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Low-level laser therapy for the treatment of phlebitis in children

Terapia láser de baja intensidad en el tratamiento de la flebitis en niños

Laser de baixa intensidade no tratamento da flebite em crianças

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Abstract

The aims were to describe the applicability of low-level laser therapy (LLLT) in children who developed phlebitis during intravenous therapy; to standardize LLLT as a nursing care method for treating phlebitis in a pediatric hospital; and to develop a protocol for low-level light therapy in children with phlebitis. This was an experimental, exploratory, descriptive, longitudinal study. Forty-eight children (100%) participated in the study between January 2023 and October 2024. Most children presented with moderate to severe phlebitis (grades 2, 3, and 4) before the intervention. Complete resolution of phlebitis (grade 0) was observed in a large portion of the sample after one or two photobiomodulation applications. The most frequent sites of phlebitis were the antecubital fossa and the dorsum of the hand. It is concluded that photobiomodulation proved to be an effective, safe, and rapid-response therapeutic strategy for treating phlebitis in children, demonstrating potential for incorporation into pediatric nursing care protocols.

Descriptors: Photobiomodulation; Low-Level Light Therapy; Pediatrics; Phlebitis; Nursing Care.

Resumén

El objetivo fue describir la aplicabilidad de la terapia láser de baja intensidad (LLLT) en niños que desarrollaron flebitis durante la terapia intravenosa; estandarizar la LLLT como método de cuidados de enfermería en el tratamiento de la flebitis en un hospital pediátrico; y desarrollar un protocolo para la terapia láser de baja intensidad en niños con flebitis. Este es un estudio experimental, exploratorio, descriptivo y longitudinal. Cuarenta y ocho niños (100%) participaron en el estudio entre enero de 2023 y octubre de 2024. La mayoría de los niños presentaban flebitis de moderada a grave (grados 2, 3 y 4) antes de la intervención. Se observó la resolución completa de la flebitis (grado 0) en gran parte de la muestra después de una o dos aplicaciones de fotobiomodulación. Las zonas más frecuentes de flebitis fueron la fosa cubital y el dorso de la mano. Se concluye que la fotobiomodulación ha demostrado ser una estrategia terapéutica eficaz, segura y de acción rápida para el tratamiento de la flebitis en niños, lo que evidencia su potencial para su incorporación en los protocolos de cuidados de enfermería pediátrica.

Descriptores: Fotobiomodulación; Terapia con Luz de Baja Intensidad; Pediatría; Flebitis; Cuidados de Enfermería.

Resumo

Objetivou-se descrever a aplicabilidade do laser de baixa intensidade (LBI) em crianças que desenvolveram flebite durante a terapia intravenosa; padronizar o LBI como método de cuidado de enfermagem no tratamento da flebite no hospital pediátrico; e desenvolver um protocolo para terapia com luz de baixa intensidade em crianças com flebite. Trata-se de uma pesquisa experimental, exploratória, descritiva, longitudinal. Participaram da pesquisa 48 crianças (100%) entre jan/2023 e out/2024. A maioria das crianças apresentava flebite de grau moderado a grave (graus 2, 3, 4) antes da intervenção. Observou-se resolução completa da flebite (grau 0) em grande parte da amostra após uma ou duas aplicações de fotobiomodulação. Os locais mais frequentes de flebite foram a fossa cubital e o dorso da mão. Conclui-se que a fotobiomodulação demonstrou ser uma estratégia terapêutica eficaz, segura e de rápida resposta no tratamento da flebite em crianças, evidenciando potencial para sua incorporação aos protocolos assistenciais de enfermagem pediátrica.

Descritores: Fotobiomodulação; Terapia com Luz de Baixa Intensidade; Pediatria; Flebite; Cuidados de Enfermagem.

Introduction

Every day, countless cases of phlebitis due to the use of intravenous therapy (IVT) are diagnosed in hospitals around the world. Intravenous therapy (IVT) represents approximately 80% to 90% of all tasks performed by nursing team professionals[1,2].

Peripheral IVT requires careful assessment of the venous network to choose the best puncture site and an effective technique, allowing the entry of a technological device directly into the bloodstream. Nursing professionals need to acquire technical and scientific competence regarding the peripheral venipuncture procedure to provide nursing care free of harm and with quality[3].

In the study hospital, the institutional protocol related to the Vascular Access and Infusion Therapy Team (TAVTI) reinforces the care to be provided in IVT to ensure safe nursing care, without risk or harm to the pediatric patient caused by negligence, malpractice, or imprudence in accordance with Art. No. 12 of the Code of Ethics for Nursing Professionals[4]. The TAVTI nurse is a reference for regularly evaluating intravascular devices, including the need for installation and permanence of the most appropriate device for infusion therapy according to the child's needs, ensuring a safe hospitalization with quality of care. Another important dato relates to the number of phlebitis cases reported at the Cândido Fontoura Children's Hospital (HICF). Between January and April 2021, 2,628 punctures were performed for intravenous therapy among Peripheral Venous Access (PVA), Peripherally Inserted Central Catheter (PICC), and Central Venous Catheter (CVC). The latter was inserted by physicians of the institution and monitored by TAVTI. Of this amount, of the Adverse Events (AE) related to phlebitis, in this period 21 (0.79%) were reported in PVA and 11 (0.41%) in PICC; there were no phlebitis cases in CVC[5-7].

Currently, TAVTI evaluates and monitors phlebitis based on studies grounded in scientific evidence. The Maddox scale adapted to the service was adopted, and interventions were standardized, namely:

Chart 1. Maddox Scale. São Paulo, SP, Brazil, 2026

Grade 0	Absence of reaction (no signs of inflammation)
Grade 1	Mild pain and mild erythema around the insertion site
Grade 2	Pain, erythema, edema (around the insertion site)
Grade 3	Pain, erythema, induration along the catheter path
Grade 4	Pain, erythema, induration along the catheter path, and palpable venous cord
Grade 5	Pain, erythema, induration along the catheter path, palpable venous cord, and pyrexia (local heat). Purulent drainage. Apparent venous thrombosis

Source: Adapted from Maddox et al.[8], Jackson[9], INS[10], Enes SMS et al.[11].

The nursing interventions for the management of phlebitis include monitoring of clinical signs every six hours, with immediate removal of the peripheral catheter upon identifying any grade of the condition; if the condition presents a grade higher than one, it is recommended, in the initial phase, the alternating application of cold and warm compresses (up to 38 °C) to the affected site, for intervals of fifteen minutes over thirty minutes, to relieve pain, promote vasodilation, and reduce edema, followed by the application of compresses moistened with chamomile infusion (also at up to 38 °C) three times a day (morning, afternoon, and evening), for twenty minutes, with changes every five minutes, maintaining this care for 24 to 48 hours, during which the affected limb should remain elevated; if symptoms persist, the central catheter should be removed between 24 and 48 hours, and the site should be monitored for another 48 hours after device removal to detect late phlebitis, and in the presence of bacterial or indeterminate-cause phlebitis, catheter removal should be immediate[10].

Phlebitis falls within the group of adverse events, being one of the local complications related to the use of peripheral venous catheters. It consists of the inflammatory process of the inner layer of the veins, with the main clinical manifestations being pain, edema, hyperemia, and heat[12]. Phlebitis involves increased capillary permeability, enabling the extravasation of proteins and fluids into the interstitial space. In this case, the traumatized tissue becomes chemically or physically inflamed. In the immune system, there is an accumulation of leukocytes at the site of inflammation, consequently presenting a larger or smaller area of erythema and sensitivity, according to the severity of the phlebitis grade, and may occur in peripheral catheters and peripherally inserted central catheters (PICC)[10,13]. The consequence of phlebitis is the persistence of pain and local edema for days and even weeks, potentially prolonging hospitalization[14].

International research discusses the severity of this problem, investigating the incidence of phlebitis in health services, such as an observational study conducted in a hospital in Peru, which identified an incidence of 53%[15]. Another international study, conducted in Colombia, revealed an incidence of approximately 10%[16]. Nationally, an integrative literature review study points to an incidence variation of phlebitis between 3% and 59%[17]. Nursing professionals are primarily responsible for the care of selection, insertion, and maintenance of peripheral venous catheters[18].

In Brazil, mortality related to bloodstream infection (BSI) acquired through PICC insertion varies between 6.5% and 75%; this fact is related to: inadequate antibiotic therapy, dissemination of device use, greater participant survival, sterile barrier breach, inadequate device maintenance, and, rarely, due to contaminated infusion[19].

Laser, an acronym for Light Amplification by Stimulated Emission of Radiation, penetrates the skin and transfers photons to cells, more precisely to the electron chain of the mitochondrial membrane, raising the proton rate and, consequently, ATP levels. Therefore, the chemical and electrochemical changes that occur in mitochondrial membranes increase ATP synthesis and, consequently,

increase cellular activity, favoring the wound healing process[20]. In skin lesions, low-power lasers are the most used, as they generate a low-energy current in various tissues in the wound, and their healing, analgesic, and anti-inflammatory effects are observed[21,22].

In the 1960s and 1970s, significant effects on the healing process were observed; thus, it was possible for other studies to prove the use of low-intensity therapeutic laser in wounds, describing its benefits. Thus, therapeutic laser has been considered a valuable resource in the treatment of lesions due to its healing capacity[21,23]. Therefore, LLLT should be part of nursing care regarding the intervention and therapy of acute and chronic wounds[24].

Low-level laser therapy (LLLT) or therapeutic laser, with power up to 500 mW, range and wavelength between 600 nm and 1000 nm, that is, visible light (red) and invisible, near-infrared[25].

The main parameters for the use of laser therapy focus on energy measured in joules (J), which means the amount of radiation that will be applied to the lesion, and on the wavelength, measured in nanometers (nm), indicating penetration potential. These standardizations vary according to the device brand, type of laser, and its applicator pen[26]. LLLT plays an important role in pain relief, and its application is considered, in most cases, painless[15,27].

Studies report positive results in the lesion healing period with the use of LLLT in pressure injuries (PI) in children. When used correctly by a qualified professional, regardless of the type of lesion, it favors evolution during treatment. The findings show that this therapy contributes to pain reduction, increases local vascularization, and accelerates the tissue healing process, favoring a positive evolution during the treatment of lesions[28,29].

Phototherapy with LLLT has been used for the treatment of traumatic ulcers, generating acceleration in tissue repair, reduction of edema and pain, with effective anti-inflammatory action, stimulating fibroblast proliferation, tissue regeneration, and neovascularization. With the application of infrared wave (808 nm, 100 mW), 4 joules per point (29 seconds) intrabuccal at 5 points around the lesion, every 24 hours in two sessions, and after 9 days, the same protocol for control. The results show total repair of the lesion and significant reduction of pain. LLLT is an analgesic, reparative therapeutic alternative without side effects for the treatment of this modality in a child[30]. The application of light to a biological system is capable of inducing a photochemical process, mainly in mitochondria, with stimulation of energy production in the form of adenosine triphosphate (ATP), increasing cellular metabolism and producing effects such as analgesia, tissue regeneration, wound healing, reduction of muscle fatigue, neural repair, among others[31-36].

It is imperative to add that light therapy by visible and infrared light is judged as being of insignificant risk by the U.S. Food and Drug Administration (FDA) and has been approved for use in humans. LLLT (includes red and infrared laser) is collimated, coherent, and monochromatic. Red laser mode: 22% increase in ATP production; increase in collagen fibers; regeneration of blood vessels; increase in nerve growth speed; increase in reepithelialization; stimulation of regeneration in various types of wounds; treatment of soft tissue lesions; pain relief; in addition to greater anti-inflammatory action; stimulation of soft tissue healing; stimulation of burn healing; decreases pain to a greater proportion; while in infrared laser mode: analgesic and anti-inflammatory action; biostimulation in the healing of deep tissues (bone, cartilage, and nervous tissue)[29,30].

The nurse may perform low-level laser therapy (LLLT) after certification of specialization or a course provided by a regulated teaching institution, as this practice requires the professional to have knowledge of physics, biophotonics, laser interaction with biological tissue, dosimetry, in addition to deepening in physiology and rehabilitation. LLLT is considered a procedure exclusive to nurses within the nursing team, using the Systematization of Assistance with a multiprofessional approach[37].

The opinion of the COFEN technical chamber, No. 13/2018, concludes that there are no obstacles to the use of laser therapy, with the nurse's autonomy, after being properly trained through a course, as this practice requires the professional to know physics, biophotonics, laser and biological tissue interaction, dosimetry, in addition to deepening in physiology and rehabilitation[38].

Thus, a critical reflection on the part of this professional category regarding its role in the care of patients using peripheral intravenous devices becomes necessary, since phlebitis can be an initial pathway to more complex conditions, such as thrombophlebitis and sepsis. Considering the complexity and magnitude of adverse events for the health system, scholars dedicate themselves to expanding the production of knowledge regarding the characteristics of this condition[10,13]. According to Law No. 7,498, of June 25, 1986, which provides for the practice of nursing and other measures, it is incumbent upon the nurse to organize and direct nursing services in relation to their technical and auxiliary activities, preventing and controlling hospital infections and any harm resulting from nursing care to the clientele[39].

The frequent search for interventions that contribute to monitoring and, consequently, to the healing process, applying a non-invasive technique, without restrictions and of rapid execution, allowing treatment to be initiated still in the initial stage, is, without a doubt, an innovation in nursing care. Aware of our daily practice, the implementation of nursing care grounded in scientific evidence becomes fundamental, in order to promote qualified, excellent, and safe assistance. This concern gains breadth given the awareness that interventions in phlebitis occur in different ways and are sometimes not effective.

Therefore, we seek to answer about the applicability of low-level laser therapy (LLLT) in children who develop phlebitis during therapy with low-intensity light. A complementary and high-technology method to assist in the monitoring of phlebitis intervention, as there is no existing and validated protocol for this therapy in children. This research is justified by the scarcity of studies addressing its efficacy, being used as an evaluative method, and highlights

the importance of low-intensity light therapy as a resource based on scientific evidence.

Our objectives are to describe the applicability of low-level laser therapy (LLLT) in children who developed phlebitis during intravenous therapy, to standardize low-level laser therapy (LLLT) as a nursing care method during the treatment of phlebitis in the pediatric hospital, and to develop a protocol for low-intensity light therapy in children with phlebitis.

Methodology

This is an experimental, exploratory, descriptive, longitudinal study[40]. It was conducted in a children's hospital in São Paulo from January 2023 to October 2024.

The study included children older than 2 years, hospitalized in the study hospital, who presented phlebitis during intravenous therapy. The equipment used was Laser Recover, which enabled the use of low-level laser therapy (LLLT) and has red and infrared λ modes, registered by ANVISA.

A total of 48 children affected by phlebitis during intravenous therapy were attended, with the signing of the Free and Informed Consent Term (TCLE), the Assent Term (TALE), and all ethical precepts of the National Health Council Resolutions No. 466/2012 and 510/2016[41,42].

The application of photobiomodulation was performed by the responsible researcher in children who presented phlebitis (grades 1 to 5). Images were recorded to monitor the evolution of therapy, as well as to complete a specific form for clinical documentation. During the procedure, protective goggles were used for the professional, the patient, and the companion, ensuring the safety of all involved through the blocking of wavelengths emitted by the equipment. The inclusion criteria used were: children who presented phlebitis during intravenous therapy, after notification of the event, whose legal guardians consented to participation in the research by signing the TCLE and who manifested assent, when applicable[42,43]. As exclusion criteria: refusing to participate in the research; not signing the Free and Informed Consent Term (TCLE) and the Free and Informed Assent Term (TALE). Children who present contraindications, as described above; under 2 years of age, patients who have a pacemaker; children who started the intervention according to the institutional protocol.

This research was approved under Opinion No. 5,837,485 by the Research Ethics Committee of the São Paulo State Health Department.

Results

A total of 48 children (100%) participated in the research. Of these, 15 (31.25%) were female, 33 (68.75%) were male, and in 03 (6.25%) cases, this information was not recorded. Regarding age group, 11 (22.91%) children were less than 1 year old; 12 (25.0%) were in the age group of 1 to 5 years; 9 (18.75%) were between 6 and 10 years; and 11 (22.91%) were between 11 and 15 years. Only 3 (6.25%) participants were older than 15 years. There was no record of the age of 2 (4.16%) children. The distribution of participants according to the grade of phlebitis before the photobiomodulation intervention is presented in Graph 1. At the beginning of treatment, 4 (8.5%) children were identified with grade 5 phlebitis, one of whom had an associated thrombus. Grade 4 phlebitis was observed in 12 (25%) children; Grade 3 in 14 (29.20%), Grade 2 in 13 (27%), and Grade 1 in 5 (10.4%) participants.

Graph 1. Distribution according to the number of children and the grade of phlebitis before photobiomodulation. São Paulo, SP, Brazil, 2026

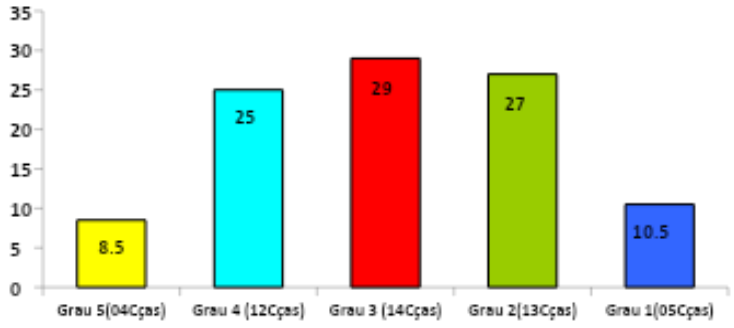

Table 1. Distribution according to the site of phlebitis. São Paulo, SP, Brazil, 2026

Site of phlebitis	Number of Children (n)	Percentage (%)
Right/Left cubital fossa	15	31.2
Right/Left dorsum of the hand	13	27
Right/Left arm	04	8.3
Right/Left axillary region	04	8.3
Right/Left foot	03	6.3
Right/Left forearm	02	4.2
Right/Left temporal region	02	4.2
No information	05	10.5
Total	**48**	**100**

Graph 2. Distribution according to the number of photobiomodulation applications (until healing – phlebitis grade 0). São Paulo, SP, Brazil, 2026

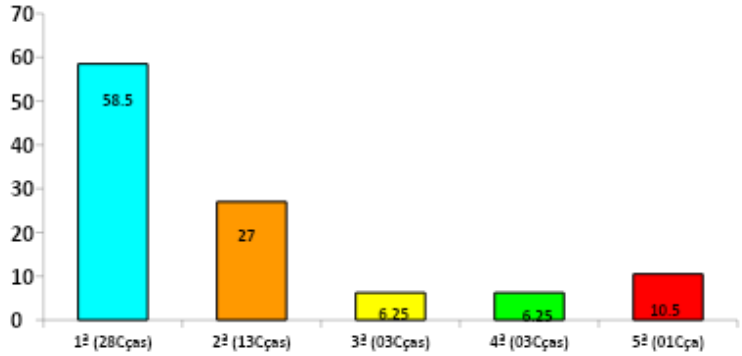

Table 2. Distribution according to the grade of phlebitis, number of applications, and joules applied. São Paulo, SP, Brazil, 2026.

Phlebitis grade	Number of children	Number of applications	N.R. Not reported	IR +R Infrared + red	R Red	Joules
Grade 1	05	01	--	05	03	06
		02				03
		--				02
Grade 2	13	06	01	11	06	06
		02				04
		--				03
						02
						N.R.
Grade 3	14	01	01	13	--	06
		02				04
		03				03
		--				N.R.
Grade 4	12	01	--	10	--	06
		02				04
		03				03
Grade 5	04 (01 thrombus)	01	--	05	--	06
		02				04
		03				08
Total	**48**	**29**	**02**	**44**	**08**	----

Regarding the site of phlebitis, a higher frequency was observed in the right or left cubital fossa, with 15 (31.2%) cases, followed by the dorsum of the hand R/L, with 13 (27%) cases. Four (8.3%) were recorded in the arm region and 4 (8.3%) in the axillary region. Location in the foot was observed in 3 (6.30%) children, while the forearm and temporal region presented 02 (4.20%) cases. In 05 (10.5%) participants, there was no record of the venipuncture site. Regarding the number of photobiomodulation applications necessary for the resolution of phlebitis (grade 0), it was verified that 28 (58.30%) children received only one application. Thirteen (27.1%) required two applications, 3 (6.3%) received three applications, and 3 (6.3%) received four applications. Only 1 (2.1%) child required five applications.

Twenty-eight (58.5%) children received only 01 application; 13 (27%) children received 02 applications; 03 (6.25%) children received 3 applications; and 03 (6.25%) received 4 applications. Only 01 (2.08%) child received 5 photobiomodulation applications. After daily assessment of the phlebitis grade using the Maddox scale adapted to the service, the nurse applied the Joule based on their clinical analysis.

After daily assessment of the phlebitis grade using the Maddox Scale adapted to the service, the nurse researcher qualified in laser defined the dosimetry to be applied based on the individual clinical assessment of each participant.

Discussion

The positive results observed in this study reinforce photobiomodulation as an effective therapeutic intervention in the treatment of phlebitis in pediatrics, especially considering the high proportion of cases classified as moderate and severe grades at the beginning of the intervention. The rapid regression of the inflammatory process, with resolution to grade 0 in most children after one or two applications, is in line with scientific evidence

indicating photobiomodulation as a safe, non-invasive technology with relevant clinical effects in the control of vascular inflammation[44]. In this context, photobiomodulation acts directly on these mechanisms by modulating mitochondrial activity, increasing ATP production, and reducing inflammatory mediators, such as prostaglandins and interleukins.

The predominance of phlebitis located in the cubital fossa and dorsum of the hand observed in this study is compatible with the literature, which identifies these sites as the most used and, simultaneously, the most susceptible to mechanical and inflammatory irritation in pediatrics[45]. The favorable response of photobiomodulation in these regions suggests that the method is effective even in areas subject to greater mobility and mechanical stress, which reinforces its clinical applicability in nursing care.

The reduced number of applications required for the resolution of phlebitis corroborates findings from experimental and clinical studies demonstrating that photobiomodulation accelerates the tissue repair process and angiogenesis, in addition to promoting local analgesia[46]. In children, these effects are particularly relevant, as they contribute to the reduction of pain, discomfort, and the need for additional pharmacological interventions.

The variable dosimetry applied in this study, defined from the clinical assessment, recommends the individualization of the photobiomodulation protocol according to the grade of the lesion and the patient's clinical response[47]. In pediatrics, this approach is even more pertinent, since the biological response to light may vary according to age, skin thickness, and stage of the inflammatory process.

Recent studies specifically focused on the use of photobiomodulation in phlebitis indicate a significant reduction in edema, hyperemia, and pain when compared to conventional measures, such as warm or cold compresses[48-50]. Although randomized clinical trials in the pediatric population are still limited, the available evidence points to consistent benefits and the absence of relevant adverse effects, reinforcing the safety of the method.

Thus, the results presented, combined with the support of current scientific literature, indicate that low-intensity photobiomodulation constitutes a promising and effective therapeutic strategy in the treatment of phlebitis in children, with the potential to be incorporated into nursing care protocols. However, the expansion of controlled, multicenter studies with standardization of application parameters is recommended to strengthen the level of evidence and consolidate specific guidelines for pediatric practice.

Conclusion

Photobiomodulation has proven to be an effective, safe, and rapid-response therapeutic strategy in the treatment of phlebitis in children, demonstrating potential for its incorporation into pediatric nursing care protocols. Although this study presents methodological limitations, the results obtained suggest that photobiomodulation constitutes a promising alternative for the management of this complication, contributing to the improvement of care quality. Studies with larger samples and more robust designs are recommended to confirm these findings and strengthen the evidence on its clinical applicability.

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