.R. Johnson, S. Rao, S.B. Hussey, P.S. Morley, J.L. Traub-Dargatz, Thermographic eye temperature as an index to body temperature in ponies, *J. Equine Veter. Sci.* 31 (2011) 63–66.
- 279) R.M. Nelson, K.W. Hayes, D.P. Currier, *Clinical Electrotherapy*, Pearson Education, Taiwan, 1991.
- 280) M. Ernst, M.H.M. Lee, Sympathetic vasomotor changes induced by manual and electrical acupuncture of the hoku point visualized by thermography, *Pain* 21 (1985) 25–33.
- 281) T. Watson, Ultrasound in contemporary physiotherapy practice, *Ultrasonics* 48 (2008) 321–329.
- 282) B.W. Wilkins, C.T. Minson, J.R. Halliwill, Regional hemodynamics during postexercise hypotension. II. Cutaneous circulation, *J. Appl. Physiol.: Respirat., Environ. Exer. Physiol.* 97 (2004) 2071–2076.
- 283) D.O. Draper, M.D. Ricard, Rate of temperature decay in human muscle following 3 MHz ultrasound: the stretching window revealed, *J. Athlet. Train.* 30 (1995) 304–307.
- 284) O. Rathklob, K. Ammer, Skin temperature of the fingers after different methods of heating using a Wax Bath, *Thermol Osterr* (1996) 125–129.
- 285) P.H. Goodman, J.E. Foote, R.P. Smith, Detection of intentionally produced thermal artifacts by repeated thermographic imaging, *Thermology* (1991) 253–260.
- 286) C.-L. Wu, K.-L. Yu, H.-Y. Chuang, M.-H. Huang, T.-W. Chen, C.-H. Chen, The application of infrared thermography in the assessment of patients with coccygodynia before and after manual therapy combined with diathermy, *J. Manipulative Physiol. Ther.* 32 (2009) 287–293.
- 287) O. Rathklob, T. Schartelmuller, L. Hein, K. Ammer, Hauttemperatur am Kniegelenk nach Kaltluftbehandlung, *Thermol Osterr* (1991) 9–14.
- 288) K. Ammer, Occurrence of hyperthermia after ice massage, *Thermol Osterr* (1996) 17–20.
- 289) A. Cholewka, Z. Drzazga, A. Michnik, A. Sieron, B. Wisniowska, Temperature effects of whole body cryotherapy determined by thermography, *Thermol. Int.* 14 (2004) 57–63.
- 290) A. Cholewka, Z. Drzazga, A. Sieron, Monitoring of whole body cryotherapy effects by thermal imaging: preliminary report, *Physica Med.* 22 (2006) 57–62.
- 291) A. Cholewka, Z. Drzazga, A. Sieron, A. Stanek, Thermovision diagnostics in chosen spine diseases treated by whole body cryotherapy, *J. Therm. Anal. Calorim.* 102 (2010) 113–119.
- 292) A. Cholewka, A. Stanek, A. Sieron, Z. Drzazga, Thermography study of skin response due to whole-body cryotherapy, *Skin Res. Technol.* 18 (2012) 180–187.
- 293) E. Ring, C. Jones, K. Ammer, P. Plassmann, T. Bola, Cooling effects of Deep Freeze Cold gel applied to the skin, with and without rubbing, to the lumbar region of the back, *Thermol. Int.* 14 (2004) 64–70.
- 294) E. Ring, C. Jones, K. Ammer, P. Plassmann, T. Bola, Cooling effects of Deep Freeze Cold Gel compared to that of an ice pack applied to the skin, *Thermol. Int.* 14 (2004) 93–98.
- 295) J. Selfe, J. Alexander, J.T. Costello, K. May, N. Garratt, S. Atkins, S. Dillon, H. Hurst, M. Davison, D. Przybyla, A. Coley, M. Bitcon, G. Littler, J. Richards, The effect of three different (-135 degrees c) whole body cryotherapy exposure durations on elite rugby league players, *PLoS ONE* 9 (2014) e86420.

- 296) J. Selfe, N. Hardaker, J. Whitaker, C. Hayes, Thermal imaging of an ice burn over the patella following clinically relevant cryotherapy application during a clinical research study, *Phys. Ther. Sport* 8 (2007) 153–158.
- 297) J. Selfe, N. Hardaker, J. Whitaker, C. Hayes, An investigation into the effect on skin surface temperature of three cryotherapy modalities, *Thermol. Int.* 19 (2009) 119–124.
- 298) N.J. Hardaker, A.D. Moss, J. Richards, J. Sally Jarvis, I. McEwan, J. Selfe, The relationship between skin surface temperature measured via Non-contact Thermal Imaging and intra-muscular temperature of the Rectus Femoris muscle, *Thermol. Int.* 17 (2007) 45–50.
- 299) H.M. Schnell, J.G. Zaspel, Cooling extensive burns: sprayed coolants can improve initial cooling management: a thermography-based study, *Burns* 34 (2008) 505–508.
- 300) J. Costello, I.B. Stewart, J. Selfe, A.I. Karki, A. Donnelly, Use of thermal imaging in sports medicine research: a short report, *Int. Sport. J.* 14 (2013) 94–98.
- 301) M. Savic, B. Fonda, N. Sarabon, Actual temperature during and thermal response after whole-body cryotherapy in cryo-cabin, *J. Therm. Biol* 38 (2013) 186–191.
- 302) A. De Ąbiec-Ba Ąk, K. Gruszka, A. Sobiech Krzysztof, A. Skrzek, Age dependence of thermal imaging analysis of body surface temperature in women after cryostimulation, in: *Human Movement*, 2013, p. 299.
- 303) A. De Ąbiec-Ba Ąk, A. Skrzek, H. Podbielska, Application of thermovision for estimation of the optimal and safe parameters of the whole body cryotherapy, *J. Therm. Anal. Calorim.* 111 (2013) 1853–1859.
- 304) K.L. Knight, *Cryotherapy in Sport Injury Management*, Human Kinetics, Champaign, IL, 1995.
- 305) J.T. Costello, A.E. Donnelly, A. Karki, J. Selfe, Effects of whole body cryotherapy and cold water immersion on knee skin temperature, *Int. J. Sports Med.* 35 (2014) 35–40.
- 306) C.M. Bleakley, J.T. Hopkins, Is it possible to achieve optimal levels of tissue cooling in cryotherapy?, *Phys Therapy Rev.* 15 (2010) 344–350.
- 307) F.G. Oosterveld, J.J. Rasker, J.W. Jacobs, H.J. Overmars, The effect of local heat and cold therapy on the intraarticular and skin surface temperature of the knee, *Arthritis Rheum.* 35 (1992) 146–151.
- 308) J. Kennet, N. Hardaker, S. Hobbs, J. Selfe, Cooling efficiency of 4 common cryotherapeutic agents, *J. Athlet. Train.* 42 (2007) 343–348.
- 309) Y.H. Kim, S.S. Baek, K.S. Choi, S.G. Lee, S.B. Park, The effect of cold air application on intra-articular and skin temperatures in the knee, *Yonsei Med. J.* 43 (2002) 621–626.
- 310) E. Herrera, M.C. Sandoval, D.M. Camargo, T.F. Salvini, Motor and sensory nerve conduction are affected differently by ice pack, ice massage, and cold water immersion, *Phys. Ther.* 90 (2010) 581–591.
- 311) A. Kainz, *Quantitative Überprüfung der Massagewirkung mit Hilfe der IRThermographie*, *Thermol Osterr* (1993) 79–83.
- 312) H. Mori, H. Ohsawa, T.H. Tanaka, E. Taniwaki, G. Leisman, K. Nishijo, Effect of massage on blood flow and muscle fatigue following isometric lumbar exercise, *Med. Sci. Monit.: Int. Med. J. Exp. Clin. Res.* 10 (2004) CR173–CR178.
- 313) P. Bonnett, D.B. Hare, D.D. Jones, E.F.J. Ring, C.J. Hare, Some preliminary observations of the effects of sports massage on heat distribution of lower limb muscles during a graded exercise test, *Thermol. Int.* 16 (2006) 143–149.

- 314) R.A. Roy, J.P. Boucher, A.S. Comtois, Paraspinal cutaneous temperature modification after spinal manipulation at L5, *J. Manipulative Physiol. Ther.* 33 (2010) 308–314.
- 315) L.A. Holey, J. Dixon, J. Selfe, An exploratory thermographic investigation of the effects of connective tissue massage on autonomic function, *J. Manipulative Physiol. Ther.* 34 (2011) 457–462.
- 316) C. Walchli, G. Saltzwedel, D. Krueker, C. Kaufmann, B. Schnorr, L. Rist, J. Eberhard, M. Decker, A.P. Simoes-Wust, Physiologic effects of rhythmical massage: a prospective exploratory cohort study, *J. Altern. Complement. Med.* 20 (2014) 507–515.
- 317) D. Boguszewski, J.G. Adamczyk, N. Urban´ ska, N. Mrozek, K. Piejko, M. Janicka, D. Białoszewski, Using thermal imaging to assess the effect of classical massage on selected physiological parameters of upper limbs, *Biomed. Hum. Kinet.* 6 (2014) 146–150.
- 318) Q.Y. Xu, J.S. Yang, L. Yang, Y.Y. Wang, Effects of different scraping techniques on body surface blood perfusion volume and local skin temperature of healthy subjects, *Journal of traditional Chinese medicine = Chung i tsa chih ying wen pan/sponsored by All-China Association of Traditional Chinese Medicine, Acad. Trad. Chin. Med.* 31 (2011) 316–320.
- 319) D. Rusch, G. Kiesselbach, Comparative thermographic assessment of lower leg baths in medicinal mineral waters (Nauheim springs), in: E.F.J. Ring, B. Phillips (Eds.), *Recent Advances in Medical Thermology*, Plenum Press, New York, 1984, pp. 535–540.
- 320) E.F.J. Ring, J.R. Barker, R.A. Harrison, Thermal effects of pool therapy on the lower limbs, *Thermology* 3 (1989) 127–131.
- 321) D. Zhang, S.Y. Li, S.Y. Wang, H.M. Ma, Application of infrared thermography in studies of acupuncture mechanisms and meridians, *Chin. Acupunct. Moxibust.* 24 (2004) 499–502.
- 322) D. Zhang, A method of selecting acupoints for acupuncture treatment of peripheral facial paralysis by thermography, *Am. J. Chin. Med.* 35 (2007) 967–975.
- 323) D. Zhang, H. Gao, B. Wen, Z. Wei, Research on the acupuncture principles and meridian phenomena by means of infrared thermography, *Zhen ci yan jiu Acupuncture research/[Zhongguo yi xue ke xue yuan Yi xue qing bao yan jiu suo bian ji]* 15 (1990) 319–323.
- 324) E. Kitzinger, K. Ammer, *Thermologie in der Akupunktur*, *Dtsch Zschr Akupunktur* (1992) 132–139.
- 325) G. Litscher, Infrared thermography fails to visualize stimulation-induced meridian-like structures, *Biomed. Eng.* 4 (2005) 38 (online).
- 326) G. Litscher, Bioengineering assessment of acupuncture, part 1: thermography, *Crit. Rev. Biomed. Eng.* 34 (2006) 1–22.
- 327) K.P. Schlebusch, W. Maric-Oehler, F.A. Popp, Biophotonics in the infrared spectral range reveal acupuncture meridian structure of the body, *J. Altern. Complement. Med.* 11 (2005) 171–173.
- 328) B.X. Jin, X.S. Lai, C.Z. Tang, Progress in researches on the specificity of acupoints, *Zhen ci yan jiu Acupuncture research/[Zhongguo yi xue ke xue yuan Yi xue qing bao yan jiu suo bian ji]* 33 (2008) 135–138.
- 329) H.Q. Yang, S.S. Xie, X.L. Hu, L. Chen, H. Li, Appearance of human meridian-like structure and acupoints and its time correlation by infrared thermal imaging, *Am. J. Chin. Med.* 35 (2007) 231–240.
- 330) R. Chen, Z. Lv, Infrared thermography fails to visualize stimulation-induced meridian-like structures: comment by Rixin Chen and Zhimai Lv and reply from Gerhard Litscher, *Biomed. Eng.* 10 (2011) 80.

- 331) M. Piquemal, Coupling IR thermography and BIA to analyse body reaction after one acupuncture session, *J. Phys: Conf. Ser.* 434 (2013) 012068.
- 332) A.J. Ipolito, A.L. Ferreira, Thermic effects of acupuncture on Taixi (KI 3) evaluated by means of infrared telethermography, *World J. Acupunct. Moxibust.* 23 (2013) 38–40.
- 333) S.Y. Lo, Meridians in acupuncture and infrared imaging, *Med. Hypotheses* 58 (2002) 72–76.
- 334) J.M. Johnson, Exercise and the cutaneous circulation, *Exerc. Sport Sci. Rev.* 20 (1992) 59–97.
- 335) G.P. Kenny, F.D. Reardon, W. Zaleski, M.L. Reardon, F. Haman, M.B. Ducharme, Muscle temperature transients before, during, and after exercise measured using an intramuscular multisensor probe, *J. Appl. Physiol.: Respirat. Environ. Exer. Physiol.* 94 (2003) 2350–2357.
- 336) W.L. Kenney, J.M. Johnson, Control of skin blood flow during exercise, *Med. Sci. Sports Exerc.* 24 (1992) 303–312.
- 337) J.W. Draper, J.W. Boag, The calculation of skin temperature distributions in thermography, *Phys. Med. Biol.* 16 (1971) 201.
- 338) M. Čoh, B. Širok, Use of the thermovision method in sport training, *Phys. Educ. Sport* 5 (2007) 85–94.
- 339) F. Bandeira, M.A. Muniz de Moura, M. Abreu de Souza, P. Nohama, E. Borba, Neves, Pode a termografia auxiliar no diagnostico de lesoes musculares em atletas de futebol?, *Rev Bras. Med. Esporte* 18 (2012) 234–239.
- 340) M. Frohlich, O. Ludwig, S. Kraus, H. Felder, Changes in skin surface temperature during muscular endurance indicated strain – an explorative study, *Int. J. Kinesiol. Sports Sci.* 2 (2014) 23–27.
- 341) M. Abate, L.D. Carlo, S.D. Romualdo, S. Ionta, A. Ferretti, G.L. Romani, A. Merla, Postural adjustment in experimental leg length difference evaluated by means of thermal infrared imaging, *Physiol. Meas.* 31 (2010) 35–43.
- 342) A. Merla, V. Romano, F. Zulli, R. Saggini, L. Di Donato, G.L. Romani, Total body infrared imaging and postural disorders, in: 24th Annual Conference and the Annual Fall Meeting of the Biomedical Engineering Society EMBS/BMES Conference of the Proceedings of the Second Joint Engineering in Medicine and Biology, 2002, vol. 1142, 2002, pp. 1149–1150.
- 343) M. Chudecka, A. Lubkowska, The use of thermal imaging to evaluate body temperature changes of athletes during training and a study on the impact of physiological and morphological factors on skin temperature, *Human Move.* 13 (2012) 33–39.
- 344) E.B. Akimov, R.S. Andreev, V.V. Arkov, A.A. Kirdin, V.V. Saryanc, V.D. Sonkin, A.G. Tonevitsky, Thermal “portrait” of sportsmen with different aerobic capacity, *Acta Kinesiologiae Universitatis Tartuensis* 14 (2009) 7–16.
- 345) D. Formenti, N. Ludwig, M. Gargano, M. Gondola, N. Dellerma, A. Caumo, G. Alberti, Thermal imaging of exercise-associated skin temperature changes in trained and untrained female subjects, *Ann. Biomed. Eng.* 41 (2013) 863–871.
- 346) N. Ludwig, M. Gargano, D. Formenti, D. Bruno, L. Ongaro, G. Alberti, Breathing training characterization by thermal imaging: a case study, *Acta Bioeng. Biomech./Wroclaw Univ. Technol.* 14 (2012) 41–47.
- 347) M. Sillero Quintana, E. Conde Pascual, P.M. Gomez Carmona, I. Fernandez- Cuevas, T. Garcia-Pastor, Effect of yoga and swimming on body temperature of pregnant women, *Thermol. Int.* 22 (2012) 143–149.
- 348) H.H. Al-Nakhli, J.S. Petrofsky, M.S. Laymon, L.S. Berk, The use of thermal infrared imaging to detect delayed onset muscle soreness, *J. Vis. Exp.* (2012) e3551.

- 349) D.J. BenElياهو, Infrared thermography in the diagnosis and management of sports injuries: a clinical study and literature review, *Chiropractic Sports Med.* 4 (1990) 46–53.
- 350) H. Tauchmannova, J. Gabrhel, M. Cibak, Thermographic findings in different sports, their value in the prevention of soft tissue injuries, *Thermol Osterr* 3 (1993) 91–95.
- 351) W.A. Sands, J.R. McNeal, M. Stone, Thermal imaging and gymnastics injuries: a means of screening and injury identification, *Sci. Gymnast. J.* 3 (2011) 5–12.
- 352) M. Sillero Quintana, P.M. Gomez Carmona, M.A. Garcia de la Concepcion, I. Fernandez Cuevas, S. Pinonosa Cano, C.A. Cordente, Application of thermography as injury prevention method and monitoring of the injury recovery in Athletics, in: *World Congress on Science in Athletics*, INEFC Barcelona, 2010.
- 353) V. Badz'a, V. Jovanc'evic' , F. Fratric' , G. Roglic' , N. Sudarov, Possibilities of thermovision application in sport and sport rehabilitation, *Vojnosanit. Pregl.* 69 (2012) 904–907.
- 354) E. Barcelos, W. Caminhas, E. Ribeiro, E. Pimenta, R. Palhares, A combined method for segmentation and registration for an advanced and progressive evaluation of thermal images, *Sensors* 14 (2014) 21950–21967.
- 355) A.S. Roque Domingues, Anthropometric thermal evaluation and recommendation method of physiotherapy for athletes, in: *Faculdade de Engenharia, Universidade do Porto, Portugal*, 2014, p. 93.
- 356) F.A. Pinto Barbosa, Anthropometric thermal assessment method for early injuries in athletes, in: *Faculdade de Engenharia, Universidade do Porto, Portugal*, 2014, p. 90.
- 357) W. Bertucci, A. Arfaoui, L. Janson, G. Polidori, Relationship between the gross efficiency and muscular skin temperature of lower limb in cycling: a preliminary study, *Comp. Meth. Biomech. Biomed. Eng.* 16 (2013) 114–115.
- 358) J.G. Adamczyk, D. Boguszewski, M. Siewierski, Thermographic evaluation of lactate level in capillary blood during post-exercise recovery, *Kinesiology* 46 (2014) 186–193.
- 359) G.F. Lewis, R.G. Gatto, S.W. Porges, A novel method for extracting respiration rate and relative tidal volume from infrared thermography, *Psychophysiology* 48 (2011) 877–887.
- 360) A.J. Purvis, H. Tunstall, Effects of sock type on foot skin temperature and thermal demand during exercise, *Ergonomics* 47 (2004) 1657–1668.
- 361) F. Gasi, E. Bittencourt, Evaluation of textile materials in physical activity, *Chem. Eng. Trans.* 17 (2009) 1783–1787.
- 362) A. Mao, J. Luo, Y. Li, X. Luo, R. Wang, A multi-disciplinary strategy for computer-aided clothing thermal engineering design, *Comput. Aided Des.* 43 (2011) 1854–1869.
- 363) B. Mijovic' , I. Salopek C' ubric' , Z. Skenderi, U. Reischl, Thermographic assessment of sweat evaporation within different clothing systems, *Fibres Text. East. Eur.* 20 (2012) 81–86.
- 364) D. Banerjee, S.K. Chattopadhyay, S. Tuli, Infrared thermography in material research – a review of textile applications, *Indian J. Fibre Text. Res.* 38 (2013) 427–437.
- 36) J. Bulut, M. Janta, V. Senner, J. Kreuzer, Determination of insulation properties of functional clothing using core body temperature gradients as quantification parameter, *Proc. Eng.* 60 (2013) 208–213.
- 366) S.H. Faulkner, R.A. Ferguson, N. Gerrett, M. Hupperets, S.G. Hodder, G. Havenith, Reducing muscle temperature drop after warm-up improves sprint cycling performance, *Med. Sci. Sports Exerc.* 45 (2013) 359–365

- 367) R.P. Clark, B.J. Mullan, L.G. Pugh, Skin temperature during running a study using infra-red colour thermography, *J. Physiol.* 267 (1977) 53–62.
- 368) A. de Andrade Fernandes, P.R. Amorim, C.J. de Brito, A.G. Moura, D.G. Moreira, C.M. Costa, M. Sillero-Quintana, J.C. Marins, Measuring skin temperature before, during and after exercise: a comparison of thermocouples and infrared thermography, *Physiol. Meas.* 35 (2014) 189–203.
- 369) J.I. Priego Quesada, F.P. Carpes, R.R. Bini, R. Salvador Palmer, P. Perez-Soriano, R.M. Cibrian Ortiz de Anda, Relationship between skin temperature and muscle activation during incremental cycle exercise, *J. Therm. Biol* 48 (2015) 28–35.
- 370) A. Merla, L. Di Donato, S. Di Luzio, G. Farina, S. Pisarri, M. Proietti, F. Salsano, G.L. Romani, Infrared functional imaging applied to Raynaud's phenomenon, *Engin. Med. Biol. Magaz., IEEE* 21 (2002) 73–79.
- 371) A. Merla, P. Iodice, A. Tangherlini, G. De Michele, S. Di Romualdo, R. Saggini, G. Romani, Monitoring skin temperature in trained and untrained subjects throughout thermal video, in: *Conference of the Proceedings of IEEE Engineering on Medicine and Biology Society*, vol. 2, 2005, pp. 1684–1686.
- 372) J.-Y. Lee, V.S. Koscheyev, u.-H. Kim, J.M. Warpeha, Thermal dynamics of core and periphery temperature during treadmill sub-maximal exercise and intermittent regional body cooling, *J. Korean Soc. Living Environ. Syst.* 16(2009). 89–10.
- 373) A. Arfaoui, W.M. Bertucci, T. Letellier, G. Polidori, Thermoregulation during incremental exercise in masters cycling, *J. Sci. Cycl.* 3 (2014) 32–40.
- 374) E.R. Nadel, R.W. Bullard, J.A. Stolwijk, Importance of skin temperature in the regulation of sweating, *J. Appl. Physiol.: Respirat., Environ. Exer. Physiol.* 31 (1971) 80–87.
- 375) N. Charkoudian, Mechanisms and modifiers of reflex induced cutaneous vasodilation and vasoconstriction in humans, *J. Appl. Physiol.: Respirat., Environ. Exer. Physiol.* 109 (2010) 1221–1228.
- 376) G. Stuttgarten, J. Eilers, Reflex heating of the skin and telethermography, *Arch. Dermatol. Res.* 272 (1982) 301–310.
- 377) B.G. Vainer, FPA-based infrared thermography as applied to the study of cutaneous perspiration and stimulated vascular response in humans, *Phys. Med. Biol.* 50 (2005) R63.
- 378) M. Chudecka, E. Szczepanowska, A. Kempinska, Changes of thermoemission of upper extremities in female handball players - the preliminary study, *Medicina Sportiva* 12 (2008) 99–102.
- 379) K. Ammer, Does neuromuscular thermography record nothing else but an infrared sympathetic skin response?, *Thermol Int.* 19 (2009) 107–108.
- 380) K. Cena, J.A. Clark, Thermographic observations of skin temperatures of trained and untrained runners, *J. Physiol.-London* 257 (1976) P8–P9.
- 381) R.G. Fritzsche, Cutaneous blood flow during exercise is higher in endurance-trained humans, *J. Appl. Physiol.: Respirat., Environ. Exer. Physiol.* 88 (2000) 738.
- 382) Y. Liu, K. Mimura, L. Wang, K. Ikuda, Physiological benefits of 24-style Taijiquan exercise in middle-aged women, *J. Physiol. Anthropol. Appl. Human Sci.* 22 (2003) 219–225.
- 383) J.G. Adamczyk, M. Mastej, D. Boguszewski, D. Białoszewski, Usage of thermography as indirect non-invasive method of evaluation of physical efficiency. Pilot study, *Pedagog., Psychol. Med. Biol. Prob. Phys. Train. Sports* 3 (2014) 90–95.

- 384) J.B. Mercer, L. de Weerd, Thermography and thermal symmetry, in: IEEE (Ed.) IEEE International Symposium on Medical Measurements and Applications (MeMeA), 2014, IEEE, Lisboa, Portugal, 2014, pp. 1–3.
- 385) S. Uematsu, Symmetric of skin temperature comparing one side of the body to the other, *Thermology* 1 (1985) 4–7.
- 386) H.M. Oerlemans, R.S. Perez, R.A. Oostendorp, R.J. Goris, Objective and subjective assessments of temperature differences between the hands in reflex sympathetic dystrophy, *Clinical Rehab.* 13 (1999) 430–438.
- 387) G. Wasner, J. Schattschneider, R. Baron, Skin temperature side differences – a diagnostic tool for CRPS? *Pain* 98 (2002) 19–26
- 388) C. Hildebrandt, C. Raschner, An intra-examiner reliability study of knee temperature patterns with medical infrared thermal imaging, *Thermol. Int.* 19 (2009) 73–76.
- 389) R. Vardasca, E.F.J. Ring, P. Plassmann, C.D. Jones, Thermal symmetry of the upper and lower extremities in healthy subjects, *Thermol. Int.* 22 (2012) 53–60.
- 390) M.T. Gross, C.P. Schuch, E. Huber, J.F. Scoggins, S.H. Sullivan, Method for quantifying assessment of contact thermography: effect of extremity dominance on temperature distribution patterns, *J. Orthop. Sports Phys. Ther.* 10 (1989) 412–417.
- 391) C.E. Wade, J.H. Veghte, Thermographic evaluation of the relative heat loss by area in man after swimming, *Aviat. Space Environ. Med.* 48 (1977) 16–18.
- 392) H. Zaidi, R. Taiar, S. Fohanno, G. Polidori, The influence of swimming type on the skin-temperature maps of a competitive swimmer from infrared thermography, *Acta Bioeng. Biomech.* 9 (2007) 47–51.
- 393) N. Ludwig, D. Formenti, M. Gargano, G. Alberti, Skin temperature evaluation by infrared thermography: comparison of image analysis methods, *Infrared Phys. Technol.* 62 (2014) 1–6.
- 394) A. Seixas, T. Gonjo, R. Vardasca, J. Gabriel, R. Fernandes, J.P. Vilas-Boas, A preliminary study on the relationship between energy expenditure and skin temperature in swimming, in: 12th International Conference on Quantitative InfraRed Thermography, Bordeaux, France, 2014, pp. 90–97.
- 395) B.L. Smith, M.K. Bandler, P.H. Goodman, Dominant forearm hyperthermia: a study of fifteen athletes, *Thermology* 2 (1986) 25–28.
- 396) B.C. Buckhout, M.A. Warner, Digital perfusion of handball players, Effects of repeated ball impact on structures of the hand, *Am. J. Sports. Med.* 8 (1980) 206–207.
- 397) T.J. Malkinson, Skin temperature response during cycle ergometry, in: Canadian Conference on Electrical and Computer Engineering, 2002, IEEE CCECE 2002, vol. 1122, 2002, pp. 1123–1128.
- 398) M. Chudecka, A. Lubkowska, Evaluation of the body surface temperature changes in the basketball players' after training [in Polish], *In_zynieria Biomedyczna. Acta Bio-Optica et Informatica Medica* 17 (2011) 271–275.
- 399) J. Sampedro, S. Pinonosa Cano, I. Fernandez-Cuevas, Thermography as a new assessment tool in basketball. Pilot study carried out with a professional player in the ACB, *Cuadernos de Psicologia del Deporte* 12 (2012) 51–56.
- 400) J. Arnaiz Lastras, I. Fernandez Cuevas, P.M. Gomez Carmona, M. Sillero Quintana, M.A. Garcia de la Concepcion, S. Pinonosa Cano, Pilot study to determinate thermal asymmetries in judokas, in: N.T. Cable, K. George (Eds.), 16th Annual Congress of the European College of Sport Sciences ECSS, ECSS, Liverpool, United Kingdom, 2011, p. 107.

- 401) I. Fernandez-Cuevas, M. Sillero-Quintana, M.A. Garcia-Concepcion, J. Ribot Serrano, P.M. Gomez-Carmona, J.C. Bouzas Marins, Monitoring skin thermal response to training with infrared thermography, *New Stud. Athletics* 29 (2014) 57–71.
- 402) M. Chudecka, A. Lubkowska, Evaluation of temperature changes in upper extremities of waterpolo players by thermovision [in Polish], *In_zynieria Biomedyczna. Acta Bio-Optica et Informatica Medica* 16 (2010) 334–338.
- 403) D. Garza, B. Rolston, T. Johnston, G. Sungar, J. Ferguson, G. Matheson, Heat Loss Patterns in National Football League Players as Measured by Infrared Thermography, in: I.T.C. ITC (Ed.) *InfraMation, Infrared Training Center ITC*, 2008.
- 404) I. Pušnik, I. Čuk, Thermal imaging of hands during simple gymnastics elements on the wooden bar with and without use of magnesium carbonate, *Sc. Gymnast. J.* 6 (2014) 67–72.
- 405) R.S. Burnham, R.S. McKinley, D.D. Vincent, Three types of skin-surface thermometers: a comparison of reliability, validity, and responsiveness, *Am. J. Phys. Med. Rehabil./Assoc. Acad. Physiat.* 85 (2006) 553–558.
- 406) E. Choi, P.-B. Lee, F.S. Nahm, Interexaminer reliability of infrared thermography for the diagnosis of complex regional pain syndrome, *Skin Res. Technol.* 19 (2013) 189–193.
- 407) F.J. Huygen, S. Niehof, J. Klein, F.J. Zijlstra, Computer-assisted skin videothermography is a highly sensitive quality tool in the diagnosis and monitoring of complex regional pain syndrome type I, *Eur. J. Appl. Physiol.* 91 (2004) 516–524.
- 408) M.A. Calin, G. Mologhianu, R. Savastru, M.R. Calin, C.M. Brailescu, A review of the effectiveness of thermal infrared imaging in the diagnosis and monitoring of knee diseases, *Infrared Phys. Technol.* 69 (2015) 19–25.
- 409) P.B. Rich, G.R. Dulabon, C.D. Douillet, T.M. Listwa, W.P. Robinson, B.L. Zarzaur, R. Pearlstein, L.M. Katz, Infrared thermography: a rapid, portable, and accurate technique to detect experimental pneumothorax, *J. Surg. Res.* 120 (2004) 163–170.
- 410) G. Martini, K.J. Murray, K.J. Howell, J. Harper, D. Atherton, P. Woo, F. Zulian, C.M. Black, Juvenile-onset localized scleroderma activity detection by infrared thermography, *Rheumatology (Oxford)* 41 (2002) 1178–1182.
- 411) J. George, A. Bensafi, A.M. Schmitt, D. Black, S. Dahan, F. Loche, J.M. Lagarde, Validation of a non-contact technique for local skin temperature measurements, *Skin Res. Technol.* 14 (2008) 381–384.
- 412) O. Faust, U. Rajendra Acharya, E.Y.K. Ng, T.J. Hong, W. Yu, Application of infrared thermography in computer aided diagnosis, *Infrared Phys. Technol.* 66 (2014) 160–175.
- 413) J.W. Bartlett, C. Frost, Reliability, repeatability and reproducibility: analysis of measurement errors in continuous variables, *Ultrasound Obstet. Gynecol.: Off. J. Int. Soc. Ultrasound Obstet. Gynecol.* 31 (2008) 466–475.
- 414) A.E. Denoble, N. Hall, C.F. Pieper, V.B. Kraus, Patellar skin surface temperature by thermography reflects knee osteoarthritis severity, *Clin. Med. Insights, Arthr. Musculoskel. Disorders* 3 (2010) 69–75.
- 415) A.C.S. Costa, A.V. Dibai Filho, A.C. Packer, D. Rodrigues-Bigaton, Intra and inter-rater reliability of infrared image analysis of masticatory and upper trapezius muscles in women with and without temporomandibular disorder, *Brazil. J. Phys. Therapy* 17 (2013) 24–31.
- 416) I. Rossignoli, P.J. Benito, A.J. Herrero, Reliability of infrared thermography in skin temperature evaluation of wheelchair users, *Spinal Cord* (2014) 1–6.

- 417) J.D. Pauling, J.A. Shipley, S. Raper, M.L. Watson, S.G. Ward, N.D. Harris, N.J. McHugh, Comparison of infrared thermography and laser speckle contrast imaging for the dynamic assessment of digital microvascular function, *Microvasc. Res.* 83 (2011) 162–167.
- 418) A.J.E. Bach, I.B. Stewart, A.E. Disher, J.T. Costello, A comparison between conductive and infrared devices for measuring mean skin temperature at rest, during exercise in the heat, and recovery, *PLoS ONE* 10 (2015) e0117907.
- 419) C.A. James, A.J. Richardson, P.W. Watt, N.S. Maxwell, Reliability and validity of skin temperature measurement by telemetry thermistors and a thermal camera during exercise in the heat, *J. Therm. Biol* 45 (2014) 141–149.
- 420) I. Fernandez-Cuevas, J.C. Marins, P.M. Gomez Carmona, M.A. Garcia Concepcion, J. Arnaiz Lastras, M. Sillero Quintana, Reliability and reproducibility of skin temperature of overweight subjects by an infrared thermography software designed for human beings, *Thermol. Int.* 22 (2012) 130–137.
- 421) G. Plaugher, M.A. Lopes, P.E. Melch, E.E. Cremata, The inter- and intraexaminer reliability of a paraspinal skin temperature differential instrument, *J. Manipulative Physiol. Ther.* 14 (1991) 361–367.
- 422) K. Ammer, Need for standardisation of measurements in Thermal Imaging, in: B. Wiecek (Ed.), *Thermography and Lasers in Medicine*, Akademickie Centrum Graficzno-Marketigowe Lodar S.A, Lodz, Poland, 2003, pp. 13–17.
- 423) J. Hart, B. Omolo, W.R. Boone, C. Brown, A. Ashton, Reliability of three methods of computer-aided thermal pattern analysis, *J. Can. Chiropr. Assoc.* 51 (2007) 175–185.
- 424) J.E. Gold, M. Cherniack, A. Hanlon, J.T. Dennerlein, J. Dropkin, Skin temperature in the dorsal hand of office workers and severity of upper extremity musculoskeletal disorders, *Int. Arch. Occup. Environ. Health* 82 (2009) 1281–1292.
- 425) M. McCoy, I. Campbell, P. Stone, C. Fedorchuk, S. Wijayawardana, K. Easley, Intra-Examiner and Inter-Examiner Reproducibility of Paraspinal Thermography, *PLoS ONE* 6 (2011) e16535.
- 426) K. Ammer, Influence of imaging and object conditions on temperature readings from Medical Infrared Images, *Pol. J. Environ. Stud.* 5 (2006) 117–119.
- 427) P. Plassmann, E.F. Ring, C.D. Jones, Quality assurance of thermal imaging systems in medicine, *Thermol. Int.* 16 (2006) 10–15.
- 428) E.F.J. Ring, K. Ammer, A. Jung, P. Murawski, B. Wiecek, J. Zuber, S. Zwolenik, P. Plassmann, C. Jones, B.F. Jones, Standardization of infrared imaging, in: *Conference on the Proceedings of IEEE Engineering, Medicine and Biology Society*, vol. 2, 2004, pp. 1183–1185.
- 429) E.F.J. Ring, K. Ammer, B. Wiecek, P. Plassmann, C.D. Jones, A. Jung, P. Murawski, Quality assurance for thermal imaging systems in medicine, *Thermol. Int.* 17 (2007) 103–106.
- 430) K. Ammer, The Glamorgan Protocol for recording and evaluation of thermal images of the human body, *Thermol. Int.* 18 (2008) 125–129.
- 431) M. Tkacova, R. Hudak, P. Foffova, J. Zivcak, An importance of camera–subject distance and angle in musculoskeletal application of medical thermography, *Acta Electrotech. Inf.* 10 (2010) 57–60.
- 432) K. Ammer, Temperature readings from thermal images are less dependent on the number of pixels of the measurement area than on variation of room temperature, *Thermol. Int.* 15 (2005) 131–133.

- 433) M. Tkacova, P. Foffova, J. Zivcak, R. Hudak, The methodics of medical thermography in the diagnostics of the human body musculoskeletal system, in: 8th International Symposium on Applied Machine Intelligence and Informatics (SAMI), 2010, IEEE, 2010, pp. 275–277.
- 434) D.J. Watmough, P.W. Fowler, R. Oliver, The thermal scanning of a curved isothermal surface: implications for clinical thermography, *Phys. Med. Biol.* 15 (1970) 1–8.
- 435) J.A. Clark, Effects of surface emissivity and viewing angle on errors in thermography, *Acta Thermograph.* 1 (1976) 138–141.
- 436) Z. Chen, G. Jiang, F. Zheng, H. Liu, B. Zhu, A Correction method of medical thermography's distortion, in: Conference on the Proceedings of IEEE Engineering, Medicine and Biology Society, vol. 2, 2005, pp. 1677-1679.
- 437) S. Westermann, H.H. Buchner, J.P. Schramel, A. Tichy, C. Stanek, Effects of infrared camera angle and distance on measurement and reproducibility of thermographically determined temperatures of the distolateral aspects of the forelimbs in horses, *J. Am. Vet. Med. Assoc.* 242 (2013) 388–395.
- 438) V.S. Cheng, J. Bai, Y. Chen, A high-resolution three-dimensional far-infrared thermal and true-color imaging system for medical applications, *Med. Eng. Phys.* 31 (2009) 1173–1181.
- 439) R. Simpson, H. McEvoy, G. Machin, K. Howell, M. Naeem, P. Plassmann, F. Ring, P. Campbell, C. Song, J. Tavener, I. Ridley, In-field-of-view thermal image calibration system for medical thermography applications, *Int. J. Thermophys.* 29 (2008) 1123–1130.
- 440) C. Hildebrandt, Medical infrared thermography as a screening tool for knee injuries in professional junior alpine-ski-racers in Austria – findings of a pilot study, in: E.E.C.o.S. Sciences (Ed.), 14th Annual ECSS Congress, ECSS European College on Sport Sciences, Oslo, Norway, 2009.
- 441) J.-G. Wang, H.L. Toh, Visualizing skin temperature before, during and after exercise for dynamic area telethermometry, in: Proceedings of the 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2001, vol. 2833, 2001, pp. 2831–2835.
- 442) N. Maniar, A.J.E. Bach, I.B. Stewart, J.T. Costello, The effect of using different regions of interest on local and mean skin temperature, *J. Therm. Biol.* 49–50 (2015) 33–38.
- 443) R. Vardasca, U. Bajwa, Segmentation and noise removal on thermographic images of hands, *Thermol. Int.* 18 (2008) 89–94.
- 444) E.Y. Ng, N.M. Sudharsan, Computer simulation in conjunction with medical thermography as an adjunct tool for early detection of breast cancer, *BMC Cancer* 4 (2004) 17.
- 445) D. Fournet, B. Redortier, G. Havenith, A method for whole-body skin temperature mapping in humans, *Thermol. Int.* 22 (2012) 157–159.
- 446) A. Duarte, L. Carrao, M. Espanha, T. Viana, D. Freitas, P. Bartolo, P. Faria, H.A. Almeida, Segmentation algorithms for thermal images, *Proc. Technol.* 16 (2014) 1560–1569.
- 447) P. Murawski, A. Jung, F.E.J. Ring, J. Zuber, P. Plassmann, B. Kalicki, “Image ThermaBase” – a software programme to capture and analyse thermographic images, *Thermol. Int.* 13 (2003) 5–9.
- 448) I. Fujimasa, T. Chinzei, I. Saito, Converting far infrared image information to other physiological data, *IEEE Eng. Med. Biol. Mag.* 19 (2000) 71–76.
- 449) A. Mao, J. Chen, J. Luo, 3D visualization of the body skin temperature with mapping functions, *J. Inf. Comput. Sci.* 9 (2012) 2363–2370.

- 450) U. Bajwa, R. Vardasca, E.F.J. Ring, P. Plassmann, Comparison of boundary detection techniques to improve image analysis in medical thermography, *Imag. Sci. J.* 58 (2010) 12–19.
- 451) R. Vardasca, J. Gabriel, C.D. Jones, P. Plassmann, E.F.J. Ring, A template based method for normalizing thermal images of the human body, in: 12th International Conference on Quantitative InfraRed Thermography, Bourdeaux, France, 2014, pp. 63–89.
- 452) S.J. Yoon, T.H. Ryu, S.C. Noh, B.C. Yoo, H.H. Choi, J.H. Park, A study of image construction algorithm in infrared thermal imaging system with point sensing method, in: R. Magjarevic, J.H. Nagel (Eds.), *World Congress on Medical Physics and Biomedical Engineering 2006*, Springer, Berlin Heidelberg, 2007, pp. 1575–1578.
- 453) J.F. Head, R.L. Elliott, Infrared imaging: making progress in fulfilling its medical promise, *Eng. Med. Biol. Magaz.*, IEEE 21 (2002) 80–85.
- 454) W.E. Snyder, H. Qi, R.L. Elliott, J.F. Head, C.X. Wang, Increasing the effective resolution of thermal infrared images, *IEEE Eng. Med. Biol. Mag.* 19(2000) 63–70.
- 455) R. Vardasca, P. Plassmann, J. Gabriel, E.F.J. Ring, Towards a medical imaging standard capture and analysis software, in: 12th International Conference on Quantitative InfraRed Thermography, Bordeaux, France, 2014, pp. 162–168.
- 456) T. Vardasca, H.M.G. Martins, R. Vardasca, J. Gabriel, Integrating medical thermography on a RIS using DICOM standard, *Thermol. Int.* 22 (2012) 79–81.
- 457) P. Plassmann, E.F.J. Ring, An open system for the acquisition and evaluation of medical thermological images, *Eur. J. Thermol.* 7 (1997) 216–220.
- 458) I. Fujimasa, T. Chinzei, K. Mabuchi, Development of a database for medical infrared imaging, in: I.E.i.M.a.B. Society (Ed.), 18th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, IEEE Engineering in Medicine and Biology Society, Amsterdam, 1996, pp. 2091–2092.
- 459) G. Schaefer, J. Huguet, S.Y. Zhu, P. Plassmann, F. Ring, Adopting the DICOM standard for medical infrared images, *Conference on the Proceedings of IEEE Engineering, Medicine and Biology Society*, vol. 1, 2006, pp. 236–239