VARIA

Local cryotherapy and thermovision assessment of cooling effects during cryostimualtion procedure

Edmund Kiełbasa
SPECIALIST IN REHABILITATION AND REVALIDATION OF INDIVIDUALS WITH INTELLECTUAL AND MULTIPLE DISABILITIES, WARSAW, POLAND

ABSTRACT
In physical medicine, cryotherapy refers to the brief exposure of a selected body region (local cryotherapy) or the whole body to extremely low temperatures. In practice, this involves local cryotherapy devices and various types of cryogenic chambers. Local cryotherapy remains an important adjunct in treatment and rehabilitation, while integration of the blower nozzle with a thermovision camera expands procedural monitoring capabilities. Thermovision enables assessment of temperature distribution before, during, and after cooling, supporting both patient safety and improved adaptation of procedural parameters to the treated area.

KEY WORDS: cryotherapy, cryostimulation, thermovision

Wiad Lek. 2026;79(3):671-673. doi: 10.36740/WLek/221052 DOI

INTRODUCTION

In physical medicine, cryotherapy refers to the brief exposure of a selected body region (local cryotherapy) or the whole body to extremely low temperatures. In practice, this involves local cryotherapy devices and various types of cryogenic chambers. The primary aim is to elicit reflexive physiological responses to cold and to influence metabolic processes, thereby supporting core treatment and rehabilitation [1].

EVOLUTION OF LOCAL CRYOTHERAPY DEVICES

Devices dedicated to local cryotherapy, originally developed several decades ago, have fundamentally retained their capacity to achieve low temperatures. Over the years, nomenclature, branding, and design have evolved. Manufacturers have focused on efficiency, such as reducing gas consumption during procedures (e.g., by introducing air pumps to gas tanks instead of standard heaters). Improvements have also been made in the insulation of cryogenic tubing to minimise energy losses, while larger screens and touch controllers have enhanced device operation.

REVIEW AND DISCUSSION

BLOWER NOZZLE WITH INTEGRATED THERMOVISION CAMERA

Recently, a solution has been developed enabling the use of a blower nozzle with an integrated infrared thermovision camera for assessing the effectiveness of local cryotherapy procedures. This system is designed for cryotherapy devices powered by nitrogen vapour and equipped with such a nozzle. The concept is based on principles that both enhance procedural safety and facilitate highly effective cooling.

The most crucial parameter is body temperature, which reflects the energetic state of the organism. Elevated temperature is associated with increased metabolism, such as inflammation and processes leading to increased blood flow in skin vessels. Conversely, decreased temperature is observed with impaired blood flow and in degenerative or necrotic tissue conditions. Therefore, thermograms obtained prior to cryotherapy show hyperthermic zones in areas of inflammation and hypothermic zones in areas of degeneration [2-8].

Thermographic examination allows the detection of a skin temperature difference of 0.25±0.2°C over the examined region compared to the corresponding area on the opposite side of the body or surrounding healthy tissue, which may indicate pathological changes. As skin temperature varies according to anatomical structure, gender, and age, accurate thermogram interpretation requires the use of thermal maps of the human body. Cooling during local cryotherapy highlights differences in surface skin temperature distribution. Post-cooling thermal imaging may reveal details not visible on pre-procedure thermograms, offering more precise information regarding cooling heterogeneity and the localization of pathological changes. Consequently, a thermogram taken immediately after the procedure enables assessment of the cooling effect and verification of proper procedural execution. The nozzle with an integrated camera allows for more uniform cooling of the treated area; if post-procedure thermograms reveal inadequately cooled spots, this guides the therapist to increase airflow intensity in subsequent sessions to optimize therapeutic outcomes [9-14].During procedures using nitrogen vapor, current guidelines recommend: a nozzle outlet distance from the skin of no less than 15 cm; procedure duration for a single body region ranging from 30 seconds to 3 minutes; and therapeutic mechanisms and safety principles are taken into account. The expected outcome is a reduction in mean temperature of the treated region by between 5°C and 15°C, which can be confirmed by comparing thermograms taken before and immediately after the procedure [7,13-18,24]. Due to the substantial number of factors influencing surface body temperature and the course of temperature measurement, reliable interpretation of thermograms before and after treatment is only possible with proper patient preparation and strict adherence to thermographic examination protocols, in accordance with current standards [15-22].

RESEARCH AND DEVELOPMENT PROJECT (POIR.01.01.01-00-1192/17)

The blower nozzle with thermovision camera indicating tissue surface temperature (measured before, during, and after the procedure) was constructed and evaluated according to the objectives of project POIR.01.01.01-00-1192/17: "Innovative nozzle for local cryotherapy with integrated infrared imaging and efficacy assessment support system". The following outcomes were achieved.

Industrial research was conducted, developing a procedural methodology for cryotherapy with IR camera (8-12 μm), taking environmental conditions and medical standards into account. The FLIR Lepton 3.5 sensor (160×120 px) was selected as optimal for nozzle integration. Dedicated control electronics were designed for indicators, RGB diode, and interface. Comparative tests with the FLIR T1020 camera and system calibration were performed, examining environmental impacts on measurements. Methodology followed standards including ISO/TR 80601-2-56:2013, ASTM, IACT, and the Glamorgan protocol.

Development work included creation of an algorithm for thermogram analysis using a measurement grid and colour-coded therapeutic decision signals. The algorithm underwent clinical validation by Prof. Agata Stanek, MD, PhD. Software integrating the IR camera with user interface was developed, and ergonomic nozzles (Solid Edge) were designed and evaluated by physiotherapists. Prototypes were produced using injection moulding, and functional tests were conducted. A total of 100 test procedures were performed (average ergonomic score 9.8/10, software score 4.9/5). Expert validation by Prof. Grzegorz Cieślar, MD, PhD, confirmed the solution's efficacy and safety. Intellectual property protection was sought: patent application in Poland (P.451922) and community design in the EU (MTC-3/2021).

CONCLUSIONS

Local cryotherapy remains an important adjunct in treatment and rehabilitation, while integration of the blower nozzle with a thermovision camera expands procedural monitoring capabilities. Thermovision enables assessment of temperature distribution before, during, and after cooling, supporting both patient safety and improved adaptation of procedural parameters to the treated area.

Thermal imaging increases the objectivity of cooling efficacy assessment and facilitates detection of cooling heterogeneity within the treated region. A thermogram taken immediately after the procedure supports procedural correctness and planning of subsequent sessions by indicating areas requiring adjustment of airflow intensity.

Integration of the IR camera with the nozzle allows real-time insight into the procedure and enhances safety (enabling rapid response to excessively low local temperatures).

Standardisation of measurement and interpretation methodology (environmental conditions, thermal maps, decision thresholds) is crucial for comparability of results and accurate interpretation of thermographic data.

Design work and prototype validation indicate practical feasibility of implementation and highlight the potential for personalised therapy according to local pathological changes.

REFERENCES

1. Łuczak J, Placek K. Practical application of low temperatures in medicine. Acta Balneol. 2025;67(5):333-339. doi: 10.36740/ABAL202505103. DOI
2. Fernandez-Cuevas I, Bouzas Marins JC, Lastras JA, et al. Classification of factors influencing the use of infrared thermography in humans: A review. Infrared Phys Technol, 2015;71: 28-55.
3. Pochaczevsky R. Thermography in posttraumatic pain. Am J Sports Med. 1987;15:243-250. doi: 10.1177/036354658701500309. DOI
4. Łuczak J, Klonowska J, Michalik J. Modification of patients' sensitivity to galvanic Current After the Administered systemic Cryotherapy. Acta Balneol. 2021;2(164):88-92. doi: 10.36740/ABAL202102102. DOI

5. Łuczak J, Michalik J, Dąbrowski R. Comparison of the Effects of systemic Cryotherapy and Kinesiotaping on the Trunk muscles of men practising Targeted physical Training. Acta Balneol. 2022;3:220-223. doi: 10.36740/ABAL202203103. DOI
6. Łuczak J, Michalik J, Gawrońska K et al. Systemic cryotherapy in treatment of autistic children. Acta Balneol. 2022;6:503-506. doi: 10.36740/ABAL202206102. DOI
7. Xiaojuan W, Liping J, Min Z et al. Evaluation of Application Effect of Self- Made Compression Cold Therapy in Postoperative Rehabilitation of Patients with Orthopedic Dyskinesia. Comput Math Methods Med. 2022:8222933. doi:10.1155/2022/8222933. DOI
8. Aggarwal A, Adie S, Harris I et al. Cryotherapy following total knee replacement. Cochrane Database Syst Rev. 2023;9(9):CD007911. doi:10.1002/14651858.CD007911. DOI
9. Bednarski P, Kiwerski J. Evaluation of Local Cryotherapy after Anterior Cruciate Ligament Reconstruction. Critical Review of the Literature. Ortop Traumatol Rehabil 2019;21(5):319-328.
10. Capodaglio P, Alito A, Duguè BM et al. Contraindications to Whole-Body Cryostimulation (WBC). A position paper from the WBC Working Group of the International Institute of Refrigeration and the multidisciplinary expert panel. Front Rehabil Sci. 2025;6:1567402. doi:10.3389/fresc.2025.1567402. DOI
11. Stanek A, Romuk E, Wielkoszyński T et al. The Impact of Whole- Body Cryotherapy on Endothelium Parameters in Patients with Ankylosing Spondylitis. Antioxidants (Basel). 2023;12(2):521. doi:10.3390/antiox12020521. DOI
12. Arfaoui A, Bouzid MA, Pron H, Taiar R, Polidori G. Application of infrared thermography as a diagnostic tool of knee osteoarthritis. J Therm Sci Technol. 2012;7: 227-235.
13. Ismail E, Capo A, Amerio P, Merla A. Functional-thermoregulatory model for the differential diagnosis of psoriatic arthritis. Biomed Eng. 2014;13:162.
14. Vardasca R, Ring EFJ, Plassmann P, Jones CD. Thermal symmetry of the upper and lower extremities in healthy subjects. Thermol Int. 2012;22:53-60.
15. Bleakley CM, Hopkins JT. Is it possible to achieve optimal levels of tissue cooling in cryotherapy? Phys Ther Rev. 2010;15:344-350.
16. Cholewka A, Stanek A, Sieroń A, Drzazga Z. Thermography study of skin response due to whole body cryotherapy. Skin Res Technolol. 2012;18(2):180-187. doi: 10.1111/j.1600-0846.2011.00550.x. DOI
17. Bauer J, Dereń E. Standaryzacja badań termograficznych w medycynie i fizykoterapii [Standardization of thermographic examinations in medicine and physical therapy]. Acta Bioeng Biomech/Inż Biomed. 2014;20(1):11-20. (Polish)
18. Sieroń A, Cieślar G, editors: Krioterapia - leczenie zimnem [Cryotherapy - cold treatment]. α-medica press, Bielsko-Biała 2007. (Polish)
19. Costello JT, McInerney CD, Bleakley CM, Selfe J, Donnelly AE. The use of thermal imaging in assessing skin temperature following cryotherapy: A review. J Thermal Biol. 2012:37(2):103-110.
20. Oosterveld FG, Rasker JJ, Jacobs JW, Overmars HJ Therm Biol. The effect of local heat and cold therapy on the intraarticular and skin surface temperature of the knee. Arthritis Rheum. 1992;35:146-151.
21. Vardasca R, Magalhaes C, Silva P, Mendes JG. Are the IR cameras FLIRONE suitable for clinical applications? Thermol Int. 2019;29:95-102.
22. Amalu W, Block, Amalu W, Block J, Chaudhry A, et al. International Academy of Clinical Thermology Quality Assurance Guidelines. Standards and Protocols in Clinical Thermographic Imaging. International Academy of Clinical Thermology, Foster City. 2015:1-35.32.

CONFLICT OF INTEREST

The Author declare no conflict of interest

CORRESPONDING AUTHOR

Edmund Kiełbasa
e-mail:edmund.kielbasa@proton.me

CONTRIBUTIONSHIP

Edmund Kiełbasa: A B D E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 15.02.2026
ACCEPTED: 16.03.2026