Guidelines for Neuro-Musculoskeletal

Infrared Medical Thermology & Sympathetic Skin Response (SSR) Studies

General Statement:

This guideline was prepared by members of the American Academy Of Thermology (AAT) as a guide to aid the performance of medical infrared imaging in evaluating patients with neuro-musculoskeletal (NMSK) complaints. It implies a consensus of those substantially concerned with its scope and provisions. This AAT guideline may be revised or withdrawn at any time. The procedures of the AAT require that action be taken to reaffirm, revise or withdraw this guideline no later than three years from the date of publication. Suggestions for improvement of this guideline are welcome and should be sent to the executive director of the American Academy of Thermology.

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Statement Of Need

Measuring skin temperature aberrations (deviations or abnormalities in the skin temperature from the expected or baseline levels) provides important insight into physiologic manifestations of potential injury or illness. In addition, pre-existing vasomotor tone and vasomotor capacitance play a significant role in thermoregulation, clinical symptomatology, and manifestations of systemic illness. Infrared Thermal Imaging is the only non-invasive technology available to image and map microcirculatory shunting (vasomotor instability) associated with these disorders.

As a result, it can play an important role in clinical diagnosis and may be helpful distinguishing between central and peripheral changes affecting the sympathetic nervous system. Infrared sympathetic skin response (SSR) imaging may also be valuable to document drug induced symptoms and paradoxical responses to sympathetic and peripheral nerve blockade.

There are numerous musculoskeletal conditions whose diagnosis and treatment would be aided and abetted by infrared imaging that are not necessarily of autonomic origin as well. Ranging from thoracic outlet syndrome, fibromyalgia, and small fiber peripheral neuropathy to sports injuries, inflammatory arthritis, and overuse syndromes, these conditions often are lacking in objective diagnostic gold standards. Neuro-musculoskeletal medical thermology can play an important role in helping to delineate each of these conditions like no other testing modality can.

Other technologies like PET scan, MRI, Spectroscopy, Electrodiagnostics, or EEG do not provide the physiologic information offered by Medical Thermal imaging. The clinical application of Infrared Thermal and SSR imaging may be instrumental in understanding the pathophysiology associated with these changes and improving patient outcomes.

The American Academy of Thermology ardently supports the integration of infrared thermal imaging into clinical medicine. The AAT is committed to advancing continuing medical education in both the science and methodology of thermal imaging. This commitment extends to the practical clinical application of diverse heat patterns derived from thermal imaging, underscoring their pivotal role in enhancing diagnostics, patient monitoring, and overall clinical care.

Purpose:
Infrared NMSK and SSR evaluations are performed to provide an overview of the location, extent and severity of sympathetic skin response abnormalities. When abnormalities due to vasomotor/sudomotor dysfunction occur there are associated changes in skin galvanic impedance and skin temperature. Skin galvanic impedance changes map closely with skin temperature. In physics, this is explained by the fractal nature of infrared waves and their relationship to resistance and conductivity. The NMSK and SSR evaluation can be performed from the cranium to the base of the spine (inclusive of all segments) and torso to the extremities, extended to the fingers and toes.

Common Indications:
Some of the common indications for performance of infrared SSR and NMSK head, neck, spine and extremity imaging include:

- Evaluation or follow-up of patients with known or suspected vasomotor instability.

- Assessment of patients with presumptive Complex Regional Pain Syndrome (CRPS) Type I or II - formally known as Reflex Sympathetic Dystrophy (RSD), Thoracic Outlet Syndrome, Vaso-motor Headache and Barre'-Leiou Syndrome.

- Pre-procedure assessment for the planning of interventional therapeutics.

- Follow-up to determine the technical adequacy of surgical intervention, i.e., sympathetic block, sympathectomy, peripheral nerve stimulator implantation and/or spinal cord stimulator placement.

- Follow-up to detect improvement, progression or spread of disease, which may reflect the change in condition.

- Evaluation of vasospastic disorders, rheumatic inflammation, and unexpected post-operative or post-fracture pain.

- Evaluation of sports injuries, tendinopathies, ligamentous strain, and persistent or aberrant soft-tissue pain.

- Evaluation of somato-autonomic and visceral-autonomic responses which may be present secondary to acute trauma or disease.

- Evaluation of other disorders associated with autonomic dysfunction such as shoulder-hand syndrome.

- Evaluation of non-myelinated neuropathies (small fiber neuropathies).

- Mapping of the extent of vasomotor instability to guide sympathetic response generator identification.

- Mapping of the location of vasomotor instability for impairment rating purposes.

- Confirmation of diagnostic inclusion criteria for clinical diagnostic purposes.

- Confirmation of diagnostic inclusion criteria for research purposes.

- Documentation for medical and medicolegal expert purposes.

Contraindications and Limitations:

Contraindications for extremity and spinal infrared SSR imaging include the following:

- Presence of casts, bandages or other technical factors that preclude the ability to expose skin to a temperature equilibration environment.

- An uncooperative patient

Guideline Part 1: Patient Communication and Preparation:

Communication:

1. The laboratory's medical director should ensure that the patient understands the medical necessity for performing Infrared NMSK and SSR imaging.

2. The laboratory's medical director should ensure that any patient questions and concerns about any aspect of the examination are responded to.

3. The laboratory's medical director should ensure that the patient is advised about risk factors and symptoms of vasomotor instability and associated pathophysiology and obtain informed consent either written or orally from the patient to proceed with infrared SSR imaging.

4. The laboratory's medical director should ensure that specific diagnostic, treatment or prognosis questions are referred to the patient's physician.

Preparation (exceptions should be noted in the record):

5. The patient should not have contact with any object if that body part is being imaged. Cotton garments may be worn to cover breast or genital areas when they are not under study with the understanding that the genital area and buttock should be exposed as much as possible for imaging.

6. The patient should shower or bathe the morning of the test to ensure that the skin is as clean as possible. The patient should avoid hot water exposure to the skin for at least two hours prior to the test.

7. The patient should avoid placing any material of any kind on the skin, such as any skin lotions, sunscreens, deodorants, preparations, moisturizers, liniments, makeup, hair spray, hair cream, topical analgesics, etc., the day of the exam.

8. Nicotine and caffeine products should be discontinued by the patient 4 hours prior to imaging.

1.9 The patient should wear loose clothing to the test; avoid anything binding against the skin; avoid support undergarments or pantyhose. The patient should not wear jewelry, preferably including rings if the hands are to be examined (exceptions are made for rings which cannot be removed or jewelry which the patient chooses not to remove for personal reasons).

1.10 To the extent possible, discontinue the use of medical appliances such as braces, neoprene wraps, Ace bandages, etc., on the day of testing.

1.11 Avoid massage, skeletal manipulation, acupuncture, physical therapy, dry needling, moxibustion, occupational therapy, saunas, extended sun exposure, the use of TENS or electric muscle stimulation units, laser therapy, or ozone therapy 24 hours prior to imaging. Electrodiagnostic testing should be avoided for 24 hours prior to imaging. Exceptions should be noted in the record.

1.12 Whenever possible steroids, sympathetic blockers, vasoactive medications, opiates and transdermal patches should be avoided for 24 hours prior to testing (15-19 hours minimum). Exceptions should noted in the record.

1.13 When Cold Stress examinations are being performed, medications that are not medically necessary and that alter sympathetic function should be avoided for at least 24 hours prior to testing.

1.14 In the absence of extenuating circumstances, for original diagnostic studies, sympathetic and neurolytic blocks should be avoided for 3 days prior to testing.

1.15 Peripheral nerve implants and spinal cord/dorsal column stimulators should be turned off 4 hours prior to testing.

Guideline Part 2: Patient Assessment

Patient assessment should be performed before infrared SSR imaging. This includes assessment of the patient's ability to tolerate the procedure and an evaluation of any contra-indications to the procedure.

2.1 Obtain a complete, pertinent history by interview and/or review of the patient's medical record. A pertinent history includes:

a. Current medical status, especially regarding pain and vasomotor instability.

b. Presence of any signs or symptoms of allodynia or hyperalgesia in association with sudomotor, vasomotor, or other autonomic dysfunction. A symptom diagram should be completed (ie: pain, numbness, tingling, etc).

c. Relevant risk factors for inflammation or vasomotor instability: prior history of RSD or CRPS, trauma, fracture, repetitive use, vibration syndrome, peripheral neuropathy, spinal pathology, radiculopathy, vasomotor headache, odontalgia, rheumatic illness, recent surgery, cardiovascular disease, hypertension, diabetes, peripheral vascular disease, coagulopathy, birth control pill use, hypothyroidism or infection.

d. Pathology/Laboratory investigation values.

e. Current medication or therapies.

f. Results of other SSR, thermographic or vascular studies.

g. Results of prior autonomic, sympathetic or vascular interventions.

h. Results of other relevant anatomic or physiologic studies (such as CT, MRI, Diagnostic Ultrasound, and electromyography).

2.2 Complete a limited, focused, detailed or extensive physical examination, which includes assessment of all structures under study. Inflammation, tender points, erythema, trophic changes, vasomotor or sudomotor changes, neurological symptoms, and possible pain generators should be documented.

Guideline Part 3: Exam Time Recommendations

High quality and accurate results are fundamental elements of the infrared SSR study. A combination of direct and indirect exam components is the foundation for maximizing exam quality and accuracy. Recommended time: 60 minutes.

3.1 Indirect exam components include pre-exam procedures:

a) obtaining previous exam data, completing pre-exam paperwork,
b) exam room and equipment preparation and
c) patient assessment, history, and positioning (Guideline 1 & 2).

3.2 Post exam procedures include:

a) initial report preparation consisting of compiling, processing, and reviewing data for preliminary and/or formal interpretation (Guidelines 3 and 4),
b) patient communication (Guideline 2),
c) examination charge and billing activities where appropriate.

3.3 Direct exam components include equipment optimization, patient positioning throughout the exam, and the actual hands-on examination process.

Guideline Part 4: Examination Procedures

In order to produce quality infrared images, certain requirements should be followed. The technical aspects of infrared imaging equipment, the environment of the imaging room, and patient's physiology need to be taken into account.

4.1 To establish minimum specifications for breast thermography, certain assumptions are considered. The lens field of view (FOV) is assumed to ranging from 24 to 54 degrees, with the patient-to-imager distance set between 3 to 8 feet, adjusted as needed to ensure that the region of interest fills approximately 75% of the image. Larger FOV lenses are preferable as they allow for a more extensive capture of the breast area and occupy less space in the examination room. Additionally, satisfactory lens quality ensures clear and accurate imaging for most observers.

Most cameras come with 24-degree lenses as they are designed for capturing images from a distance and industrial application (open field, outdoor). Cameras with lenses ranging from 42 to 54 degrees are more suitable for medical clinic use as they don't require as much distance to obtain the same quality image as a 24-degree lens (indoor). All brands in the market offer these lens degree options.

4.2 Emissivity is a fractional representation of the amount of energy radiated from a material versus the energy from a black body at the same temperature. Medical-grade imagers should be calibrated against the emissivity of a black body at 1.0 spanning the physiologic temperature range, if required for the examination being performed. This calibration should be conducted using accepted protocols or by the manufacturer. Calibration should be performed at least every two years. The imager emissivity correction should be set to 0.98, specifically calibrated for human skin. This adjustment accounts for variations in skin emissivity and enhances the accuracy of temperature readings.

4.3 Medical-grade infrared imagers should adhere to specific technical specifications to ensure accurate and reliable results.

The imager's detector spectral bandwidth is crucial, typically ranging from 8 to 14 microns (long wave). This specification ensures that the imager captures the relevant infrared wavelengths emitted by the human body, allowing for optimal thermal imaging.

A preferred absolute detector resolution of greater than 640 X 480, coupled with a suitable microbolometer and lens, is essential for achieving high-quality thermal images. While many medical imaging systems use uncooled focal plane array detectors in the 320 X 240 sensor range, advancements in microbolometer quality and software innovations can approach the image quality and spatial resolution of 640 X 480 systems.

Measurable spot size, spot resolution quality, and spatial resolution quality at specified distances contribute to the precision of thermal imaging. These factors ensure that the imager can accurately detect and differentiate temperature variations in the observed area.

The imager should have a thermal sensitivity of greater than 50 mK NETD to detect subtle temperature differences. NETD (Noise Equivalent Temperature Difference) represents the smallest temperature difference that a thermal imaging system can reliably detect. It should perform accurate quantitative differential temperature analysis with a precision of greater than or equal to approximately 0.05 ºC. Additionally, repeatability and precision in detecting temperature differences should be maintained at greater than or equal to approximately 0.5º C.

Strict control over thermal drift, calibration to a known temperature standard, and maintenance of detector uniformity are essential for reliable and consistent imaging results (v<0.2m/s). The imager should also provide high-resolution color and grayscale images, supporting detailed analysis and interpretation.

For video mode applications, real-time capabilities, including image focus and capture, are preferred, with higher frame rates (e.g., 50Hz) enhancing temperature analysis. The imager's temperature range should cover human emissions (18-45 ºC), ensuring applicability to physiological variations.

Precision autofocus is recommended to optimize infrared image clarity. The imager should incorporate appropriate instrumentation for real-time display, electronic static image capture, storage, annotation, and hard copy documentation. Archiving capabilities enable future reference and image comparison, maintaining consistency in patient positioning and distance.

Software manipulation should adhere to strict parameters to preserve the original image qualities, and the imaging software should identify areas for temperature calculations and reporting locations. These technical specifications collectively contribute to the reliability and accuracy of medical thermography, ensuring its effectiveness as a diagnostic tool.

Given the current advancements in non-contact digital infrared imaging, older contact thermology devices that involve single or multiple probes or sheets of thermally-sensitive liquid crystals are deemed outdated for thermographic analysis. While several new wearable innovations are being introduced, their application for medical purposes remains to be seen. Thermographic scanning systems incapable of capturing and displaying thermal differences of 0.05°C are not currently supported for medical purposes.

4.4 Environmental Controls:

All studies should be performed in a room where ambient temperature is strictly controlled, free from drafts, and without exposure to significant external or internal infrared sources (ex. sunlight, incandescent lighting). Ventilation systems should be designed to avoid airflow onto the patient and imager, and natural convection kept at or below 0.2 m/s. Walls and ceiling should be of a matte finish non-reflective to infrared radiation. Mirrors, glass framed pictures, glass cabinets, or any reflective surface should not be placed in the imager field of view. Carpeted flooring is preferred.

4.5 Thermal Equilibration, Acclimation, and Stress Testing:

In the context of this Guideline, it is noted that the body does not at any point reach thermal equilibrium with room temperature; it consistently remains warmer than the ambient temperature. Providing an adequate environment and time period for skin temperature thermal equilibration, however, is still necessary for the person under study. Physiologically, this procedure provides an opportunity for the body's skin to adjust to the room's lower temperature; it allows the skin to cool and provide a clear thermal signature.

The patient will be asked to disrobe and not to stand any areas of draft. The patient most commonly undergoes thermal equilibration in a standing or sitting position; however other positioning as determined by the interpreting thermologist for the study being performed may be utilized as well. A physiologic cooling time of fifteen minutes is deemed appropriate prior to obtaining the images, less or equal than ten minutes is not recommended. The patient will be asked not to have any contact with their skin, especially those that include a region of interest (ROI) for the study in question, during this time.

Infrared studies performed in a steady state can be accomplished with one set of images, providing the patient equilibrated for 15-20 minutes prior to imaging in a cool environment 19°C-25^{0}C (±1°C). If studies are intended to be used for medical or medical-legal purposes however then more than one set of images taken at 15 minute or pre-defined recovery time monitoring intervals is advised. In any instance, the temperature of the room should be such that the patient's physiology is not altered to the point of shivering or perspiring.

If Infrared studies are performed in an environment where the ambient image suite temperature is greater than 21°C, or if the thermologist desires to assess SSR, recovery time, reproducibility, or progressive change with prolonged exposure to cold ambient temperature, then repeating the study one to two times at fifteen minute or pre-defined recovery time monitoring intervals should be performed. In post sympatholytic blockade studies or in patients who are undergoing monitoring solely for cold water autonomic functional stress testing, post blockade equilibration is not required and imaging suite temperature is not as critical.

Room temperature changes during the course of an examination should be gradual so that steady state physiology is maintained and all parts of the body can adjust uniformly. Further, 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 moisture build up on the skin, perspiration, or vapor levels that can interact with radiant infrared energy. Relative Humidity below 70% is generally acceptable.

4.6 Passive Infrared Imaging:

a) A standard exam protocol for each segment evaluated should be used. This will frequently require multiple infrared images with different points of focus (arm, forearm, wrist, hand, thigh, leg, foot, cervical, thoracic and lumbosacral spine). Each point of focus should include anterior, posterior, medial, and lateral oblique views. Contralateral and AP views should be equidistant and fill the image screen. When possible, it is recommended that the contralateral extremity images should be captured in the same image. Additional image obtainment may be required for patients with specific, unique circumstances.

b) Additional images beyond those described in 3.7a may be requested and are up to the discretion of the interpreting thermologist. The interpreting thermologist is also encouraged to look beyond pathophysiologic findings related solely to the neuromusculoskeletal system.

Example templates are available for Members in the Knowledge Center within the AAT Member Portal.

4.7 Temperature Range & Color Scales:

NMSK and SSR studies that wish to highlight vasomotor mapping and that are prepared for interpretation without post-acquisition radiometric image manipulation typically employ color scales of no less than ten colors and are formatted at 1°C per color. Many laboratories have found it beneficial to use a temperature span of more than 10°C (the 1°C per color format, however, is retained). The intent of using a broader temperature span is to ensure that no relevant radiometric image information is lost at the extremes of temperature maxima or minima across a wide range of regions of interest.

While vasomotor mapping for SSR studies and neuropathic pain may be more readily visible with a 12 ^{0}C temperature span when 1°C per color is employed, gradient color scales that span less than 10°C are also commonly used in various NMSK studies. This is especially true for examinations that have a limited focus or region of interest and where visualization of vasomotor maps may not be necessary..

If a specific office does employ post-acquisition manipulation of data to reduce temperature span then care should be taken not to sacrifice qualitative or quantitative information as otherwise referenced in this Guideline. This cautionary approach is rooted in the technical consideration that excessively narrowing the temperature span (color compression effect) may result in the loss or distortion of critical image details, adversely affecting the accuracy and reliability of both qualitative and quantitative assessments.

Different temperature spans may also be desirable as necessitated by radiometric findings. The purpose of employing a wider temperature span is to guarantee the retention of all pertinent radiometric image information, avoiding loss at the temperature extremes within the range of all regions of interest. However, caution is advised as an

excessively broad temperature display range has the potential to 'wash out' finer details in the qualitative image. It is important to note that alterations in the span can have an impact on the scope of findings, emphasizing the need for thoughtful consideration and adjustment.

Ultimately, the interpreting thermologist must also ensure that the range of temperature maxima and minima utilized does not mask (or effectively filter out) any radiometric data and laboratories must establish individual protocols for acquisition that do not exclude relevant findings.

4.8 Patient Monitoring:

a) The patient's physical and mental status is assessed and monitored during the examination, with modifications made to the procedure plan according to changes in the patient's clinical status during the procedure. Also, findings are analyzed throughout the course of the examination to ensure that sufficient data is provided to the physician to direct patient management and render a thermographic impression.

b) The patient's physical and mental status should be evaluated prior to discharge. Additional discharge instructions may include a recommendation to schedule follow-up appointments with their attending physician and to resume all medication that may have been discontinued prior to the infrared SSR study.

Guideline Part 5: Review and Presentation of the Infrared Examination

5.1 The data acquired during the examination should be reviewed to ensure that a complete and comprehensive evaluation has been performed and documented. Any exceptions to the routine examination protocol (i.e., study omissions or revisions) should be noted and reasons given.

5.2 Record all technical findings required to complete the final interpretation so that the measurements can be classified according to the laboratory procedures & protocols (these may be internally generated or from published data, but in any event they must be internally validated). It is important to realize that equipment, operator, and interpretation variability is inherent to this process.

5.3 The quality of findings should be analyzed throughout the examination to assure that sufficient data is provided to the physician to direct patient management and render a thermographic impression.

5.4 Record the technical findings utilized to complete the final interpretation.

5.5 Complete all required laboratory documentation of the study so that it may become part of the patient's medical record.

5.6 Present the record of diagnostic images and when applicable, explanations for sub-optimal examination findings to the interpreting physician for use in diagnosis and archival purposes.

5.7 Alert medical director, or the responsible physician, when immediate medical attention is indicated, based on examination findings.

5.8 It is the interpreting thermologist's responsibility to assure that all pre-imaging preparation and office protocols are followed. Any deviation should be charted by the technician. If a technician obtains images independent of medical direction then the patient should be notified of the same.

Example templates can be accessed by members in the Knowledge Center within the AAT Member Portal.

Guideline Part 6: Reporting

6.1 Report layout: The body of the Infrared Thermographic report should clearly state that laboratory procedures that follow a peer-reviewed, internationally accepted guideline were utilized. The imager model used and the set of images obtained for the study should be documented. If a standard protocol for obtaining and reading images is used then this should be stated as well.

6.2 Thermographic Findings should be documented and any abnormalities, along with any pertinent normal findings, noted. NMSK findings should be reported as asymmetric skin response when done as a cold stress sympathetic skin response study. Findings include asymmetry of $\geq$ 1 degree Centigrade in $\geq$ 25% of the surface area of any individual region of interest or localized hot spots. Other findings include call-outs such as venous tortuosities.

6.3 Thermographic Impressions include classification according to an accepted naming system or summarization of the Thermographic Findings. When recognized patterns (thermal signatures) are seen due to the clustering of findings, they should be noted.

Thermographic Impressions may include the description of that pattern (for example, a sympathetic skin response asymmetry pattern is seen in an L5 distribution) however care should be taken not to make any statements about clinical diagnosis or generator of that signature in this section of the report.

6.4 Neither Clinical nor Thermographic Impressions are to be included in the Thermographic Findings section.

6.5 Clinical Impressions are medical opinions. Statements in this section of the report include differential diagnosis and recommendations for further diagnostic assessment or treatment. Clinical Impressions should not be provided by the interpreting thermologist unless he/she has performed a history and physical examination of that patient.

6.6 Treatment recommendations should not be formulated based on imaging alone. Imaging may clarify the diagnosis, and recommendations may include further studies to more accurately assess the diagnosis, but any treatment recommendations must be based

on patient contact. This does not preclude treatment recommendations from imaging done in conjunction with a patient consultation.

Guideline Part 7: Report Timeliness and Storage of Exam Findings

7.1 Images should ideally be reviewed within 48 hours of the examination, and it is recommended that imaging facilities consider sending a summary report to each patient within 7 days of the thermographic examination as part of their protocol. However, it is crucial to acknowledge the importance of timely medical communication, especially in telemedicine, where remote patient care is a priority. Considering the potential urgency of certain abnormalities, it might be advisable for interpreting thermologists to notify patients and referring practitioners as soon as possible if abnormalities with urgent findings are identified. This approach aligns with the goal of providing prompt and effective healthcare services, minimizing patient anxiety, and facilitating swift responses to urgent medical situations.

7.2 Images should be taken and saved in radiometric file format at the highest resolution possible to help assure the best possible focus and adequate vascular pattern analysis. All radiometric images should have the capability to be converted to standard digital image formats to assist in record keeping and interpretative report preparation.

DICOM (Digital Imaging and Communications in Medicine) imaging formats are preferred because they are commonly employed in standard universal medical imaging and storage procedures. This alignment with the technological infrastructure of modern healthcare systems is crucial. The integration of DICOM plays a pivotal role within Hospital Information Systems (HIS) and Radiology Information Systems (RIS), forming a standardized framework for the management and exchange of medical images.

DICOM offers a comprehensive solution by encapsulating not only the visual representation of thermal images but also essential metadata, ensuring the seamless identification of patients, imaging protocols, and pertinent clinical data. This standardized format facilitates interoperability, allowing for the integration of thermal images into the broader medical imaging landscape.

Furthermore, adherence to the principles of the Health Insurance Portability and Accountability Act (HIPAA) is of paramount importance in the healthcare ecosystem. The utilization of DICOM aligns with HIPAA's mandate to safeguard patient information, providing a secure and standardized method for transmitting, storing, and retrieving medical images while upholding strict privacy and security standards.

By leveraging DICOM, healthcare providers can ensure compliance with HIPAA regulations, as the format inherently supports encryption, access controls, and audit trails. This not only enhances the security and confidentiality of thermal images but also promotes the seamless flow of information across different healthcare systems.

While DICOM export is preferred, other formats such as JPEG, TIF, or PNG image formats may also be utilized. “Lossless” image formats such as TIF or PNG are generally preferred over JPEG because they better preserve image findings with less distortion (it is noted, however, that some manufacturers preserve radiometric data in their JPEG export format). Irrespective of the format used, images should be time and date stamped and include demographics within the image in a location that does not interfere with image analysis.

7.3 The imaging clinic should adhere to all established federal and state regulations. Archiving of image data and the analysis/report are to be maintained for no less than seven years.

Guideline Part 8: Continuing Professional Education

Interpreting Thermologist certification: the person performing the analysis/reporting of a Medical Thermology study should be a member in good standing of a nationally recognized medical thermographic organization that offers literature, training and support specific to medical thermology and should maintain appropriate certification from that organization.

Technologist certification is considered the standard of practice for infrared and SSR technology. It indicates an individual’s competence to perform neuro-musculoskeletal infrared studies at the entry level.

Supervising physicians should keep current on advances in diagnosis and treatment of neuro-musculoskeletal disease, especially thermal imaging equipment, imaging techniques, new interpretation and reporting software, and published studies on thermal imaging. They should at a minimum be a member in good standing of a nationally recognized medical thermographic organization that offers literature, training including, but not necessarily limited to, Medical Neuro-musculoskeletal Thermology.

All Thermologists are expected to keep current with:

8.1 Advances in diagnosis and treatment of pain syndromes with and without sympathetic nervous system dysfunction (vasomotor instability).

8.2 Changes in infrared and SSR examination protocols or published laboratory diagnostic criteria.

8.3 Advances in infrared and SSR technology used for the extremity and spine examinations.

8.4 Advances in other technology used for neuro-musculoskeletal infrared and SSR examination.

Guideline Part 9: Emerging Technologies

9.1 Technology is constantly being introduced that can challenge existing guidelines or that does not necessarily conform to currently accepted practices. These technologies can span the entire spectrum of sophistication and hence require different adaptive responses. On one end of the spectrum, there are innovations based upon accepted medical scientific methodology that have gained regulatory acceptance, and on the other end, there are technologies that are intended for personal use only or that have applications in non-medical fields but have not been accepted as suitable for medical practice.

9.2 General industrial or personal use thermal imagers that do not meet the specification guidelines contained herein are not intended for use in Medical Thermology. "Add-on" thermal imagers that plug into a cellular phone are, at present, not adequate for medical thermology imaging.

9.3 Technologies not otherwise covered in these Guidelines that employ methodologies, hardware, or protocols that have gained Federal Regulatory approval for Medical Thermology may become available over time. In cases where these technologies are employed, the body of the report should document which deviations occurred and why, and other components of the Guideline should still be followed.

References

1) Friedman MS. The Use Of Thermology In Sympathetically Maintained Pain. Iowa Orthopaedic Journal 1994;14:141-7.

2) Pecina M M, Bojanic I. Overuse Injuries Of The Musculoskeletal System, New York: CRC Press, 1993. pgs 234,60,17,19,21,289.

3) Aronoff GM, Editor. Evaluation and Treatment Of Chronic Pain. Baltimore, Williams & Wilkins, 1998.

4)Merskey H, Bogduk N, Editors. Classification Of Chronic Pain: Descriptions Of Chronic Pain Syndromes And Definitions Of Pain Terms. Second Edition. Seattle, IASP Press, 1994.

5) Gulevich SJ, Conwell TD, Lane J, et al. Stress Infrared Telethermology is useful in the diagnosis of complex regional pain syndrome, type 1 (formerly reflex sympathetic dystrophy). Clinical Journal of Pain 1997;13:50-59

6) Gonzalez, E, Editor. The Nonsurgical Management of Acute Low Back Pain. Physiologic Assessment: Thermology, pgs 87-90, New York: Demos Vermande, 1997

7) Verdugo RJ, Ochoa JL: Use And Misuse Of Conventional Electrodiagnosis, Quantitative Sensory Testing, Thermology, And Nerve Blocks In the Evaluation Of Painful Neuropathic Syndromes. Muscle & Nerve 1993;16:1056-1062.

8) Schwartz R. Electric Sympathetic Block: Current Theoretical Concepts And Clinical Results. Journal Of Back And Musculoskeletal Rehabilitation 1998; 10:31-46.

9) Pecina M, Krmpotic-Nemanic J, Markiewitz A. Tunnel Syndromes: Peripheral Nerve Compression Syndromes. New York: CRC Press, 2001. pgs 10,23,67,69,143,213,226,261.

10) Guide To The Evaluation Of Permanent Impairment, 6th Edition. Chicago: The American Medical Association, 2008.

11) Wallace D, Clauw, D, Editors. Fibromyalgia and other Central Pain Syndromes. NY, Williams & Wilkins, 2005

12) Stein J.H. (Ed), Internal Medicine, 4th Ed, Edmeads, J., Headache and Facial Pain, Mosby, 1994. St. Louis, Chapter 113.

13) Tauchmannova, H., Gabriel, J,. Cibak, M. Thermographic Findings in Different Sports, Their Value in the Prevention of Soft Tissue Injuries, Themol. Osterr. 1993, 3, 91-95.

14) Ammer,K., Ring, E.F.J. Eds. The Thermal Image in Medicine and Biology. Thermal Evaluation of Tennis Elbow. Uhlen Verlag, Wein, 1995, 214.

15) Ho-Yeol Zhang, Yong-Eun Cho, Young-Soo Kim. Thermographic Findings of Spinal Cord Tumor. Pan Am J Med Thermol 1(1): 55-67, 2014. 16) Kruma E, Frettloh J, et al: Long-term skin temperature measurements – A practical diagnostic tool in complex regional pain syndrome. Pain 2008:8-22

17) Raj PP, Editor. Pain Medicine A Comprehensive Review. St. Louis: Mosby-Year Book Inc, 2003.

18) Orlandini G, Thermographic Changes After Surgery For Pain Syndromes. Thermology International 2002;12:43-50.

19) Sympathetic Skin Response Studies; Harvard Medical School's online medical text, July, 2007; www.wikidoc.org
20) Policy Statement on Infrared Imaging. Arlington, American Chiropractic Association, 1999.

21) Clark, R.P. and De Calcina-Goff, M. Guidelines for Standardization in Medical Thermology Draft International Standard Proposals. Thermol. Osteee., 7, 47, 1997.

22) Togawa. T. and Saito, H. Non-Contact imaging of thermal properties of the skin. Physiol. Meas., 15,291, 1994.

23) Wilson PR, Stanton-Hicks M, Harden NR. CRPS: Current Diagnosis and Therapy. Seattle, IASP Press, 2005.

24) Lee M, Cohen, J. Editors. Rehabilitation Medicine and Thermology. New York University Medical Center. Wilsonville, Impress Publications, 2008

25) Hooshmand H, Hashmi M, Phillips EM. Infrared Thermal Imaging As A Tool In Pain Management-Part I. Thermology International 2001;11:53-65.

26) Hooshmand H, Hashmi M, Phillips EM. Infrared Thermal Imaging As A Tool In Pain Management-Part II. Thermology International 2001;11:117-30.

27) Wasner G, Schattschneider J, Baron R: Skin Temperature Side Differences -A Diagnostic Tool For CRPS. Pain 2002;98:19-26.

28) Uematsu S, Edwin DH, Jankel WR, et al: Quantification Of Thermal Assymetry: I. Normal Values And Reproducibility. J Neurosurg 69: 552, 1988.

29) Koor I. The Collected Papers of Irvin M. Koor. Barbara Peterson, Editor. American Acadmy of Osteopathy, 1979.

30) Schwartz R. Resolving Complex Pain, Morrisville. LuLu Press, 2006

31) 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.

32) Schwartz R. Stem Cells for the Treatment of Complex Regional Pain Syndrome (CRPS)/Reflex Sympathetic Dystrophy (RSD): a Case Study. Pan American Journal of Medical Thermology 2015, 1(2): 89-92.

33) Overview Of Digital Infrared Thermal Imaging. Colorado Springs: American College Of Clinical Thermology. 2004.

34) Ammer, K. et al. Rationale for standardized capture and analysis of infrared thermal images. Proceedings Part II, EMBEC'02 2. European Medical & Biological Engineering Conference. Hutten, H. and Krosel, P. eds, IFMBE, Graz, 2002, p. 1608.

35) Ring, E.F.J. et al. Errors and artifacts in thermal imaging. Proceedings Part II, EMBEC'02 2, European Medical & Biological Engineering Conference. Hutten, H. and Krosel, P. eds, IFMBE, Graz, 2002, p. 1620.

36) Ammer K, Ring F. Standard Procedures for Infrared Imaging in Medicine. N.A Diakides (Ed) Infrared Imaging Section, Biomedical Engineering Handbook (3rd. Edition). London. CRC Press, 2006.

37) Brioschi M, Et al. Medical Thermology Textbook: Principles and Applications. Editora e Livrarai Andreoli 2010, Sao Paulo, Brazil

38) Balbinot,L, Et al. Plantar thermology is useful n the early diagnosis of diabetic neuropathy. Clinics (Sao Paulo) 2012, 67(12):1419-25

39) Gabrhel JL. The Relationship Between Thermographic and Musculoskeletal Ultrasound Findings in the "Painful Knee Syndrome". Thermology International 2012, 12(2):43-52.

40) Nahm, F, Et al. Infrared Thermology In Pain Medicine, Korean J Pain, 2013 Jul; 26(3): 219–222.

41) Birklein F, Schlereth T. Complex regional pain syndrome-significant progress in understanding. Pain 2015, 156;S94-S103.

42) Schwartz, R, Et al. Cold stress testing in medical Thermal Imaging. Pan American Journal of Medical Thermology. 2016,3(1):25-31

43) Bioschi M, Et al. Automated Computer Diagnosis of IR Medical Imaging. Flir Technical Series, Application Note for Research and Science, August, 2011.

44) Neves, E, Et al. Thermology in Neurologic Practice. The Open Neurology Journal. 2015, 9, 24-27.

45) Onik G, Kasprzyk T, Knapik K, et al. Myofascial Trigger Points Therapy Modifies Thermal Map of Gluteal Region. Biomed Res Int. 2020;2020:4328253. Published 2020 Feb 20. doi:10.1155/2020/4328253

46) Benito-de-Pedro M, Becerro-de-Bengoa-Vallejo R, Losa-Iglesias ME, et al. Effectiveness between Dry Needling and Ischemic Compression in the Triceps Surae Latent Myofascial Trigger Points of Triathletes on Pressure Pain Threshold and Thermography: A Single Blinded Randomized Clinical Trial. J Clin Med. 2019;8(10):1632. Published 2019 Oct 5. doi:10.3390/jcm8101632

47) Faiz Md Shakhih M, et al. Muscle activation and fatigue monitoring with thermology. Med Biol Eng Computing. 2021 Aug;59(7-8):1447-1459. Epub 2021 Jun 22. https://pubmed.ncbi.nlm.nih.gov/34156602/ doi: 10.1007/s11517-021-02387-x.

48) Park D, et al. Application of digital infrared thermography for carpal tunnel syndrome evaluation. Sci Rep (scientific Reports). 2021 Nov 9;11(1):21963. doi: 10.1038/s41598-021-01381-5.

49) Zhang S, et al. Infrared thermography for assessment of thoracic paravertebral block: a prospective observational study. BMC Anesthesiol (bio med central). 2021 Jun 11;21(1):168. doi: 10.1186/s12871-021-01389-4.

50) Schwartz R, Terzella M, O'Young B. Medicine through the lens of the autonomic nervous system: A thermographic approach. PMR Secrets, 4th Edition, Chapter E90, Mosby (Elsevier) Press. 2023

51) Neves E, et al. Correlation between skin temperature and heart rate during exercise and recovery, and the influence of body position in these variables in untrained women. Infrared Physics & Technology 75 (2016) 70–76

52) Neves E, et al. Different Responses of the Skin Temperature to Physical Exercise: Systematic Review. 37th Annual International Congress of the IEEE EMBS, Milan Italy, August 25-29, 2015.

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