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Clinical effects of low-intensity laser in the treatment of pressure injuries: a systematic review

Efeitos clínicos do laser de baixa intensidade no tratamento de lesões por pressão: revisão sistemática

Efectos clínicos del láser de baja intensidad en el tratamiento de las lesiones por presión: revisión sistemática

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ABSTRACT

Objective: to identify evidence of the clinical effectiveness of low-intensity laser in the process of tissue repair in pressure injuries. **Método:** systematic literature review carried out in the BIREME/OPAS Virtual Health Library, PubMed, and Embase databases, in Portuguese, English, and Spanish in July 2022, including publications from 2000 to 2019. **Resultados:** the 658nm laser at 4J/cm2 showed efficacy in healing pressure injuries, but the heterogeneity of the studies and the lack of standardization make comparative analyses difficult. **Conclusões:** studies show that the therapy is effective in healing pressure injuries, especially with the 658 nm wavelength. However, the heterogeneity of the studies and the lack of methodological standardization make comparative analyses and confirmation of the level of evidence difficult, requiring a relevant expansion of investigations, with a significant sample size, bringing more robustness and enabling comparative analyses of the data.
Descriptors: Nursing; Evidence-Based Practice; Pressure Ulcer; Low-Level Light Therapy; Laser Therapy.

RESUMO

Objetivo: identificar as evidências da efetividade clínica do laser de baixa intensidade no processo de reparo tecidual em lesões por pressão. **Método:** revisão sistemática da literatura realizada nas bases de dados Biblioteca Virtual da Saúde da BIREME/OPAS, PubMed e Embase, em português, inglês e espanhol em julho de 2022, incluindo publicações no período de 2000 a 2019. **Resultados:** o laser de 658nm a 4J/cm^2 demonstrou eficácia na cicatrização de lesões por pressão, porém, a heterogeneidade nos estudos e a falta de padronização dificultam análises comparativas. **Conclusões:** os estudos apontam efetividade da terapia na cicatrização de lesão por pressão, pincipalmente com o comprimento de ondas de 658 nm. No entanto, a heterogeneidade nos estudos e a falta de padronização metodológica dificultam análises comparativas e confirmação do grau de evidência, sendo necessária relevante ampliação das investigações, com tamanho amostral significativo, trazendo mais robustez e possibilitando analises comparativas dos dados.
Descritores: Enfermagem; Prática Clínica Baseada em Evidências; Lesão por Pressão; Terapia com Luz de Baixa Intensidade; Terapia a Laser.

RESUMEN

Objetivo: identificar evidencia de efectividad clínica del láser de baja intensidad en el proceso de reparación de tejidos en lesiones por presión. **Método:** revisión sistemática de literatura realizada en las bases de datos de la Biblioteca Virtual en Salud de BIREME/OPAS, PubMed y Embase, en portugués, inglés y español en julio de 2022, incluyendo publicaciones de 2000 a 2019. **Resultados:** el láser de 658 nm 4J/cm2 demostró ser eficaz en la cicatrización de lesiones por presión, sin embargo, la heterogeneidad de los estudios y la falta de estandarización dificultan los análisis comparativos. **Conclusiones:** los estudios indican que la terapia es efectiva para la cicatrización de lesiones por presión, especialmente con longitud de onda de 658 nm. Sin embargo, la heterogeneidad de los estudios y la falta de estandarización metodológica dificultan los análisis comparativos y confirmar el nivel de evidencia; es necesario realizar una importante ampliación de las investigaciones, con un tamaño de muestra significativo, que aporte mayor robustez y permita análisis comparativo de los datos.
Descriptores: Enfermería; Práctica Clínica Basada en la Evidencia; Úlcera por Presión; Terapia por Luz de Baja Intensidad; Terapia por Láser.

INTRODUCTION

Pressure injuries (PI) are serious events in Brazil and worldwide and especially affect hospitalized, elderly, and chronically ill patients. They are characterized by damage to the skin and/or underlying tissue, usually in areas of bony prominences and occasionally related to healthcare devices, resulting from sustained pressure and shear[1,2].

The incidence and prevalence of PI vary globally, with averages ranging from 7% in the USA and 4 to 10% in the UK to alarming levels of 39.81% in Brazil in hospitalized patients. Risk factors include advanced age, immobility, clinical complications, and the use of vasoactive drugs[3,4].

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Research Article
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PI, an adverse event with a 95% chance of prevention, is a serious health problem, occurring mainly in the sacral, calcaneal, and trochanteric regions of the femur. Its treatment is more costly than its prevention[4].

The prevention and treatment of PI continue to be a major global challenge, and it has gained great visibility during the COVID-19 pandemic. This is due not only to the severity and pathophysiological aspects of the disease, leading to prolonged hospitalizations, but also to the severity of the pressure injuries suffered by these patients[5].

The nurse leads the prevention and treatment of Pressure Injuries (PI), planning strategies and personalized care based on evidence, relying on new technologies and treatments, such as the low-intensity laser, which are emerging to improve tissue healing[5-7].

Laser therapy has been highlighted as a safe technique, without side effects or discomfort, promising in accelerating skin healing, increase epithelial and granulation tissue, and reduce secretion, odor, and injury size. Photobiomodulation consists of the application of a technology, such as a low-intensity laser or Led-light emitting diode, which uses artificial light with therapeutic effects, promoting biomodulation, protection, and regeneration of damaged tissues. In nursing, it has been used in the prevention and healing of wounds, through cell stimulation, producing collagen and relieving pain, contributing to a faster and more effective recovery from this condition[6,7]. However, the scientific evidence relating to the clinical effectiveness of the use of laser as a nursing intervention in the treatment of pressure injuries is not clearly established.

In this sense, a mapping of clinical scientific evidence was developed with the aim of systematizing information on the clinical effectiveness of low-intensity laser in the treatment of pressure injuries[8], using a systematic review as its first stage.

This study aimed to identify evidence of the clinical effectiveness of low-intensity laser in the process of tissue repair in pressure injuries.

METHOD

This is a systematic review conducted according to the guidelines established by the International Initiative for Impact Evaluation (3iE) for preparing evidence maps[9,10], but without registering the associated protocol in a public repository.

The literature search strategy adopted the process of structuring the study's research question, based on evidence-based practice, known by the acronym PICOS, where P refers to the Patient, I to the Intervention, C to the Comparison, O to the clinical Outcomes, and S to the Study design[11]. For this study the following were highlighted: P for people with pressure injuries, I for the use of low-power laser, C for conventional pressure injury treatment, and O for pressure injury healing. Thus, the following research question was developed: What is the clinical effectiveness of low-intensity laser in the treatment of pressure injuries?

A search strategy involving selected terms was implemented, using descriptors in English from the Medical Subject Headings (MeSH) of PubMed and in Portuguese and Spanish from the Descriptors in Health Sciences (*Descritores em Ciências da Saúde*, DeCS) of the Virtual Health Library (VHL), applied to the PubMed, VHL and EMBASE databases, with its strategy in each, using controlled vocabularies and the Boolean operators AND, and OR. Specific descriptors were included to select systematic reviews published between 2000 and 2019. The search keys were not shared due to the limitations of the journal space, but are available on request to the authors.

The references obtained were stored in the ENDNOTE® reference management software and selected using the Intelligent Systematic Review software (Rayyan®), with two reviewers evaluating studies by title, abstract, and keywords, with blinding. After opening the blinding process, any discrepancies were resolved through discussion with a third reviewer. The articles were then read in full to finalize the selection. The selected texts were then organized in a tool created by the research team, identifying their title, author, journal, country, year of publication, and language.

The inclusion criteria were studies such as systematic reviews, published in Portuguese, English, and Spanish, which dealt with the use of laser therapy in pressure injuries. Studies that did not answer the guiding question were excluded, as were systematic reviews that did not present a compatible methodology. Figure 1 shows the selection process for the studies.

Research Article
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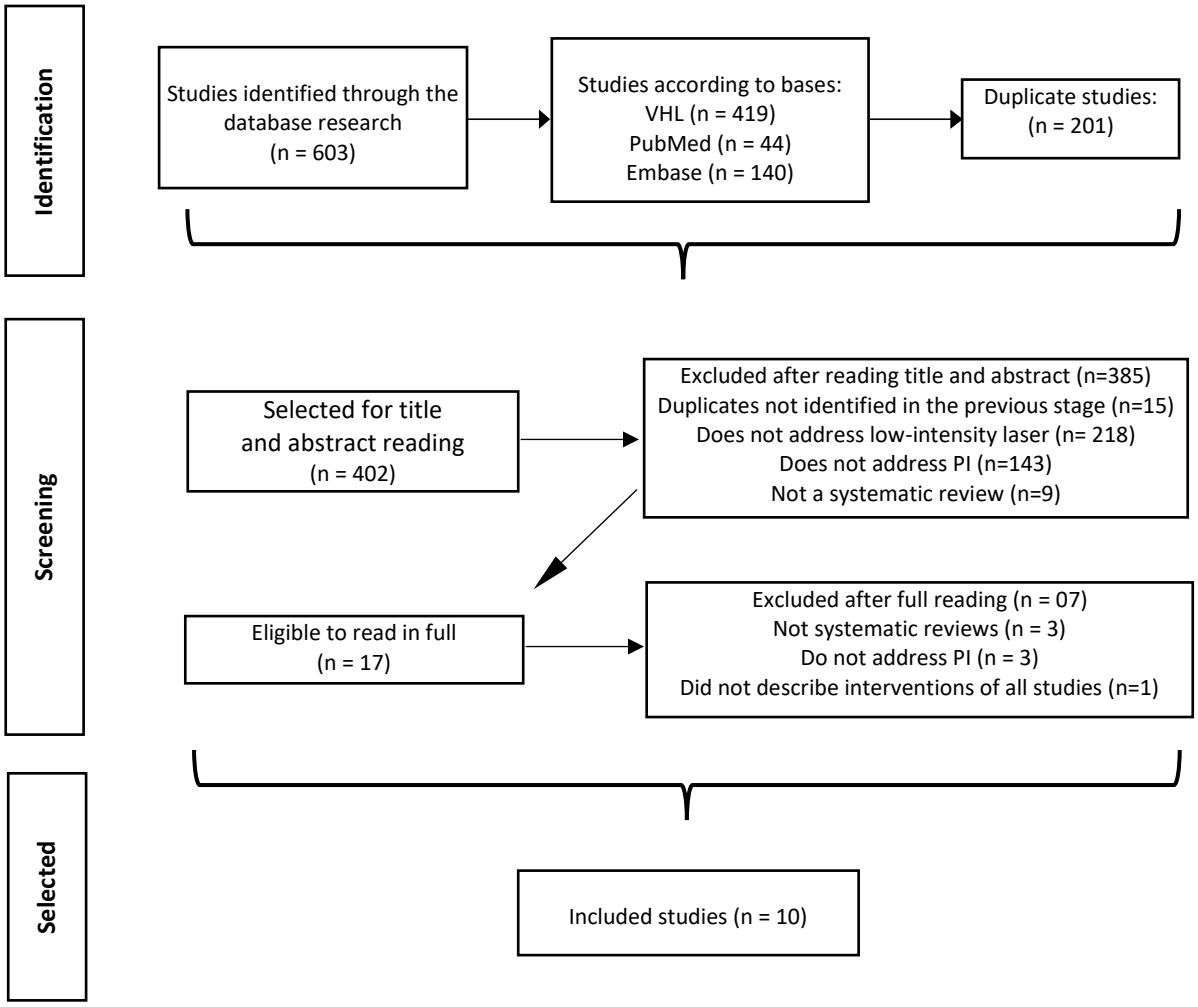

Figure 1: Study selection flowchart. Rio de Janeiro, RJ, Brazil, 2023.

Methodological quality and reliability levels were assessed using the AMSTAR2® tool, which has 16 items for assessing the reviews' reliability and are classified as high, moderate, low, and critically low[12].

RESULTS

Currently, laser therapy is one of the therapeutic resources that has been used for tissue healing and repair, contributing as adjuvant therapy in th

e treatment of pressure injuries, and acute and chronic wounds, showing great promise. The light emitted by lasers stimulates the production of ATP in injured tissue cells, significantly speeding up the healing process. This increase in cellular energy results in reduced tissue repair time, demonstrating the substantial contribution of lasers to tissue regeneration[13]. After searching and selecting, ten systematic reviews were included, as shown in Figure 2.

Research Article
Artigo de Pesquisa
Artículo de Investigación

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Title	Authors	Journal	Country	Year of publication	Language	Type of study	Quality of study
A Systematic Review of Therapeutic Interventions for Pressure Ulcers After Spinal Cord Injury[14]	Regan MA, Teasell RW, Wolfe DL, Keast D, Mortenson WB, Aubut JA	Arch Phys Med Rehabil	Canada	2009	English	Systematic review and meta-analyses	CL
Low-level laser therapy in the treatment of pressure ulcers:systematic review[15]	Machado RS, Viana S, Sbruzzi G	Lasers Med Sci	Brazil	2017	English	Systematic review	L
Effect of Photobiomodulation on Repairing Pressure Ulcers in Adult and Elderly Patients: A Systematic Review[16]	Petz FFC, Félix JVC, Roehrs H, Pott FS, Stocco JGD, Marcos RL, et al	Photochemistry and Photobiology	Brazil	2019	English	Systematic review	CL
Efficacy of Low-Level Laser Therapy on Wound Healing in Human Subjects: A Systematic Review[17]	Lucas C, Stanborough RW, Freeman CL, Haan De RJ	Lasers Med Sci	Netherlands	2000	English	Systematic review	CL
Nonpharmacologic Interventions to Heal Pressure Ulcers in Older Patients: An Overview of Systematic Reviews (The SENATOR-ONTOP Series)[18]	Vélez-Díaz-Pallarés M, Lozano-Montoya I, Abraha I, Cherubini A, Soiza RL, O'Mahony D et al	Jamda	Spain, Italy, United Kingdom and Netherlands	2015	English	Systematic review	L
Phototherapy for treating pressure ulcers (Review)[19]	Chen C, Hou WH, Chan ESY, Yeh ML, Lo HLD	Cochrane Library	Taiwan	2014	English	Systematic review	H
Terapia a laser na cicatrização da úlcera por pressão em adultos e idosos: Revisão sistemática[20]	Petz FFC	Federal University of Paraná	Brazil	2015	Portuguese	Systematic review	H
Pressure Ulcers[21]	Cullum N, Petherick E	Clinical Evidence	United Kingdom	2008	English	Systematic review	CL
Pressure Ulcers[22]	Reddy M.	Clinical Evidence	USA	2011	English	Systematic review	CL
Pressure ulcers: treatment[23]	Reddy M.	Clinical Evidence	USA	2015	English	Systematic review	CL

Figure 2: Association between Interventions and Outcomes. Rio de Janeiro, RJ, 2023.
Key: H = High (none or one non-critical weakness); M = Moderate (more than one non-critical weakness); L = Low (one critical failure with or without non-critical weaknesses); CL = Critically low (more than one critical failure, with or without non-critical weaknesses).

All ten studies included systematic reviews, nine in English[14-19,21-23] and one in Portuguese[20] carried out between 2000 and 2019, in descending order, in Brazil (n=3), the USA (n=2), the Netherlands (n=2), the UK (n=2), Canada (n=1), Spain (n=1), Italy (n=1) and Taiwan (1). Of the ten reviews included in this study, six included only randomized clinical trials (RCTs)[14-17,19,20], three used systematic reviews, observational studies and RCTs[21-23], and one only systematic reviews[18]. Of those that used only RCTs, one carried out a review with meta-analysis[14]. Of the ten systematic reviews, three described the countries where the studies were carried out: Canada, India, the Netherlands, Iran, and Poland[14,19,20]. Regarding the quality of the studies, two were classified as high quality[19,20], two as low quality[15,18], and six as critically low quality[14,16,17,21-23]. The associations between specific interventions in the ten review studies and the outcomes and evidence are described and summarized in Figure 3.

Research Article
Artigo de Pesquisa
Artículo de Investigación

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Interventions	Outcomes
Multiwavelength GaAsAI arsenide laser[14]	**Complete healing,**18 PI in the intervention group and 14 in the control group. **Time to complete healing,** 2.52 weeks in the treatment group and 1.82 weeks in the control group. **Reducing time for area reduction,** from stages 3 and 4 to 2[14].
Laser wavelengths 660, 658, 808, 820, 880, 904, and 940nm[15]	**Area reduction,**22% in the intervention group and 41% in the control group. **Area reduction,** 658 nm reduction of 71%, and 28.3% in the others. **Weekly healing rate,** 23.7% in the intervention group, 53% in the ultrasound group, and 32.4% in the dressing group. **Complete healing,** 16.7% at 940.808 nm and 58.6% in the 658nm group[15].
Laser wavelengths of 650, 650, 658, 808, 820, and 904nm[16]	**Time to complete healing of PI,** similar benefit groups. **PI area reduction,** similar results. **PI Complete healing:** The 658nm laser was the most effective in healing PI in stages 2 and 3 when compared to the 808nm, 940nm lasers, and control group[16].
Laser 660, 820, and 880nm[17].	**Area reduction,** no positive effect at 904 nm, and positive effect for red light 660 nm[17].
Laser 904 nm 5x a week[18].	**Area reduction, time to complete healing, complete healing, with no significant results**[18].
Laser 650, 820 904, and 980nm[19]	**Time to complete healing of PI:** Intervention group mean(SD)=12.6 (5.5). Control group 6.8 (3.2)[19].
Laser 650, 658, 808, 820, 904, 940, 980 nm[20].	**Area reduction,** intervention group 83% and control group 95%. **Complete healing,** intervention group 50% and control group 35%. **Area reduction,** 87.5% reduction in the intervention group, and 75% in the control group[20].
Laser intervention group[21]	**Complete healing,** similar rates were found. A total of 50% of the laser group and 35% of the control group. **Area reduction,** the intervention group showed a reduction of 79% and the control group 57%[21].
Laser intervention group[22]	**Area reduction,** reduction in wound surface P=0.23 in the treatment group and in the control group the absolute data was not presented[22]. **Time to complete healing,** time in the treatment group of 2.45 weeks and in the control group of 1.78 weeks.
Laser intervention group[23]	**Area reduction,** reduction of the wound surface P=0.23 in the treatment group and in the control group the absolute data was not presented. **Time for healing,** time in the treatment group of 2.45 weeks, and in the control group of 1.78 weeks. **Complete healing,** with no significant differences between the groups being in the ultrasound group (6/6 [100%]) and the laser group (4/6 [67%]. **Complete healing,** with no significant differences between the groups in the ultrasound group (6/6 [100%]) and the laser group (4/6 [67%])[23].

Figure 3: Association between interventions and outcomes. Rio de Janeiro, RJ, Brazil, 2023.

The ten studies included evaluated heterogeneous populations, with ages ranging from eight to 100 years, and pressure injuries of different classifications. Most of the interventions took place in a clinical setting, with supervised care in individual sessions. As for the duration of follow-up, all the studies reported the evaluation period, ranging from weekly to the end of treatment. The characterization of the studies included title, group of interventions, interventions, outcomes, effect, group of outcomes, population, database of origin, identification code (ID), confidence level, type and design of the review, design of the studies, countries of the intervention, country and year of publication.

Among the ten reviews included in this study, eight reported more than one outcome for the same intervention[14-16,18,20-23]. There was no standardization in the interventions, with variations in wavelengths, dosages, duration, and number of applications. The parameters investigated were dose, applications, and wavelengths, including 632nm, 650nm, 658nm, 808nm, 820nm, 650nm, 904nm, and 980nm. As for dosages and weekly applications, the studies ranged from 1 to 4 J/cm2 in terms of dose and from 3 to 7 applications per week.

Of the five outcomes, eight reviews reported complete healing14-16,18-23, seven highlighted time to healing, one reported a reduction in time and a decrease in area, nine reported a reduction in area, and two in the weekly healing rate.

DISCUSSION

During the COVID-19 pandemic, there has been an increase in the use of low-intensity laser in the treatment of PI, due to the large number of people with extensive injuries, standing out as a complementary therapy, helping in post-COVID treatment and care. The expansion of laser use was observed for several patients with skin injuries during post-COVID rehabilitation, highlighting the need for more research to support clinical practice[24].

Research Article
Artigo de Pesquisa
Artículo de Investigación

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All the studies included (10) were systematic reviews (Chart 2), nine in English and one in Portuguese, carried out between 2000 and 2019. The countries of publication included Brazil, Canada, Spain, the USA, the Netherlands, Italy, the UK, and Taiwan (Chart 5).

Of the 10 reviews included in this study, 9 reported more than one outcome for the same intervention[14-18,20-23]. The outcomes found in the reviews were complete healing of PI[14-16,18,20-23], time to complete healing of PI[14,16,18-23], reduction in time to reduction in PI area[14], reduction in PI area[15-23], weekly healing rate[15,17].

The 658nm GaAlAs laser has shown efficacy in healing PI compared to other wavelengths and standard care, especially associated with a reduction in inflammatory levels and positive modulation of the tissue repair process[25]. Red light (658nm) showed beneficial effects in treatment, pointing to the need for more extensive research to support its applicability in pressure injury care protocols[25]. The results showed statistical diversity, which made comparative analysis difficult[15,16,22,24].

It is believed that this diversity of findings may be linked to the insufficient number of studies with methodological quality evidence, which limits the basis for current practice. This reveals the need for more robust research on the subject[27].

In the comparison between the two groups: one applied a 904nm laser with a dressing, while the other control group used only a dressing. The intervention group had a 22% reduction in PI, compared to 41% in the control group, showing no benefit from the laser at this wavelength[15].

Three groups used different wavelengths (940nm, 808nm, and 658nm), with an energy dose of 4J/cm2 and a dressing. A significant reduction in the PI area was observed only in the 658nm laser group, with a reduction of 71% versus 28.3% in the other groups in one month of therapy, indicating positive results in reducing the size of the PI area[15].

Regarding the total healing rate, 11.1% of PI healed after one month with 940nm, 808nm, and placebo, compared to 47% with 658nm, highlighting the positive effect of this wavelength, suggesting that this may be the crucial characteristic in PI healing, pointing to the need for new studies with parameters similar to those that found significant results[15].

Most of the studies suggest using a power of up to 100mW/cm2 and a density of between 4J/cm2 and 10J/cm2, with a complete healing rate in the 904nm laser group of 50% (18 out of 36 participants) versus 35% (15 out of 43 participants) in the control group[13,16]. Group III (658nm) showed eight healed wounds from 17 participants after one month, with statistical significance (P<0.001). The final reduction in the area of the injury was observed with different results between the groups[16]. The reductions in injury areas, comparing the 904nm laser group with an initial area of 94mm^2 with the control group with an initial area of 82.5mm^2 in the control group, were 83% and 95% respectively after six weeks, with no statistical significance (P=0.47). The author highlights the clinical and parameter heterogeneity in the laser treatment of PIs, with analyses at different wavelengths and doses as a limiting factor in the meta-analysis[16].

In terms of safety, the laser has been effective in treating various conditions, and for the healing of pressure injuries, it has been identified as an effective, safe, and promising therapy[28,29].

The studies that evaluated the time taken for complete healing of PI[14,16,18,22,23], with results for injuries between 5 and 10mm deep, obtained an average of 4.1 weeks for healing, with no significant differences between the groups[29]. Generally, complete healing occurs in eight to 12 weeks, depending on the characteristics of the injury. The 820nm laser at 4J/cm^2 can be an adjuvant therapy to accelerate healing in PI. The GaAlAs 658nm laser at 4J/cm^2 promoted complete healing of injuries in stages 2 and 3, the latter being statistically significant compared to the standard treatment. In addition, the laser stimulates the production of ATP, the main source of cellular energy, accelerating the healing of damaged tissues[29].

It is worth highlighting in this study the gap related to the lack of use of assessment scales in the studies, such as the Pressure Ulcer Scale for Healing (PUSH) and the Pressure Sore Status Tool (PSST), which can lead to inaccurate assessments[30]. The skin, which is essential for the functioning of the body, begins a complex healing process when it is damaged. Using assessment tools can improve the accuracy and reliability of the results, offering a more complete understanding of the healing process of skin injuries[30].

It should be noted that other outcomes such as infection control, pain, and adverse events have not been widely covered, but are crucial for a complete analysis of the data and can significantly impact patients' quality of life and reduce complications associated with pressure injuries[31].

It is worth mentioning, as an element to be incorporated into new studies, that antimicrobial photodynamic therapy (PDT) is a local treatment option that uses a low-intensity laser combined with a photosensitizer to prevent and control

Research Article
Artigo de Pesquisa
Artículo de Investigación

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infections. It does not induce microbial resistance, acts specifically on the affected tissues, and is well-tolerated and painless for patients. PDT shows promise for the treatment of pressure injuries[31].

CONCLUSION

Low-intensity laser therapy was found to be effective in healing pressure injuries, especially at a red wavelength of 658nm, with an energy density of 4J/cm, both in promoting the healing of pressure injuries and in the treatment of stage 2 and 3 PIs. Although studies vary, the laser may be a practical clinical option, considering its safety and efficacy. This suggests that its use may be more cost-effective than other interventions, speeding up healing and reducing complications and costs associated with PI.

The review was essential for organizing and analyzing the evidence on the use of low-intensity laser in the treatment of pressure injuries, highlighting significant gaps in the existing international scientific literature.

However, the heterogeneity of the studies and the lack of methodological standardization make comparative analyses and confirmation of the degree of evidence difficult. Although lasers have been used since the 1970s to promote wound healing, scientific support for their current use in chronic injuries is limited.

Further research exploring the clinical efficacy of this therapeutic modality in pressure injuries is essential, including studies with larger samples that allow for reliable comparative analyses. To this end, it is crucial to standardize research protocols, use appropriate assessment scales, and include relevant clinical variables, which will contribute significantly to advancing knowledge in the area and improving patient care. More research, especially aimed at Brazilian nurses, is needed to support the clinical use of lasers in this context.

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Research Article
Artigo de Pesquisa
Artículo de Investigación

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Author's contributions

Conceptualization, R.A.A., F.V.C.S. and L.G.A; methodology, R.A.A., F.V.C.S., C.V.M.A. and G.A.N.; software, R.A.A., C.V.M.A. and G.A.N.; validation, R.G., L.G.A. and G.A.N.; formal analysis, R.A.A. and F.V.C.S.; investigation, R.A.A. and G.A.N.; resources, R.A.A. and F.V.C.S.; data curation, R.A.A.; manuscript writing, R.A.A.e F.V.C.S.; writing – review and editing, L.G.A. and G.A.N.; visualization, R.A.A., F.V.C.S., C.V.M.A., R.G., L.G.A. and G.A.N.; supervision, F.V.C.S.; project administration, R.A.A.; financing acquisition, R.A.A. and F.V.C.S. All authors read and agreed with the published version of the manuscript.