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The influence of angles and distance on assessing inner-canthi of the eye skin temperature

A checklist for measuring skin temperature with infrared thermography in sports and exercise medicine

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# THERMOLOGY INTERNATIONAL

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# One step closer to evidence based infrared thermal imaging

Kurt Ammer

Medical Imaging Research Unit, University of South Wales, Pontypridd, UK
European Association of Thermology, Vienna, Austria

Evidence based medicine took shape in the nineteen nineties with the intention to apply the best available evidence for diagnosis and treatment of health problems. "Best evidence" was a label that was derived from critical scientific evaluation of methodology and results. Decision based on experience and subjective evaluations became questionable and outdated. Objective signs and their quantitative analysis in a strict study design were required as the basis for practising medicine and health care.

EBM developed several tools for the evaluation of evidence and for treatment, a hierarchy of evidence was quickly established. Meta-analysis of randomised controlled trials was put into the top rank and uncontrolled case reports were at the bottom of the hierarchy of evidence. The levels of evidence underwent several revisions and the GRADE initiative proposed to change the term "level of evidence" to "quality of evidence" (table 1). The criteria for defining the level of evidence changed from the formal assessment of study design over evaluation of the quality of the trials to the credibility of the estimate of effects. The later classification initiated by GRADE, is now the accepted standard in the Cochrane Collaboration Handbook [4].

Evaluation of the risk of bias became the main concern in evaluation of the quality of trials [5]. All these development lead to more caution in deriving recommendations from the evidence. Recommendations and their use in policy statements have been a major point of criticism raised from medical practitioners against evidence based medicine [6]. In 2008, the GRADE framework was extended for quality evaluation of diagnostic tests including medical imaging [7] and recently the quality criteria have been further developed [8].

The need of standards for infrared thermography was repeatedly enquired [9,10, 11]. The sources of bias are well known in diagnostic studies based on infrared thermal imaging and in clinical trials which employ infrared thermography as an outcome measure [12, 13, 14]. However, such obvious reasons for bias are seldom reported in review papers related to thermal imaging. Only Bach et al. mentioned the failure to control for all influencing factors on temperature measurement, as source of bias [15]. A recent review paper on infrared imaging in plastic surgery reported only the type of camera and the software package used for image analysis, but information about room temperature, conditions during image capture, patient preparation and

Table 1
Definitions of the level of evidence

| Sackett's 1997 levels of evidence [1] | Cochrane Collaboration Back Review Group 2002; levels of evidence [2] | GRADE 2011 quality of evidence [3] |
|---|---|---|
| **a. Level 1**: Randomized trials or meta-analyses in which the lower limit of the confidence interval (CI) for the treatment effect exceeds the minimal clinically important benefit. | **Strong evidence** consistent findings among multiple high-quality randomized controlled trials (RCTs) | **High quality** We are very confident that the true effect lies close to that of the estimate of the effect |
| **b. Level II**: Randomized trials or meta-analyses in which the CI for the treatment effect overlaps the minimal clinically important benefit. | **Moderate evidence** consistent findings among multiple low-quality RCTs and/or one high-quality RCT | **Moderate quality** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different |
| **c. Level III**: Non-randomized concurrent cohort comparisons between current patients who received the treatment and current patients who did not. | **Limited evidence** one low-quality RCT | **Low quality** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect |
| **d. Level IV**: Non-randomized historic cohort comparisons between current patients who received the treatment and former patients who did not. | **Conflicting evidence** inconsistent findings among multiple randomized trials (RCTs) | **Very low quality** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect |
| **e.** Case series without controls. | **No evidence from trials** no RCTs | |

detailed procedures of image evaluation are missing [16]. A critical appraisal of the quality of included studies was not performed. A recent review paper on thermal imaging of hands summarised the findings from thermographic studies employed in diagnostic assistance, treatment monitoring or creation of reference values, but the lack of informati on on the quality of included studies does not allow to relate the accumulated summary to a level of evidence [17].

The obvious deficits in reporting thermographic studies medicine was recently addressed with a checklist developed by experts from 13 different countries by means of a Delphi consensus process [18]. The checklist can be found on page 137 of this issue, and contains 15 items which encompass the participants' demographic information, camera/room or environment setup and recording/analysis of skin temperature derived from infrared thermal imaging. The aim of this checklist is to improve the reporting of thermographic studies and that will help to generate systematic reviews and raise evidence of the value of thermal imaging. The acceptance and implementation of this instrument in thermographic publications is an important topic of future research.

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*Address for correspondence*
Prof Kurt Ammer MD
European Association of Thermology,
Vienna, Austria
Email kammer1950@aol.com

# The effects of electrical stimulation on local body fat and skin temperature

Review of the paper by Graciele Aroca, Larissa Viana, Rafaela Costa, Dalilia Schmildt and Ligia de Sousa **"Thermographic and anthropometric assessment of electrical stimulation on localized body fat"**. Fisioter. Mov. 2017; 30(1): 29–37

Adérito Seixas

Escola Superior de Saúde, Universidade Fernando Pessoa, Portugal
Board Member, European Association of Thermology

## Background

Excessive caloric intake may result in the accumulation of energetic reserves in adipocytes, within the adipose tissue. This process is known as adiposity and refers to the surplus of adipose tissue in the adipose panicle. Several interventions have been proposed to promote lipolysis, electrical stimulation being one of them. Thermal imaging has been used to monitor the effects of diverse interventions but few records are available in the literature describing the effects of electrical stimulation using infrared thermography. Hence, a group of researchers from Brazil conducted a randomized controlled trial aiming to assess the effect of an intervention program, consisting in electrical stimulation, on localized body fat in the abdomen and flanks of young women with adiposity localized in those areas as well as the joule effect of electrical stimulation regarding the increase in temperature and consequent vasodilation and acceleration of the metabolism.

## Methods

The authors conducted a study in Caucasian undergraduate female students of the Federal University of Alfenas, with ages between 18 and 30 years, with sedentary behaviour for at least 2 months, with body mass index between 18.5 and 30 $Kg/m^2$ and localized adiposity in the abdomen and flanks. Participants were excluded if had already undertaken or were doing dermatological-functional treatments to reduce localized adiposity, if had cardiac, respiratory diseases, diabetes mellitus, hypertension or cancer, if were unable to give a sensitive feedback or evidenced changes in skin sensitivity and if missed three consecutive days of treatment. All participants were instructed to maintain their eating and exercise habits until completion of data collection. Volunteers were randomly distributed into the intervention group (IG) and control group (CG). Data collection comprised an assessment form (age, body mass index, smoking habits, alcohol consumption, body shape and presence of grade 1 fibrous oedema in the abdominal area), perimetry at the level of the umbilicus and two centimetres above and below, assessment of the supra-iliac and abdominal skinfold thickness and skin temperature assessment with a thermal camera. Perimetry and adipometry were assessed before the first session and after the last session and skin temperature was assessed before the intervention, immediately after the first session, 15 minutes after the first session and after the last session. The intervention consisted of ten electrical stimulation sessions (two sessions per week, for five weeks) with transcutaneous electrical nerve stimulation (TENS) using a frequency of 30Hz, 250 microseconds pulse width and 40-minute application time. Participants were positioned in supine and electrical stimulation was applied using sterile needles inserted into the subcutaneous tissue. Four channels were used, two on the right and two on the left, below the umbilicus.

## Results

The authors reported that no significant differences were verified regarding perimetry and skinfold assessments between groups and before and after the intervention and reported the existence of significant differences in skin temperature between groups and within the different assessment moments in the IG.

## Conclusions

The authors state that electrical stimulation evokes a significant increase in the temperature of the subcutaneous tissue.

## Commentary

I appreciate the opportunity to comment on the paper of Aroca et al [1] that aimed to explore the use of thermal imaging to monitor the lipolytic effects of electrical stimulation. Previous papers using thermal imaging to monitor the lipolytic effects of interventions are scarce (e.g. [2-4]) and none focused on the use of electrical stimulation.

TENS is a widely used technique in the physiotherapy setting, mainly in the treatment of pain (e.g. [5]) due to its potential role in pain modulation but also as means to stimulate muscle activation (e.g. [6]), placing the electrodes in nerve-related areas or muscle belly, respectively. The authors used TENS with a different purpose, to reduce local body fat. Other examples of application of TENS to reduce localized body fat have been provided in the study, mainly studies from Brazil, but when trying to obtain the documents to understand the rationale behind the application some referred to non-peer-reviewed documents or were not accessible for consultation (e.g. [7]). The reported effects in those papers are described as positive, however, in one [8] a mere descriptive analysis was provided and, contrary to what we are led to believe in the introduction, not all changes in outcomes were significantly positive [8, 9]. In the same journal, a previous report evidenced a lack of significant effects of the technique in weight, skinfolds and perimetry measurements [10].

One of the goals of the study was to investigate "the Joule effect of electrical stimulation regarding the increase in temperature and the consequent vasodilation and acceleration of the metabolism". The Joule effect is defined by the authors as the increase in temperature due to the electric current, inducing an anti-inflammatory and vasodilatory response. Quoting the authors, the supposed "increased circulation would increase cellular exchanges, nutrition and elimination of toxins and fat degradation metabolites". The authors do not provide evidence for such strong statements. Nonetheless, although the rationale for this application could be questioned, this commentary will focus on the methodological report and data analysis.

One of the basis of the scientific method is replication and regarding this aspect science is going through hard times [11]. A crucial aspect in evidence based practice is data reporting and fortunately researchers have several guidelines to aid them in this process, a topic previously covered in an editorial of Thermology International [12]. It is essential that researchers report the information accurately to make replication possible. Recently a consensus statement was published that can help researchers in the report of relevant information related to skin temperature assessments [13].

Regarding the intervention the authors described the type of current (TENS, 30Hz frequency, 250 microseconds pulse width) and described the use of 8 sterile needles, inserted into the subcutaneous tissue, however, the location of the needle placement is not clear. Four channels were used (therefore 8 needles), "two channels on the right and two on the left below the umbilicus" as stated by the authors, but it is not clear if all channels were placed in the abdominal area or two were in the abdominal area and two in the flanks, given the aims of the study. Precise location of the needles should be provided, for instance using a photograph of the needle and channel placement (e.g. [9]).

Regarding thermal imaging several issues were identified. Assuming the nature of the study, a more detailed description of the exercise habits of the participants should have been provided. The authors stated that participants were sedentary for at least 2 months but also reported that participants were instructed to maintain exercise habits and a characterization of those habits would be relevant to this study. Ambient temperature was reported (not as mean and standard deviation) but not relative humidity. The time of day at which the images were taken is not mentioned and is relevant due to the diurnal variations of skin temperature. The model, the resolution, the accuracy and the emissivity settings of the camera should have been reported. No information is provided regarding the existence of an acclimation period before image recording, even though it is recommended in all major guidelines for thermal imaging assessment. The position of the subject was described but specific information regarding the regions of interest is not provided. The authors reported that "the abdominal region was divided into four quadrants (two upper and two lower) using the umbilicus as the centre point" but the exact location and size of the regions of interest is not reported. A visual example of the regions of interest should have been presented. It is not clear if the intervention was in the abdomen and flanks but considering it was, given the fact that measurements of perimetry and skinfolds were taken in both regions, the definition of the regions of interest is not in line with the aims of the study since the effects of the intervention in the skin temperature of the flanks were not assessed.

Data analysis is another issue in the paper. In the abstract readers are informed that statistical analysis included the Shapiro-Wilk test, t test and one-way ANOVA but in the methodology and results no reference is made to the one-way ANOVA and authors state that comparative intra-group analysis of the four thermography assessments was performed using paired t test. Successive comparisons increase the probability of type I error and should be avoided or at least should be corrected for the number of comparisons. The approach should have been an analysis of variance with within group (different moments of assessment) and between group (intervention vs. control) factors, unless some assumptions were not met. The authors compared the study population (intervention vs. control group) regarding several characterization variables, some of them of nominal nature (e.g. smoking and drinking habits) and presented p values without informing the readers about the statistical test that was used, certainly the t test was not used in these comparisons. The p values regarding pre-and post -intervention anthropometric and perimetric data are also hard to understand because data from baseline and end of both groups is presented but for each variable only one p value is reported. For thermal imaging data, this is not the problem but in my opinion the statistical approach was not correct. There is, however, an odd result that should have been commented by the authors that is the final skin temperature value for the IG. The reported skin temperature is $32.22 \pm 14.20$ °C and such standard deviation deserved some discussion because it may be the reason for the significant differences between that assessment moment and the others. What is the reason for such high or low skin temperature values? How many subjects evidenced such discrepant values?

These limitations in data reporting and data analysis make it hard to understand the message of the paper and impossible to replicate the study - that according to the authors was a novel application of thermal imaging to assess the effects of electrical stimulation - and raise questions to the conclusions that were drawn from the data. The authors concluded that the increments in skin temperature from baseline to end of the intervention resulted in increased metabolism, facilitating lipolysis and justified the absence of significant differences in anthropometric assessment with the small sample size. This is a good case to pinpoint the need for the report of effect size estimates that would help to understand the issue. Even an intervention with very low effect size would produce significant differences in outcomes if the sample size was big enough. There is no fundament to conclude that electrical stimulation resulted in increased metabolism. In the last issue of Thermology International Ammer has written an editorial [14] reviewing and clarifying some thermal physiology concepts that would help the readers to understand why.

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# The influence of angles and distance on assessing inner-canthi of the eye skin temperature

R. Vardasca[1,5], A.R. Marques[2], J. Diz[2], A. Seixas[3,4], J. Mendes[1], E.F.J. Ring[5]

[1] LABIOMEP, UISPA-LAETA-INEGI, Faculdade de Engenharia, Universidade do Porto, Porto, Portugal
[2] Faculdade de Engenharia, Universidade do Porto, Porto, Portugal
[3] Faculdade de Ciências da Saúde, Universidade Fernando Pessoa, Porto, Portugal
[4] LABIOMEP, Faculdade de Desporto, Universidade do Porto, Porto, Portugal
[5] Medical Imaging Research Unit, University of South Wales, Pontypridd, United Kingdom

**SUMMARY**

**BACKGROUND: Infrared Thermography (IRT) has been proposed as primary screening method for mass assessment of populations at risk of pandemic condition related to high fever. Similar as other applications of IRT in medicine, distance and angles to target have an influence on the temperature measurements. Those can be partially corrected with extra camera lenses and advanced maths. This research aims to identify the impact of using different distances and angles, using standard camera lenses and standard image analysis software, in the assessment of the inner-canthi of the eye region of interest temperature.**

**METHODS: Thermal images were captured with a portable IR camera FLIR E60 in an air-conditioned room, equipped with a thermo-hygrometer, a carpet with distance and angle information and a chair.**

**A total of 14 healthy participants were recruited who signed their informed consent after the procedure was explained to them. Facial image capture was performed in line with the Glamorgan protocol recommendations. Distances were selected from 70 to 200 cm and angles from 0 to 180 degrees' angles at 15 degrees' intervals. The distance of 100 cm and angle of 90 degrees was used as reference for calculating the differences to the other settings.**

**RESULTS: In all participants, the mean temperature of the inner canthi of the eye varied by 0.1ºC at distances between 80 and 120 cm when compared with the reference, and by 0.4ºC and 0.5ºC at angles of 105 and 75 degrees, respectively.**

**CONCLUSIONS: To minimise the measurement error, distances between 80 and 120 cm and angles as close as possible to 90 degrees should be used when the inner-canthi of the eye temperature is recorded with conventional lenses and standard image analysis software for fever screening.**

**KEY WORDS:** angle of view, distance camera to object, fever assessment, inner-canthi, infrared thermography

**DIE BEDEUTUNG DES BLICKWINKELS UND DER ENTFERNUNG FÜR DIE BESTIMMUNG DER TEMPERATUR DES INNEREN AUGENWINKELS**

**HINTERGRUND: Im Fall einer drohenden Pandemie von mit hohem Fieber einhergehenden Erkrankungen wurde die Infrarot-Thermografie (IRT) als primäre Screening-Methode für die Massenuntersuchung von Populationen vorgeschlagen. Ähnlich wie viele andere Anwendungen der IRT in der Medizin, beeinflussen der Abstand und der Winkel zum Zielobjekt die Messungen, die teilweise durch den Einsatz von zusätzlichen Kamera-Objektiven und höherer Mathematik korrigiert werden können. Die vorliegende Studie zielt darauf ab, die Auswirkungen unterschiedlicher Abständen und Winkel auf die Temperaturwerte des inneren Augenwinkels bei Verwendung von Standard-Objektiven und Standard-Software zur Bildanalyse zu untersuchen.**

**METHODE: Die Wärmebilder wurden mit einer tragbaren IR-Kamera FLIR E60 in einem klimatisierten Raum aufgenommen, der mit einem Thermo-Hygrometer, einem Teppich mit Distanz-und Winkelinformationen und einem Stuhl ausgestattet war. Insgesamt wurden 14 gesunde Teilnehmer rekrutiert, die eine Einwilligungserklärung unterzeichneten, nachdem ihnen das Verfahren erklärt worden war. Die Wärmebilder des Gesichts wurden im Einklang mit den Empfehlungen des Glamorgan-Protokolls aufgenommen. Es wurden Abstände von 70 bis 200 cm und Winkel von 0 bis 180 Grad Winkel bei 15 Grad Intervallen ausgewählt. Der Abstand von 100 cm und der Winkel von 90 Grad wurde als Referenz für die Berechnung der Unterschiede zu den anderen Einstellungen verwendet.**

**ERGEBNISSE: Verglichen mit der Referenz, variierte die mittlere Temperatur des inneren Augenwinkels bei allen Teilnehmern um 0,1 °C bei Abständen zwischen 80 und 120 cm, beziehungsweise um 0,4°C und 0,5 °C bei Winkeln von 105 und 75 Grad.**

**SCHLUSSFOLGERUNGEN: Um den Messfehler zu minimieren, sollten Abstände zwischen 80 und 120 cm und Winkel so nah wie möglich bei 90 Grad verwendet werden, wenn die Temperatur des inneren Augenwinkels mit herkömmlichen Linsen und Standard-Bildanalysesoftware für Fieber-Untersuchungen aufgezeichnet wird.**

**SCHLÜSSELWÖRTER: Blickwinkel, Abstand zum Objekt, Fieberbeurteilung, Innerer Augenwinkel, Infrarot- Thermographie**

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## Introduction

Infrared thermal (IRT) imaging has been used in medical applications since 1956, it is fast, safe, remote and an innocuous modality of recording skin surface temperature. The information obtained is associated with peripheral blood flow, which is influenced by the autonomous nervous system. It has been employed in several clinical applications as a monitoring method for the vascular, sympathetic, musculo- skeletal and locomotor systems [1-3].

In order to increase the accuracy and repeatability of the method, recommendations were made [3-6] for its standardisation in terms of examination room, recording equipment and subject preparation, before and during the appointment, and manner of conducting the examination. This reduces the variables that may affect the measurement and increases the exchange and understanding.

Fever in clinical terms mean that the human body core temperature has been elevated to a value over 37.5 °C [7]. It is one of the most common medical signs, being responsible of about 30% of healthcare visits by children. Fever occurs in up to 75% of adults who are seriously sick. Prolonged fever can result in tissue destruction owing to the catabolism of body proteins. In severe cases, it can cause death or being an indicator of pandemic condition such as SARS, H1N1, H1N5 or Ebola [8].

The idea of using IRT for fever screening monitoring the face emerged in China about 15 years ago [9], during the SARS outbreak in southeast Asia. In 2004, two technical references for using the imaging technique for fever screening were developed in Asia through Singapore Standards authority SPRING [10,11]. Later, in 2006, the ISO initiated an interest group ISO/TC121/SC3-IEC62D/JWG8, Project Team 9 on Human Body Screening Thermographs. The effort of this task force resulted in two standard documents [12,13], one in the requirements and essential performance, and another that is a technical report on deployment, implementation and operational guidelines of performing the febrile identification.

Despite the existing documentation, which is poor in recommendations for distance and angles to the target, most of airports or high people traffic facilities fail to comply with the existing standards [14], putting cameras at inadequate angles and high distances, reducing the likely hood of identifying subjects at high risk of fever.

Another aspect of discussion is the region of interest [ROI] at the face that should be used for identifying the febrile states, the inner-canthi of the eye was proposed by Wood in 1964 [15].

A comparison was made between the temperature of the inner canthus of the eye obtained from infrared thermography, considered a core temperature estimation method for fever mass screening, and oesophageal temperature [as gold standard] in 10 subjects among four conditions: resting, exercise, recovery and passive heating. The two methods showed differed significantly results during all conditions [mean and their relationship was inconsistent between conditions, indicating that further research is required in the field focused in fever cases [16].

A study using high-sensitivity thermal imaging technology [17] aimed to predict core temperature of human subjects remotely from the face while performing simulated field operations wearing thermal protective garments. It consisted of 6 participants, from which measures of core and skin temperature were taken before, during, and after treadmill exercise in a heated room. A relationship and a strong correlation was found between core temperature and thermal imaging of the central region of the face in all subjects, occurring the best agreement during exercise. Despite the technology showing promise, it requires refinement, through the use of alternative measurement sites.

Another experiment was performed [18] to assess the relationship between core temperature (oral and tympanic) and IRT recordings from the frontal, lateral face (maximums) and forehead temperatures in a controlled laboratory setting with the 1517 participants (215 were considered febrile) standing at 1, 2, 3, 4 and 5 meters from the thermal camera. It was found that the forehead IRT temperature differed substantially from the core temperature, and the maximum lateral temperature should be used. The reading should also be taken at a defined distance from the camera. The recorded temperature with infrared imaging decreased linearly with the increase in distance. The agreement between core and estimated temperature was less accurate in women, elderly people, and those with fever. In order to maximize the sensitivity of infrared detection of fever, a lower cut-off temperature (≤35.5°C) was recommended.

A research aiming to verify if the temperature obtained with IRT at the inner canthus of the eye was related to brain temperature taken invasively [19], found strong correlations between temperatures of both sites of the inner canthi of the eye and of the brain. It also showed that in patients with a lesion in a side of the brain, the correspondent side had elevated inner canthus of the eye temperature.

A proposal for automatic detection and localization of the face and eyes in thermal images aiming to determine inner canthi of the eye temperature was made [20]. It can handle automatic temperature measurement which was impossible with traditional methods, a good correlation between the axilla temperature and that obtained by the algorithm was found. However, standardization of measurement through IRT is required for proper temperature assessment.

Since at a real situation, the subjects moving is random and the angles of the skin surface and distances change in a dynamic manner, which contributes to the misdetection of the inner canthi area of the eye in infrared images, that can also be affected by any other unwanted objects that have the same temperature. Asking a single person to stand still for 2 seconds to capture a thermal image of the face can be ineffective and this will lead to long queue in public. In order to address this, a combination of physiology-based and optical flow algorithm to extract vascular network from the face was proposed [21]. The thermal camera was provided with colour and audible alarming and when a suspicious individual was detected, the alarm will report to the operator its current location. Although some operational aspects need further research such as individuals wearing spectacles, masks and hats, their distance and angle to the camera.

Two recent experiments [22, 23] aiming to validate the inner canthus of the eye temperature obtained with a thermal camera as a non-invasive alternative measurement to the intestinal core temperature [through gastrointestinal telemetry pill or rectal assessment] during rest, exercise and post-exercise conditions, observed poor agreement between the values obtained and therefore, the inner canthus of the eye did not demonstrate to be a valid substitute measurement to invasive core temperature assessments in sports and exercise science settings, which is similar to other 'surface' measures.

A recent study, performed by Ring et al. [24-26], has employed the ISO standards with the inner canthi ROI and successfully identified paediatric febrile subjects with IRT.

Despite all this controversy present in the literature about the application of the inner canthi of the eye ROI in temperature assessments with IRT imaging, the improvement of its implementation requires attention.

It is aim of this research to identify the impact of using different distances and angles, using standard camera lenses and standard image analysis software, in the assessment of the inner-canthi of the eye ROI mean temperature.

## Materials and Methods

The examination took place at an acclimatized room [mean temperature of 22.9±0.3°C, relative humidity of 59.0±2.1%, absence of incident lightning and air flow) at the Faculty of Engineering, University of Porto. For images capture a recently supplied calibrated thermal camera FLIR E60sc [focal plane sensor array of 320x240, NETD of <50mK at 30ºC and measurement traceability of 2% of the overall reading) was used. For verifying the room environmental conditions, a temperature and humidity data logger Testo 175H1 with a digital display and capacity to store the mean temperature and relative humidity was used.

The sample used was composed of 14 healthy participants [described in table 1), which had avoided a heavy meal, coffee, tea, alcohol or had smoked 2 hours before the appointment. They were requested to not engage in any sport or physiotherapy activities in the day of examination and to refrain from using any oil or ointment in the face. To all the procedure was clearly explained and the informed consent signed was obtained. All the participating females were in the luteal menstrual phase.

To facilitate the capture of images in the correct distances and angles, a drawn carpet was used on the room floor [figure 1) and in every case with the camera facing the target a thermal image was taken. Before capture, a period of acclimatization of 10 minutes was applied to every subject to establish a thermal equilibrium with the room conditions. The subject was seated on a bench, remaining still with the face straight, facing the opposing wall at a 90-degree angle, to facilitate a stable position.

For comparisons and according with the internationally image capture recommendations [3, 5, 6] the values recorded at 100 cm distance and 90-degree angle were used as reference for each subject.

The first image taken was the 100 cm at 90-degree angle of the subject standing still seated in a bench and looking straight ahead, followed by the 70 to 200 cm at the same angle, then at the same distance of 100 cm images were taken from the subject from 0 to 180 degree angles, at 15-degree interval. Each subject took in average 15 minutes.

Table 1
Sample characterization.

| Gender | N | Age | BMI |
|---|---|---|---|
| All | 14 | 25.1±4.4 | 22.0±2.8 |
| Males | 7 | 26.7±5.0 | 23.4±3.3 |
| Females | 7 | 23.6±3.3 | 20.6±1.2 |

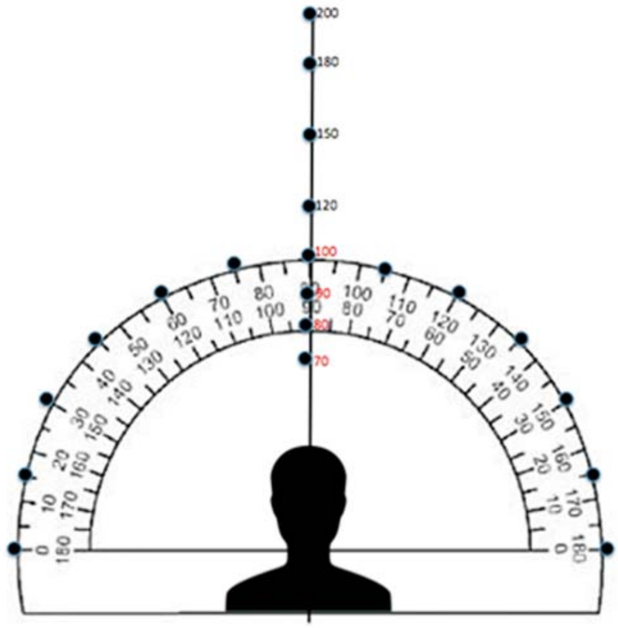


Figure 1
Indication of the capture location in terms of distances and angles.

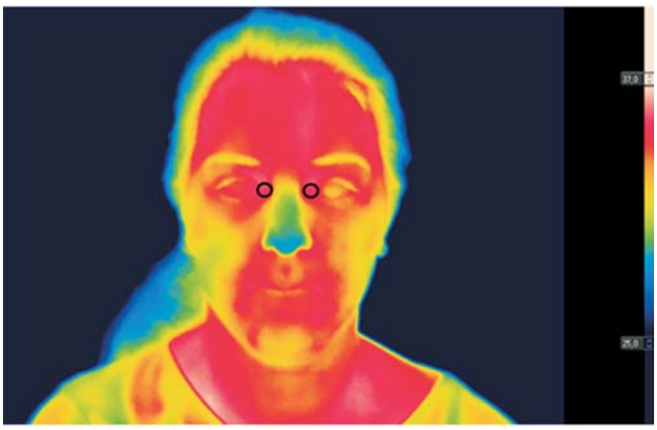

Figure 2
Indication of the ROI used to assess the inner-canthi of the eye temperature.

Table2
Comparison of the results of core body temperature determination.

| Group | Inner canthus of eyes thermal imaging |
|---|---|
| All | 35.4±0.5 |
| Females | 35.5±0.5 |
| Males | 35.2±0.4 |

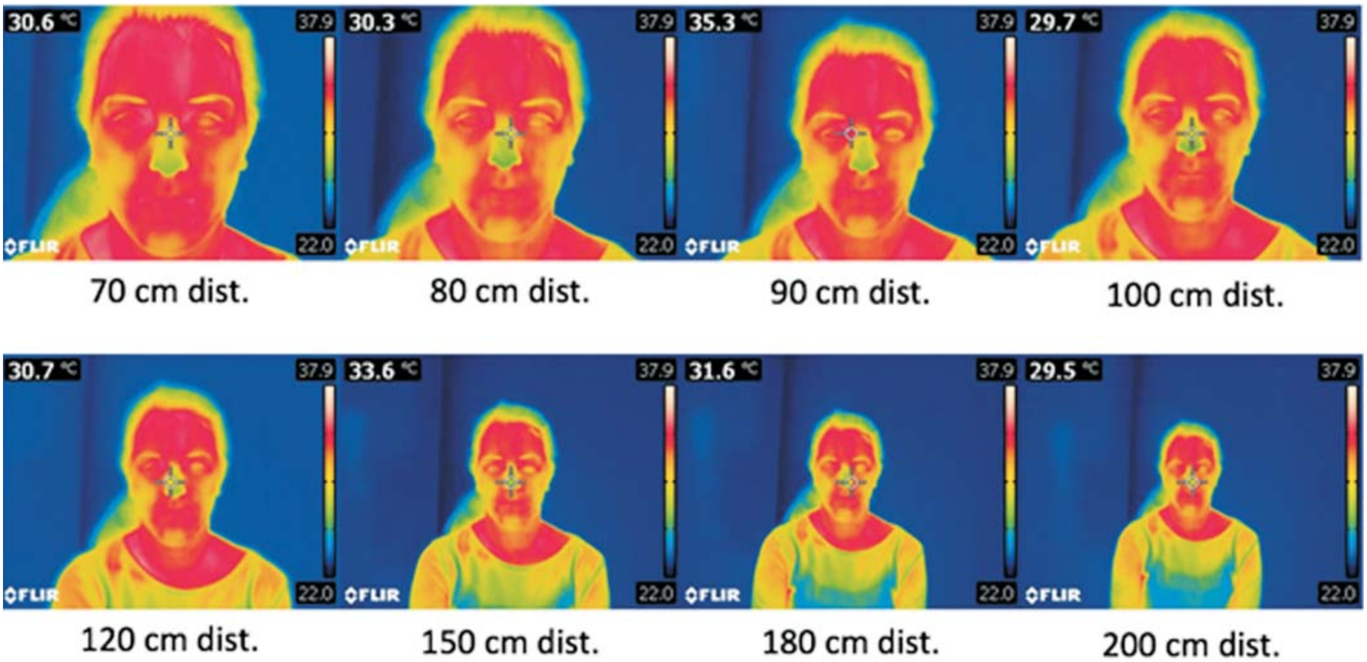


Figure 3
Examples of the images taken at different distances and 90-degree angle.

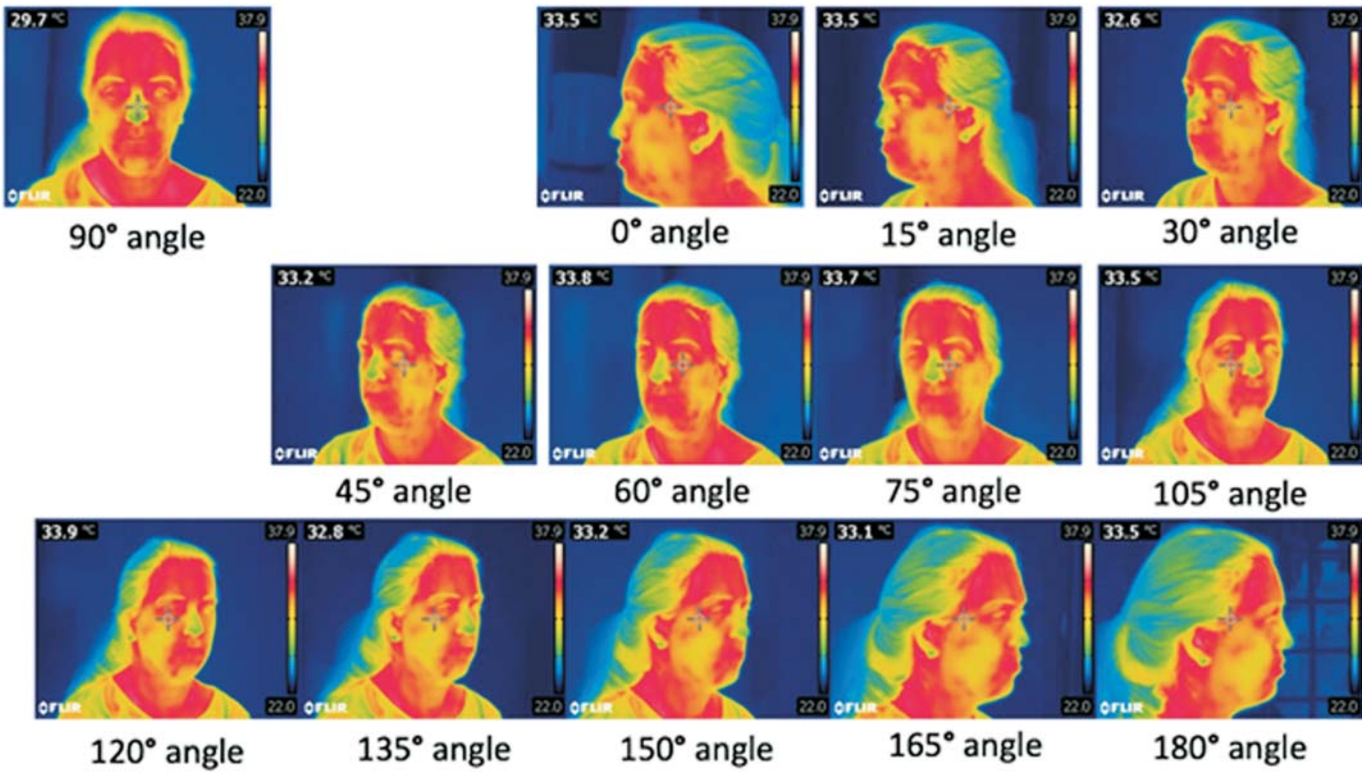


Figure 4
Examples of the images taken at different angles and 100 cm distance.

For analysing the images, the software package FLIR ThermaCAM Researcher Pro 2.10 was used. Regions of interest of 64 pixels were drawn at the area of the inner-canthi of the eye [figure 2) to enforce consistency within all distances. For both eyes in the images taken facing the camera at a 90 degrees' angle. At the area of the left inner canthi in the images facing the camera at the range from 0 to 75 degrees' angles and at the area of the right inner canthi in the images facing the camera at the range comprehended between 105 and 180 degrees' angles.

For statistical analysis, all the variables had their normality tested through the Shapiro-Wilk test and then parametric methods (ANOVA) were used to summarize the data.

## Results

The measured values with thermal imaging at the ROI of inner-canthi of the eye, mean of both eyes ROIs, at a distance of 100 cm and 90-degree angle and genders are presented in table 2.

The figure 3 shows the different images taken at the different distances and 90-degree angle and the figure 4 presents the distinct taken images at the angles from 0 to 180 degrees' angles and 100 cm distance.

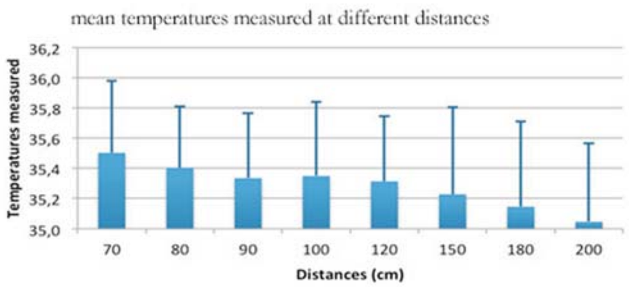


Figure 5
Comparison of mean temperatures (with SD) of the inner- canthi of the eye ROI measured at different distances and at 90-degree angle..

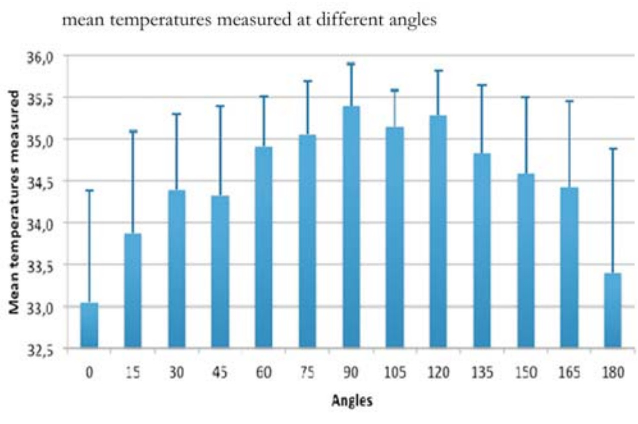


Figure 6
Comparison of mean temperatures (with SD) of the inner-canthi of the eye ROI measured at different angles and at 100 cm distance.

The results obtained in the temperature assessment of the inner-canthi of the eye ROI at different distances and 90-degree angle are provided in figure 5. From it can be observed that in a 20 cm distance difference from the reference (100 cm), below and above, the difference on the mean temperature value suffers a variation of 0.1°C. For other distances, it has higher variations. There was statistical evidence of variation in the results outside the range of 80-120 cm [$p > 0.05$).

The results obtained in the temperature assessment of the inner-canthi of the eye ROI at different angles and 100 cm distance are provided in figure 6. From it can be observed that for the closest assessed angles 75 and 105 degrees' angles, the difference was 0.5ºC and 0.4ºC correspondingly, for other more distant angles there were higher statistical significant variations ($p > 0.05$).

## Discussion

This study has followed the IRT imaging guidelines [3-6] and international ISO standards [12-13] for use in medicine and the ROI proposed [15] and used in paediatric fever assessments [24-26]. It is well known that distances can be corrected using different angle lenses, normally the IR cameras come by default with 24-degree angle lenses, for closer views higher angle lenses are required, the opposite happens for distant views. However, having more lenses mean increased cost, that most of researchers and health professional cannot afford. The angles can be corrected through complicated maths and heavy image processing techniques such as warp and morphing, which none of the currently available IRT images software package has these features. These advanced tools have also the disadvantage of generating undesired errors. In this research, it was decided to use generic standard tools, which are available to any IRT user.

Given this, in a lab setup for fever identification, using a threshold value of > 37.5°C [7], the mean temperature of the inner-canthi of the eye ROI can be used remotely, following the existing guidelines [3-6] and international standards [10-14], through IRT, since it uses a distance from the camera to the subject face comprehended between 80 and 120cm and an angle closer to 90-degree.

In another application this research could be useful is in the assessment of thyroid eye disease [27].

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*Address for Correspondence*
Dr. Ricardo Vardasca, Ph.D., ASIS, FRPS, AMBCS
LABIOMEP, UISPA-LAETA-INEGI,
Faculdade de Engenharia, Universidade do Porto, Portugal
Email: rvardasca@fe.up.pt

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# A checklist for measuring skin temperature with infrared thermography in sports and exercise medicine

Danilo Gomes Moreira[1,4], Joseph T. Costello[2], Ciro J. Brito[3], Manuel Sillero-Quintana[4]

[1] Federal Institute for Education, Science and Technology of Minas Gerais, Campus Governador Valadares,Brasil;
[2] Extreme Environments Laboratory, Department of Sport and Exercise Science, University of Portsmouth, Portsmouth, UK;
[3] Department of Physical Education, Federal University of Juiz de Fora, Governador Valadares, Brazil;
[4] Sports Department, Faculty of Sciences for Physical Activity and Sport (INEF), Technical University of Madrid, Madrid, Spain.

**SUMMARY**

**This short report introduces a recently published checklist for reporting thermographic studies in sports and exercise medicine. The checklist is the result of a Delphi consensus process, which was achieved after intensive discussion among 24 experts from different fields such as sport sciences, physiology, physiotherapy and medicine. The checklist contains in total 15 items in the domains "participants' demographic information" (3 items), "Camera/exam room or environmental conditions" (8 items) and ""Recording and analysis of the thermal image" (4 items). Applying the checklist will improve the comparability and thus data pooling of thermographic studies.**

**KEY WORDS: Infrared thermography,checklist, Delphi process**

**EINE CHECKLISTE ZUR MESSUNG DER HAUTTEMPERATUR MITTELS INFRAROT-THERMOGRAFIE IN DER BEWEGUNGS- UND SPORTMEDIZIN**

**Dieser kurze Bericht stellt eine vor kurzem veröffentlichte Checkliste für die Berichterstattung von thermografischen Untersuchungen in der Sport- und Bewegung-Medizin vor. Die Checkliste ist das Ergebnis eines Delphi Konsens, der nach intensiver Diskussion von 24 Experten aus verschiedenen Bereichen Sportwissenschaft, Medizin, Physiologie und Physiotherapie erreicht wurde. Die Checkliste enthält in insgesamt 15 Fragen in den Bereichen "demografische Informationen der Studienteilnehmer" (3Fragen), "Kamera/Untersuchungszimmer oder Umweltbedingungen" (8 Fragen) und "Aufnahme/Analyse des Wärmebildes" (4 Items). Die Anwendung der Checkliste könnte die Vergleichbarkeit und damit die Daten-Bündelung von thermografische Untersuchungen verbessern.**

**SCHLÜSSELWÖRTER: Infrarot-Thermographie, Checkliste, Delphi-Prozess**

Thermology international 2017, 27(4) 136-138

## Introduction

Measuring skin temperature using infrared thermography is common in the field of sports and exercise medicine. The quality, description and conduction of the protocol for thermographic data collection [1] should be considered as important as the quality of the camera used.

Unfortunately, research using infrared thermography (IRT) in sports medicine differs in the techniques employed and the comparison between studies is difficult as a result of these methodological inconsistencies. In addition, some studies often fail to report detailed information regarding the collection or analysis of the infrared thermography data [2, 3]. These methodological issues regarding the use of IRT have highlighted the need to develop protocols that are reliable and allow a comparison of results between studies.

In an attempt to address this problem a recent Delphi study and consensus statement on the measurement of human skin temperature using thermography in sports and exercise medicine has been published. Moreira et al. [4] developed a detailed checklist for the assessment of skin temperature using infrared thermography settings entitled "Thermographic Imaging in Sports and Exercise Medicine" (TISEM) (Table 1). The consensus statement attempts to standardize the collection and analysis of skin temperature data recorded using infrared thermography, thereby preventing bias and facilitating the comparison of results between future studies. It is intended that the TISEM will be helpful for a wide array of end-users including practitioners, sports scientists, exercise physicians, and other professionals that need to measure skin temperature using infrared thermography.

## How the TISEM checklist was developed?

Twenty-four world leading experts in IRT covering different fields and expertise (e.g. sport sciences, physiology, physiotherapy and medicine) participated in a series of questionnaires interspersed with controlled feedback [5]. All participants completed three rounds of questionnaires in which they commented and rated each item of a draft according to its validity and applicability. During the process, the items on the checklist were refined through each expert's comment, where each modification was shared and re-evaluated in the subsequent round. In the end, 15 items encompassed the participants' demographic information (items 1, 2 and 3), camera/room or environment setup (items 4, 5, 6, 7, 8, 9, 10 and 11) and recording/analysis (items 12, 13, 14 and 15) were approved using a 80% of agreement as a criteria [5-7].

## Why is it important to use TISEM?

The development of protocols for infrared thermography data collection has many elements with potential to vary,

Table 1.
Thermographic imaging in sports and exercise medicine (TISEM).

| |
|---|
| **1) The relevant individual data of the participants must be provided.**<br>Note: These could include, but are not limited to, age, sex, body mass, height, body mass index, ethnicity and whether they are smokers or not. An indication of physical activity profile (e.g. frequency, duration, intensity, and activity description) should be reported.<br>☐ Yes ☐ No ☐ Unclear |
| **2) Participants should be instructed to avoid alcohol beverages, smoking, caffeine, large meals, ointments, cosmetics and showering for four hours before the assessment. Also, sunbathing (e.g. UV sessions or direct sun without protection) should be avoided before the assessment.**<br>Note: This should be confirmed verbally before the assessment. The use of any medicinal treatments or drugs should be recorded. Any condition that could not be avoided should be reported.<br>☐ Yes ☐ No ☐ Unclear |
| **3) Extrinsic factors affecting skin temperature (e.g. physical activity prior to the assessment, massage, electrotherapy, ultrasound, heat or cold exposure, cryotherapy) should be clearly described.**<br>☐ Yes ☐ No ☐ Unclear |
| **4) Ambient temperature and relative humidity of the location where the assessment took place must be recorded and reported as mean ± standard deviation.**<br>☐ Yes ☐ No ☐ Unclear |
| **5) The assessment should be completed away from any source of infrared radiation (e.g. electronic devices, lightning) or airflow (e.g. under an air conditioning unit).**<br>Note: Any condition that could not be controlled should be reported.<br>☐ Yes ☐ No ☐ Unclear |
| **6) The manufacturer, model and accuracy of the camera used should be provided.**<br>Note: When available it is recommended to provide the maintenance information of the equipment (e.g. when and where it was completed the last calibration).<br>☐ Yes ☐ No ☐ Unclear |
| **7) An acclimation period in the examination room should be completed.**<br>Note: This item is only applicable for initial baseline measurements or basal analysis.<br>☐ Yes ☐ No ☐ Unclear |
| **8) If necessary the camera should be turned on for some time prior to the test to allow sensor stabilization following the manufacturer's guidelines.**<br>☐ Yes ☐ No ☐ Unclear |
| **9) Conditions of image recording such as mean distance between object and camera, percentage of the region of interest within the image should be detailed.**<br>☐ Yes ☐ No ☐ Unclear |
| **10) The camera should be positioned perpendicular to the region of interest.**<br>☐ Yes ☐ No ☐ Unclear |
| **11) Emissivity settings of the camera must be reported.**<br>Note: 0.98 of emissivity is suggested for a dry clean skin surface.<br>☐ Yes ☐ No ☐ Unclear |
| **12) The time of day at which the images were taken should be reported.**<br>☐ Yes ☐ No ☐ Unclear |
| **13) The standard body position of the subject and the regions of interest must be well described and appropriately selected. A visual example (with temperature scale presented and scale of colors properly configured) is recommended.**<br>☐ Yes ☐ No ☐ Unclear |
| **14) If the skin is dried (e.g. to remove surface water), the drying method should be clearly described.**<br>☐ Yes ☐ No ☐ Unclear |
| **15) The evaluation of thermograms and collection of temperature from the software should be clearly described.**<br>☐ Yes ☐ No ☐ Unclear |

Source: Moreira, D.G. et al.. Thermographic imaging in sports and exercise medicine: a Delphi study and consensus statement on the measurement of human skin temperature. Journal of Thermal Biology 69, 155.162.

such as the information given to the participant prior the test, the distance from the camera to the subject, the room temperature of the laboratory where infrared thermography is recorded, the time used for temperature stabilization, and the position of the camera. Prior to the TISEM, there was no consensus regarding which aspects were important to consider and which should be reported in a manuscript. Similar checklists have also been used in different contexts by the scientific community and their use typically improve methodological approaches [8, 9]. In this sense, it is expected that TISEM will move the field forward for researchers, peer reviewers, physiologists and clinicians by improving the quality of infrared thermography data collection, analysis and interpretation.

In conclusion, the use of the TISEM when conducting future research will help reduce methodological inconsistencies in the field of sports and exercise medicine. We also hope that the TISEM will be used to evaluate bias in thermographic studies and to guide practitioners using this technique [4].

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*Address for Correspondence:*

Danilo Gomes Moreira

Federal Institute for Education, Science and Technology of Minas Gerais,Campus Governador Valadares, Avenida Minas Gerais, nº 5189,Bairro Ouro Verde, Governador Valadares MG, Brasil, CEP: 35057-760.

E-mail: danilo.moreira@ifmg.edu.br

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# Letter to the editor

## THERMOLOGY IS MULTIDISCIPLINARY

Dear Editor,

the year 2017 was indeed very important to Thermology International in terms of visibility. Not only Elsevier has indexed almost all issues of the journal published recently in EMBASE / Scopus but also EBSCO has followed the same path and indexed Thermology International in the database Medline with full text. I congratulate the Editor, Professor Kurt Ammer, and all the authors who have submitted their research for this achievement.

I read with great interest the editorial published in the first issue of the year in which the Editor discussed the position of thermology in the scientific spectrum [1]. Being in the genesis of such debate I am compelled to answer positively to the invitation to participate in such discussion.

When consulting the SCImago Journal and Country Rank, a public portal that includes the scientific indicators obtained from the information contained in the Scopus database I noticed that Thermology International was classified in the subject category "Complementary and Alternative Medicine". For those unfamiliar with SCImago classification, journals can be grouped by subject areas (there are currently 27 major subject areas), by subject categories (currently 313 specific subject categories) or by country. The platform was named from the SCImago Journal Rank (SJR) indicator, an alternative measure of a journal scientific prestige [2]. The classification of Thermology International led me to discuss the matter with Professor Kurt Ammer, not knowing that it would be a topic for an editorial.

In the editorial, Professor Kurt Ammer defined Thermology, defined Complementary Medicine, defined Medicine and acknowledged that in present days "medicine is not the educational background of most authors who publish in the field of medical thermology". Personally, I do not use the term "medical thermology" but instead I use just "thermology" precisely because of what Professor Kurt Ammer acknowledged. I also have to agree with Professor Aleksandr Urakov [3] regarding the importance of temperature and the increase of thermal imaging applications. In fact, after a simple exercise consisting of a literature search in Scopus, Pubmed and Web of Science using the search expression: "thermal imaging" OR thermography OR "skin temperature" OR "infrared imaging"; and limiting the results by year of publication (2000-2016) we can note that the number of publications has increased every year, with few exceptions (figure 1). The year 2017 was not accounted in the analysis because it is not yet finished.

I believe that this steady increment in the number of publications related to thermology is precisely because it has become a tool that different professionals use in their practice, not only physicians. Using Thermology International as an example it is easy to find articles first authored by physicians [4], physiotherapists [5] or sport scientists [6] and this trend is present in other journals. Considering that thermology is not specific to medicine, and fol-

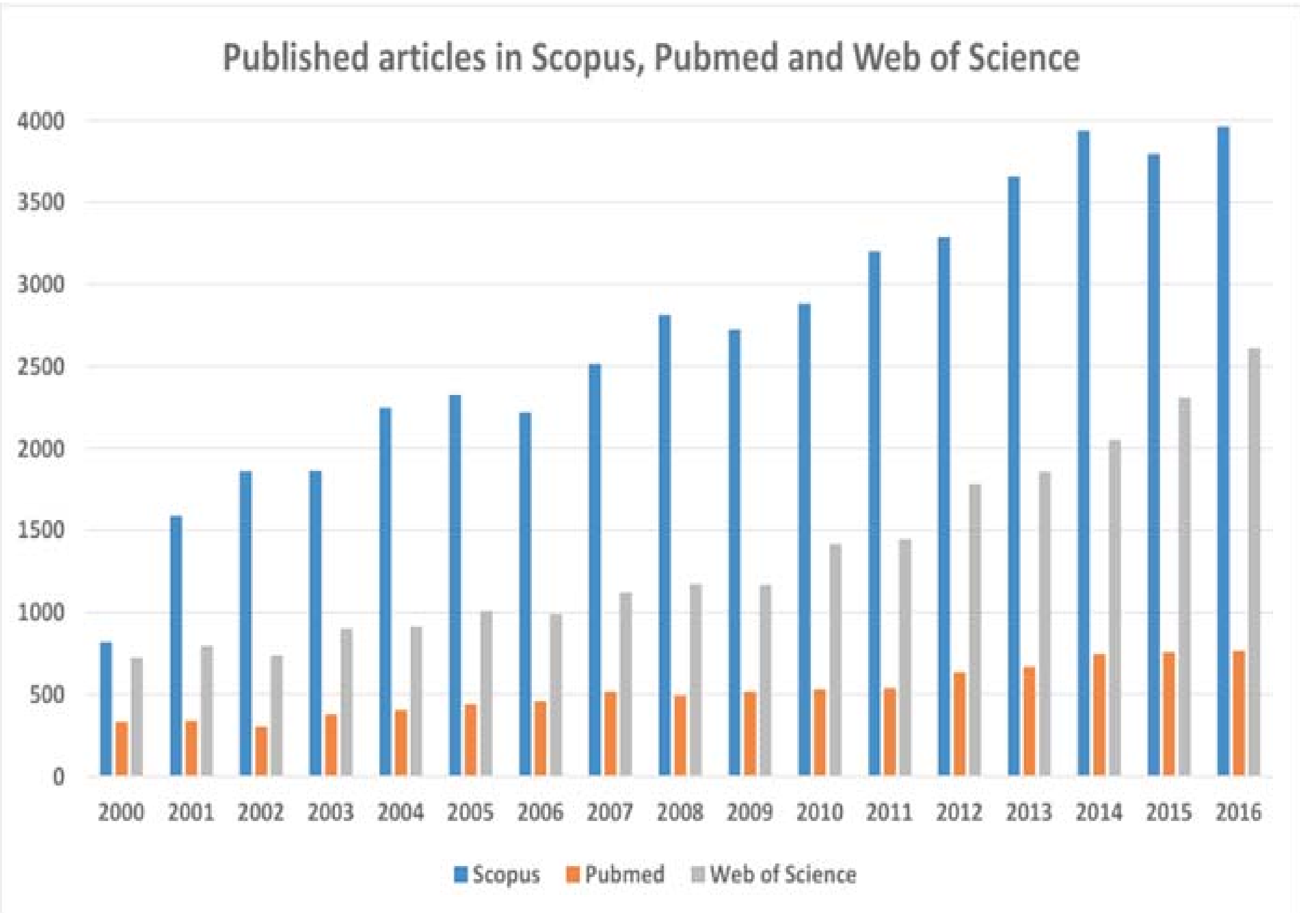


Figure 1
Number of published articles in Scopus, Pubmed and Web of Science from 2000 until 2016

lowing Professor Kurt Ammer reasoning, it would be easy to understand why Scopus considered to classify Thermology International in the subject category "Complementary and Alternative Medicine", however, we would be missing the big picture.

Going back to the SCImago classification, I see two paths for discussion. Either we look to thermology as a "Multidisciplinary" concept or we consider looking to thermology as a concept that belongs to a more specific category. Both possibilities are open to discussion but I would put my money on the first one. As stated before, there are 27 subject areas and 313 subject categories in the SCImago classification, very diverse in nature, and easily we can find research articles first authored by researchers from most subject areas (e.g. Agricultural and Biological Sciences [7], Arts and Humanities [8], Dentistry [9], Engineering [10], Health Professions [5], Medicine [4], Psychology [11] and Veterinary [12]). There is a subject area and a subject category named "Multi- disciplinary" in the list and this would be a suitable option to classify Thermology International. We should remember that this journal is the official publication organ of the European Association of Thermology whose aims are diverse but I will highlight one of them: "to assist in improving scientific research in thermology and related disciplines in basic research, technology, industry, medicine and biology" [13]. This is where I stand, we should see beyond the binomial Medicine/Complementary Medicine, thermology is multidisciplinary! As such, Thermology International should be classified as "Multidisciplinary".

The other - not as suitable - option would be to continue looking to thermology under the umbrella of a more specific category. There are two categories that I consider acceptable to classify Thermology International: "Physiology" and "Radiology, Nuclear Medicine and Imaging". The electromagnetic spectrum can be defined as the range of frequencies of the electromagnetic radiation. Several imaging modalities use information on that range of frequencies and mainly provide anatomical information [14]. Thermography provides mainly physiological information and physiology is the body of knowledge where we get most of the information to understand the changes in skin temperature, however, considering the examples given before it would not be possible to include research such as the example given for "Arts and Humanities" subject area [8] under the umbrella of the subject category "Physiology". The other option, "Radiology, Nuclear Medicine and Imaging", would be able to include all the examples because thermography is an imaging technique. Nevertheless, quoting Professor Kurt Ammer, "thermology is a general term for the study of the nature and effects of thermal energy" and it goes beyond thermography.

Classifying Thermology International in a specific subject category (e.g. Complementary and Alternative Medicine, Physiology or Radiology, Nuclear Medicine and Imaging) will leave many academical backgrounds out. In my opinion, the most suitable possibility is to classify the journal as Multidisciplinary, this is how I position thermology in the scientific spectrum. Thermology is Multidisciplinary!

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Adérito Seixas

Board Member, European Association of Thermology

Escola Superior de Saúde, Universidade Fernando Pessoa, Porto, Portugal


**RESPONSE TO ADERITO SEIXAS**

Dear Aderito Seixas!

I thank you for your letter and your arguments for defining the place of thermology within the spectrum of sciences. I am very pleased that all participants of this discussion agreed that thermology is a field of science.

I fully agree that thermology is best understood when it is approached from many disciplines. However, this also true for chemistry, physics, physiology, biology, medicine and many other fields of basic and applied sciences. Perhaps, the many aspects of thermal energy are the main reason for attracting currently so much research. As thermology is a term that describes the general nature of thermal energy, it may be advantageous to differentiate thermology by the field of application such as medical or industrial thermology. Of course, the title "Thermology international" was chosen for the journal to indicate that the topics of papers are not restricted to medicine and biology or authors originating from single geographic region.

Medicine is a scientific discipline that investigate the diagnosis and treatment of diseases. Diseases are the most important, but not the only reasons of impaired health. However, diseases are constructs or models that can explain and predict the psychophysical alterations in the state of disease. Modern western medicine, base these disease models on findings derived from anatomy, histology, biochemistry including the interaction on the level of molecules. Other medicine systems explain disease by the interaction of spiritual forces such as daemons or sequelae of curses, as a misbalance of body composition including energy, the effects internal or external toxins and many others. Currently, most of these medicine systems are considered as complementary to science based medicine, some of them are alternative explanations of health and disease.

Applying a method from science disciplines such as physics or informatics, does not imply that the resulting disease model is part of science based medicine. This is particularly obvious in models that try to explain a diseased state by temperature findings. Besides the fact, that the detailed heat transfer within temperature regulated living bodies is not well understood, it is impossible to explain and predict psycho-physical alterations of a disease by the distribution of skin temperature. Some from the surface easily accessible body sites such as the axillary pit, the oral cave and the rectum have clear relationship to deep body temperature and medical doctors used these sites for more than 150 years for fever diagnosis [1].

Average skin temperature, defined as the mean temperature of the total body surface, is necessary to estimate mean body temperature which is most frequently calculated as a weighted summation of deep-body and the average skin temperatures [2]. Mean body temperature is needed to determine body heat balance, which provides an estimation of the amount of heat exchange of the body with the environment. In animal experiments, an induced inflammation may regularly be associated with a local temperature increase over the inflamed joint and the adjacent tissue [3]. However, it remains unclear whether the elevated temperature is caused by an increased heat production or by other mechanisms induced by inflammation. Or in other words, if the magnitude of the temperature gradients between the inflamed tissue and the skin plus the geometric distribution of heat conductance of tissue along such a gradient remains unknown, a prediction of local surface temperature is not possible.

Any model claiming that a pathologic process located in deep tissues generates a thermal signal that becomes visible at the skin, must be classified as complementary if the path of heat transfer is not based on measured temperature gradients. This is also true for all models, that conclude from skin temperature on local energy metabolism and the involved physiological mechanisms. Local skin temperatures cannot predict the level of biochemical markers even when significant correlations of moderate size between skin temperature and blood sugar [4] or serum lactate [5] have been reported. Statements such as " a maximum anaerobic effort is accompanied by a substantial drop of the temperature on surface of engaged muscles and the degree of the drop is proportional to the blood lactate concentration "[5] are complementary to medicine and physiology.

Another field, which is in danger to develop complementary models, is the relationship between skin and muscle temperatures during or after exercise, the evaluation of physical fitness and the prediction of muscular injuries by skin temperature measurement. The competition between muscle and skin for blood supply during exercising is an important aspect in the evaluation of exercise induced alterations of skin temperature. During exercise, dissipation of muscular heat via vasodilation becomes difficult. Therefore, heat will be stored transiently in the muscles and slowly added to the core temperature. Crossing a threshold in various feedback loops involving core and muscle temperatures will trigger a sweating response in the skin [6]. Interpretation of local skin temperature as the result of heat generation of underlying muscles, disregards the fact that a temperature gradient exists between mean core and mean skin temperature. Heat transfer from deep tissues towards the skin leads not only to an increase of skin temperature above the heat generating muscles, but also to elevated temperature in skin areas that do not cover muscles, such as in hands, feet and the face.

Physical fitness has been defined as "the ability to carry out daily tasks with vigour and alertness, without undue fatigue and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" [7]. Some components of physical fitness can be measured, they are (a) cardiorespiratory endurance, (b) muscular endurance, (c) muscular strength, (d) body composition, and (e) flexibility. Often physical fitness is reduced to cardio- respiratory endurance measured by the maximum oxygen uptake (VO2max). Although significant correlations were reported between VO2max and a decrease of skin temperatures measured immediately after exercise cessation [8], such a change of surface temperature cannot predict or define the capacity for cardiovascular endurance.

In conclusion, application of thermology in any research field will be termed complementary when a complex outcome is reduced to single surrogate measure. Such outcomes are often defined by a significant correlation with skin temperature, but lack support by physiology or the laws of thermodynamics. I think, that thermology, particularly its use in medicine and health must be based on the highest possible level of scientific evidence. This challenge must be met by all models that explain disease and health conditions.

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Prof Kurt Ammer MD, PhD
Editor in Chief, Thermology International.
Vienna, Austria

# News in Thermology

## AAT Social Media

In the September- Newsletter of the American Academy of Thermology (AAT), their president Bobby Schwartz stated proudly that the 2017 Annual Meeting was the best since ever. In reporting the many activities of the AAT in 2017, he put great emphasis on the launch of the AAT Social Media Web site.

The AAT Social Media is a social network that resides within the AAT´s website. It allows AAT to provide a social community for anyone interested in medical thermography. The website provides tools for registration to the AATSocial Media, and after registration, the users can create connections, follow channels and personalize their AAT Social Media Page by adding a profile photo, contact data and information on educational and professional background.

However, it remains unclear whether registration will lead to an application for membership in the AAT and if not, what rights and duties are related to membership in the AATSocial Media.

Inclusion of a similar social media tool into the member section of the EAT website was recently addressed by the EAT Board members. Provision of facilities for creating a member ´s individual profile was the topic of intensive discussion. However, a final decision was not yet found.

Kurt Ammer, EAT treasurer

## EAT Board Meeting on 11. 11. 2017 in Vienna, Austria

All EAT Board members and two guests met on the 11th November 2017 in Vienna at the Palais Strudelhof. Kurt Ammer seeked for an alternative to the now closed SAS Raddison Palais Hotel, where many Thermology Conferences took place between 1990 and 2011. The Palais Strudelhof or Palais Berchtold replaced in the 19th century an older building from the late 18th century, and is nowadays used as a conference and meeting centre.

The following people wer presert at the meeting.:

Dr. Kevin Howell, President (KH)

Prof. Anna Jung, Vice-President (AJ)

Prof. Kurt Ammer, Treasurer (KA)

Dr. Ricardo Vardasca, General Secretary (RV)

Prof. Manuel Sillero (MS)

Mr. Aderito Seixas (AS)

Prof. Francis Ring (FR)

Dr. Janusz Zuber (JZ)

KH welcomed everyone to the meeting, and commented that it was wonderful the full Board could be present on this occasion in Vienna. FR, former EAT president and honorary member was invited to join the meeting, along with JZ.

The Secretary RV gave an update on EAT member numbers and their change. All Board members agreed to encourage new applicants among their contacts. Information could be added at the next congress website update, stating that in order to become a member the applicant should apply at least 3 months in advance of the date of the event to receive the discounted fee. AS mentioned that more important than acquiring new members, was to retain the existing ones.

RV suggested that it would be a good idea to have a commitment statement on the membership application form, confirming that an applicant accepts that s/he is obliged to pay the membership fee up until the point s/he terminates membership in writing.

The treasurer KA reported that there are sufficient funds in the EAT´s bank account.

### Next EAT congress London 2018.

KH reported that most of the information about the meeting was available at the website, and in the call for papers, previously distributed. KA and RV confirmed that we already have 3 abstracts submitted; 2 through the website and another that was sent by e-mail.

RV reported that a problem to distribute submitted abstract to KA and RV's had been now resolved and additional webadress also stores the submissions. KH agreed to send an email to all who had been previously mailed, reminding them of the abstract deadline and asking anyone who had submitted an abstract from 28$^{th}$ September to 6$^{th}$ November to resubmit it.

KH reported that he would meet again on 21$^{st}$ November with Graham Machin, Rob Simpson and Roger Hughes at NPL, and would enquire about NPL's updated facilities for poster presentations.

RV raised the issue that we need a preliminary draft of the congress program to make further decisions, such as deciding how many presentations we can accommodate and the location of the posters, lunches and coffee-breaks. It was decided that posters could be viewed at a specific program time and displayed on screens if available. They would be judged by 3 Board or Scientific Committee members, taking into consideration the abstract, poster contents and design and answers to any questions.

FR suggested that the abstracts submission should be extended until 15th January, and that the new date should be advertised on the 24th of November. KA suggested that 20th February should be the new latest date for the abstract acceptance notification.

KH confirmed that he would report to all EAT board members after the meeting with NPL on 21st November.

### Pre-congress thermography course review

AS reported that he had received the preliminary course material from KA, James Mercer and MS. He would circulate again a request for the course topic statements.

KH expressed his concerns about having the course ready as soon as possible. AJ commented that it would be a good idea to provide to the course attendants the abstracts of the course material. KA mentioned that it was important for the course applicants to know what they would be learning on the course.

KH asked for ideas about how to promote the course better. FR felt that it was a good idea to send information through the RPS mailing list, and exhibitors should also know about the course. MS also suggested BASES, the Sports Science society.

RV explained to KA how the course registration payment will be processed. KA raised the issue of the maximum limit of course attendants; KH would check this figure with NPL. KA mentioned that we needed spreadsheet software along with the software proposed by RV (FLIR ThermaCam Researcher Pro 2.10).

### Status of the next meeting in Zakopane (Poland) in April 2018

AJ announced the meeting, and invited all to submit abstracts. Armand Cholewka has joined the organization of the meeting. The EAT was invited to stage their next Board meeting at this Congress.

### Thermology International status today and future perspectives

KA reported that the journal was still short of paper submissions, and he was expecting more contributions of good quality from EAT members, and especially Board members.

### Status of the new EAT web site, and suggestions for improvement

RV explained the current situation, and raised the issue about what everyone wanted to see in the authenticated members' area. MS suggested a member profile with name, a picture, e-mail address and a short biography. KA, KH and RV felt that this information should only be visible to other EAT members. RV agreed to consider the impact of adding this feature. KA, AS and KH suggested educational resources, selected bibliographies and members' overviews.

The EAT board will meet next in Poland in Zakopane on 14th April 2018.

Ricardo Vardasca, EAT General Secretary

# 2018

## 13th - 15th April 2018
## XXII Meeting of the Polish Society of Medical Thermography Combined withThe European Association of Thermology, Zakopane, Poland

All are warmly invited to the annual meeting in Zakopane.

Conference venue:
"HYRNY" Hotel, Pilsudskiego str. 20, Zakopane

Abstract form will be published in Thermology International
Abstract should be submitted to a.jung@spencer.com.pl.

Abstract deadline is 15thMarch 2018

Registration fee:

Accommodation (2 nights) / meals, welcome dinner 120 E per person ( participant, accompaning person) will be paid in cash/credit card on arrival in hotel reception.

EARLY RESERVATION FOR ACCOMMODATION before March 15th to ensure hotel reservation by email: a.jung@spencer.com.pl

Scientific Committee

Dr Kevin Hovell Ph.D (UK)
Prof.Kurt Ammer MD,Ph.D (AUT)
Prof.Sillero-Quintana Manuel Ph.D (SPA)
Aderito Seixas MSc. (POR)
Prof. Ricardo Vardasca Ph.D (POR)
Prof.Boguslaw Wiecek Ph.D,Eng (Poland)
Prof.Francis Ring Dsc (UK)
Prof.Anna Jung MD,Ph.D (Poland)
Prof.Antoni Nowakowski Ph.D,Eng (Poland)
Dr.Janusz Zuber MD,Ph.D ( Poland)
Prof.Armand Cholewka Ph.D, Eng (Poland)

PROGRAMME AT A GLANCE.

13th April, Friday - 7 p.m.

Welcome Dinner ( HYRNY Hotel)

14th April, Saturday

9.00 - 11.00 Session I
11.00 - 11.20 Coffee break
11.20 -13.00 Session II
13.00 - 14.15 Lunch
14.30 - 16.00 Session III
16.00 - 16.15 Coffee break

16.15 - 18.00 EAT board meeting

## 24th - 29th June 2018
## QIRT 2018 in Berlin, Germany

14th Quantitative Infrared Thermography Conference

*Venue Conference*

H4 Hotel Berlin Alexanderplatz
Karl-Liebknecht-Straße 32
10178 Berlin

*Venue Short Courses*

Bundesanstalt für Materialforschung und - prüfung (BAM) in Berlin-Adlershof
Richard-Wilstädter-Straße 11
12489 Berlin

*Key Dates*:

Deadline for abstract submission: 30.November 2017
Acceptance notification: February 2018
Deadline for paper submission: 31 March 2018
Deadline for registration: 27 May 2018

*Contact:*

German Society for Non-Destructive Testing (DGZfP e.V)
Steffi Dehlau
Email: tagungen@dgzfp.de

QIRT Conferences http://qirt.gel.ilaval.ca
QIRT 2018: www.qirt2018.de

## 4th July 2018
## Short Course on Medical Thermography

Pre-conference course
to the 14th European Congress of Thermology

*Venue:*

National Physical Laboratory, London, Teddington, UK

Registration fee : 200.- Euro

*Course teachers:*

Prof Kurt Ammer MD, PhD

Prof James Mercer PhD

Aderito Seixas Msc

Prof Manuel Silero-Quintana PhD

Rob Simpson PhD

Prof Ricardo Vardasca PhD

National Physical Laboratory

# EXTENDED CALL FOR ABSTRACTS

## XIV European Association of Thermology Congress

## "Thermology in Medicine: Clinical Thermometry and Thermal Imaging"

*4th – 7th July 2018*

*National Physical Laboratory, Teddington, London*

*United Kingdom*

# LONDON 2018

XIV E.A.T. Congress, 4-7 July

National Physical Laboratory

Co-sponsored by:

IPEM Physiological Measurement SIG (www.ipem.ac.uk)

RPS Imaging Science Group (www.rps.org)

IPEM Institute of Physics and Engineering in Medicine

THE RPS ROYAL PHOTOGRAPHIC SOCIETY IMAGING SCIENCE GROUP

www.eurothermology.org

The EAT and the National Physical Laboratory are delighted to invite you to participate in the XIV EAT Congress in Teddington, London, United Kingdom from 4th to 7th July 2018.

The European Association of Thermology exists to promote, support and disseminate research in thermometry and thermal imaging in the fields of human and veterinary medicine and biology. We do this through our peer-reviewed journal Thermology International, regional seminars around Europe, and our flagship Congress, which takes place every three years.

Following on from the most recent meetings in Porto (2012) and Madrid (2015), the Congress heads back to northern Europe for 2018 to the National Physical Laboratory (NPL) in the United Kingdom.

The EAT Board looks forward to welcoming you to NPL's world class conference facilities in the summer of 2018.

Dr. Kevin Howell
EAT President
Chair, 2018 EAT Congress Organising Committee

## VENUE.

The National Physical Laboratory (NPL) is the United Kingdom's National Measurement Institute and is located in Teddington, south west London, approximately 30 minutes by taxi from Heathrow Airport and a 30 minute train journey from London Waterloo. www.npl.co.uk/location.

NPL's modern lecture theatre can comfortably accommodate more than 100 people. For delegates submitting posters, these can be supplied in A4 portrait format as .pdf files, and will be displayed electronically in NPL's state-of-the-art exhibition area.

**LONDON 2018**
XIV E.A.T. Congress, 4-7 July NPL

**XIV EAT CONGRESS 4th – 7th July 2018, NPL.**

## ORGANISING COMMITTEE.

Kevin Howell (GBR), Chair
Kurt Ammer (AUT)
Roger Hughes (GBR, NPL)
Anna Jung (POL)
Graham Machin (GBR, NPL)
Francis Ring (GBR)
Adérito Seixas (POR)
Rob Simpson (GBR, NPL)
Manuel Sillero-Quintana (SPA)
Ricardo Vardasca (POR)

## INTERNATIONAL SCIENTIFIC COMMITTEE.

John Allen (GBR)
Kurt Ammer (AUT)
Damiano Formenti (ITA)
Kevin Howell (GBR)
Anna Jung (POL)
Graham Machin (GBR)
James Mercer (NOR)
David Pascoe (USA)
Igor Pušnik (SLO)
Francis Ring (GBR)
Manuel Sillero-Quintana (SPA)
Adérito Seixas (POR)
Maria Soroko (POL)
Rob Simpson (GBR)
Dieter Taubert (GER)
Rod Thomas (GBR)
Ricardo Vardasca (POR)

## KEY DATES.

Abstract submission is now open, with the closing date extended to **15th January 2018**, and authors will be notified of acceptance for oral or poster presentation by 20th February 2018.

**15th January 2018.** Abstract submission deadline.
**20th February 2018**. Acceptance notification to authors.
**26th February 2018.** End of Early Registration and deadline for registration of presenting authors.

## UPDATES.

Follow all the latest news in the run-up to the congress via our Twitter feed:

@EAT_London_2018

LONDON 2018
XIV E.A.T. Congress, 4-7 July NPL

XIV EAT CONGRESS 4th – 7th July 2018, NPL.

## KEY MEETING THEMES.

Calibration and traceability in biomedical thermometry
Infrared thermography in biomedicine
Contact temperature measurement
Hardware and software solutions for infrared imaging
Biomedical applications: surgery, neurology, vascular and pain syndromes
Thermometry in exercise physiology, rehabilitation, and human performance research
Temperature measurement in animal welfare, veterinary applications and equine physiology

## REGISTRATION FEES

| | Early Registration (Until 26 FEB 2018) | Late Registration (After 26 FEB 2018) |
|---|---|---|
| EAT/IPEM/RPS MEMBER | £200 | £250 |
| Non-Member | £250 | £300 |
| Student | £170 | £220 |

Registration includes access to all congress sessions, congress lunch and coffee breaks, and the Congress Gala Dinner. Guided visit to the historic Hampton Court Palace on $7^{th}$ July for a small additional fee. Register online at the congress registration website from $17^{th}$ August 2017 at https://www.regonline.co.uk/XIVEATcongress2018

## ACCOMMODATION

There are a number of hotels within walking distance of the National Physical Laboratory and Teddington railway station, and even more choice within a 15-minute radius by train, taxi or bus. Further information about local hotels can be found at http://www.npl.co.uk/contact-us/local-hotels. Early booking in 2018 is advisable!

## ACCOMPANYING PERSONS

With central London just 30 minutes away by rail, Teddington is an excellent base for accompanying persons to enjoy the capital city of the UK without the need for an organised tour. All accompanying persons are invited to join the Congress Gala Dinner and social programme upon payment of the appropriate fee.

LONDON 2018
XIV E.A.T. Congress, 4-7 July NPL

**XIV EAT CONGRESS $4^{th}$ – $7^{th}$ July 2018, NPL.**

## ABSTRACT SUBMISSION

Online abstract submission is now open at www.eurothermology.org/congress2018 and closes on **15th January 2018**. Abstracts should be limited to a maximum of two sides of A4, using the template supplied online. All abstracts will be peer reviewed by the International Scientific Committee, with the decision on acceptance notified by 20th February 2018. The Committee reserves the right to allocate abstracts to oral or poster presentation, but will consider any preference expressed at the time of submission.

## PROVISIONAL CONGRESS SCHEDULE

Wednesday 4th July (evening):

Registration desk opens, followed by opening keynote address – **"Cardiovascular and thermoregulatory responses to heat therapy" – Prof. José González-Alonso, Centre for Human Performance, Exercise and Rehabilitation, Brunel University, UK**

Welcome drinks reception

Thursday 5th July:

Keynote address – **"The Kelvin redefinition and its implications" – Prof. Graham Machin, Head of Temperature Standards, National Physical Laboratory, UK**

Science sessions – day 1

Evening – EAT 2018 Congress Gala Dinner

Friday 6th July:

Keynote address – **"History of uncooled thermal-imaging technology" - Dr. Michael F. Tompsett (formerly English Electric Valve Company and AT&T Bell Telephone Laboratory)**

Science sessions – day 2

EAT General Assembly

Saturday 7th July:

Guided visit to Hampton Court Palace (morning, additional entrance fee payable)

Close of Congress

LONDON 2018
XIV E.A.T. Congress, 4-7 July NPL

XIV EAT CONGRESS 4th – 7th July 2018, NPL.

# European Association of Thermology

## Short Course on Medical Thermography

### *Wednesday 4th July 2018, National Physical Laboratory, Teddington, UK*

Following on from successful courses in Porto and Madrid, the next EAT Short Course on Medical Thermography will take place immediately prior to the EAT 2018 Congress at the National Physical Laboratory. The course aims to deliver a thorough introduction over one full teaching day to basic thermal physiology and the principles of infrared thermography for human body surface temperature measurement. It will be taught by an experienced faculty of EAT clinicians, biomedical researchers and imaging scientists, along with metrology experts from NPL. Aspects of reliable thermogram capture will be demonstrated in a laboratory session, and students will have the opportunity to practice thermal image analysis in a supervised "hands-on" session.

### Syllabus

- Physical principles of heat transfer
- Principles of thermal physiology/skin blood perfusion
- Standardisation of thermal imaging, recording and analysis
- Quality assurance for thermal imaging systems
- Producing a thermographic report
- Provocation tests
- Image analysis
- Hands-on supervised practice
- Educational resources

### Registration

The course fee (inclusive of lunch and coffee breaks) is €200

Register online from 17th August 2017 at www.eurothermology.org/congress2018/course

Questions? Contact Dr. Kevin Howell at k.howell@ucl.ac.uk

**LONDON 2018**

XIV E.A.T. Congress, 4-7 July NPL

**XIV EAT CONGRESS 4th – 7th July 2018, NPL.**