



Oral mucositis and treatment with low-level laser therapy: a concise systematic review

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Abstract

Antineoplastic treatments, such as chemotherapy and radiotherapy, have the main objective of destroying malignant cells. However, they also affect sensitive tissues such as the oral mucosa, causing side effects including oral mucositis. This inflammatory condition can range from mild erythema to extensive, painful ulcers, affecting antineoplastic treatment, disease control, and patient survival rates. Although several measures are adopted to control this condition – including rigorous oral hygiene, cryotherapy, and the use of analgesics – many of these approaches only temporarily relieve the symptoms. In this context, the use of low-level laser therapy emerges as a promising therapeutic alternative. This non-invasive technique has the ability to penetrate soft tissues, providing pain relief while modulating inflammatory responses and accelerating healing processes. This study aims to demonstrate the effectiveness of low-level laser treatment in patients affected by oral mucositis. Information was collected from the National Library of Medicine (NIH-PubMed), Scientific Electronic Library Online (SciELO), Scopus, Web of Science, LILACS, EBSCO, and Google Scholar, using the descriptors oral mucositis, antineoplastic treatments, and low-level laser therapy. Inclusion criteria were scientific studies in English, published between 2020 and 2026. Duplicate articles and those not related to the topic were excluded. Studies have shown that low-level laser therapy is considered a non-invasive method and has proven to be an effective ally in the treatment of oral mucositis. It provides a faster response compared to medications, as it has the capacity to modulate inflammatory markers with a low therapeutic cost compared to medications.

Keywords: Oral mucositis. Laser in dentistry. Oral inflammation. Low-level laser.

Introduction

Oncological treatments such as chemotherapy and radiotherapy have significantly improved patient survival rates. However, these treatments often present adverse effects, with oral mucositis being one of the most common and distressing complications. Oral mucositis (OM) is defined as a lesion in the mucosal lining of the oral cavity caused by chemical irritation, chemotherapy, or radiotherapy. The incidence of OM ranges from 59% to 100% in patients with oral or oropharyngeal cancer undergoing head and neck radiotherapy, and occurs in approximately 80% of patients undergoing myeloablative hematopoietic stem cell transplantation (HSCT) with high-dose conditioning regimens. OM is common in patients treated with chemotherapy for hematologic malignancies and occurs less frequently— affecting 15% to 80%, in patients with solid tumors [1-3].

In recent years, mucosal injury has become prevalent in patients treated with certain types of targeted therapy and immunotherapy. Given that the pathogenesis and course of OM depend on clinical circumstances, management is discussed separately for each cancer type and causative treatment. Oral mucositis presents a complex pathogenesis involving various cellular and molecular mechanisms. The process begins with direct cytotoxic damage to oral mucosal cells caused by antineoplastic therapies, triggering oxidative stress and a local inflammatory response. Subsequently, pro-inflammatory cytokines—such as tumor necrosis factor-alpha (TNF-α) and interleukin-1

beta (IL-1 β)—are released, compromising normal tissue repair mechanisms. Consequently, epithelial integrity is disrupted, leading to the development of mucosal ulcerations [4,5]. Clinically, oral mucositis is characterized by erythematous mucosal changes that can progress to oral ulcerations, potentially significantly compromising the patient's quality of life. The pain and discomfort resulting from this condition can reduce food intake, contributing to malnutrition, weight loss, and speech difficulties [4-6]. Furthermore, the presence of ulcerations increases susceptibility to local and systemic infections, often necessitating the use of antibiotics and, in more severe cases, hospitalization [3-5].

The most frequent late and persistent adverse effect of head and neck radiotherapy is xerostomia, or dry mouth, which has a significant negative impact on patients' quality of life. The parotid glands are frequently exposed to radiation. Parotid dysfunction begins at radiation levels of 10–15 Gy and can result in a 75% reduction in salivation at levels of 40–50 Gy. Xerostomia combined with mucositis can lead to nutritional deficiency, further debilitating the patient [6,7].

The severity of mucositis can also lead to treatment interruptions, dose reductions, or treatment discontinuation, thereby compromising the efficacy of anticancer therapies. Managing oral mucositis involves a multidisciplinary approach aimed at preventing, alleviating, and treating symptoms. Various interventions have been explored, including oral hygiene protocols, cryotherapy, mucosal protectants, pain control strategies, and growth factors [5-7]. In addition to the interventions mentioned, photobiomodulation—also known as low-level laser therapy (LLLT)—has emerged as a prominent option. Scientific evidence has demonstrated that this technique can reduce the incidence, severity, and duration of lesions, while also providing pain relief and improving patients' functional capacity [7,8].

The scientific and social relevance of this topic stems from the fact that oral mucositis remains a significant challenge in the care of oncology patients. Its pathogenesis is complex, involving various cellular and molecular mechanisms. Despite existing management strategies, further research is needed to improve preventive measures, early intervention, and therapeutic options. By understanding the impact of mucositis on cancer patients and investigating new approaches—such as low-level laser therapy (LLLT)—healthcare professionals can help improve patients' quality of life during antineoplastic treatment and optimize clinical outcomes [1,2].

Thus, this study aims to demonstrate the efficacy of low-level laser therapy in treating oral mucositis, a

common, debilitating, and sometimes fatal side effect of antineoplastic treatment, particularly in children.

Methods

Study Design

The present study followed the international systematic review model, following the rules of PRISMA (preferred reporting items for systematic reviews and meta-analysis). Available at: <http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1>. Accessed on: 05/21/2026. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: <https://amstar.ca/>. Accessed on: 05/21/2026.

Data Sources and Research Strategy

The literature search was conducted from May to July 2026 using Scopus, PubMed, Web of Science, LILACS, EBSCO, SciELO, and Google Scholar, covering scientific articles up to the present. The health science descriptors (DeCS/MeSH terms) used were "*Oral mucositis*, *Laser in dentistry*, *Oral inflammation*, *Low-level laser*", employing the Boolean operator "AND" between MeSH terms and "OR" between related terms. The descriptors employed were "oral mucositis," "antineoplastic treatments," and "low-level laser." Inclusion criteria covered scientific studies written in English, published between 2020 and 2026. Conversely, studies that did not meet these parameters were excluded, as were articles that did not match any of the search terms, those that were incomplete or unavailable in the consulted databases, and duplicate documents published on different platforms.

Study Quality and Risk of Bias

Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using the Cohen test (d).

Results and Discussion

Summary of Findings

A total of 95 articles were found that were subjected to eligibility analysis, with 15 final studies being selected to compose the results of this systematic

review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with Chi-Square $\chi^2=78.5\%>50\%$. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 15 studies with a high risk of bias and 21 studies that did not meet GRADE and AMSTAR-2.

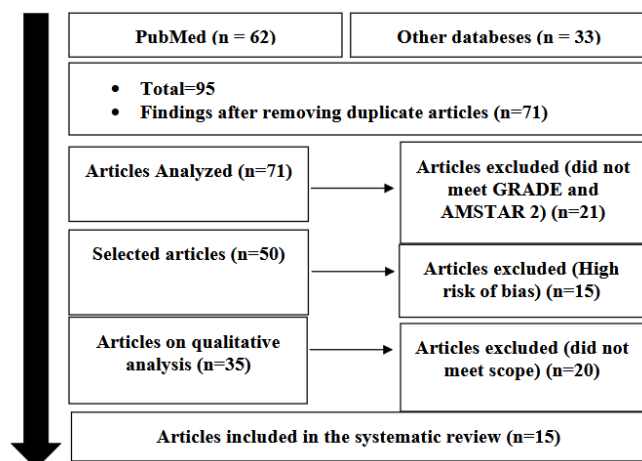


Figure 1. The article selection process by the level of methodological and publication quality. Source: Own authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both between studies with a small sample size (lower precision) that are shown at the bottom of the graph and in studies with a large sample size that are presented at the top.

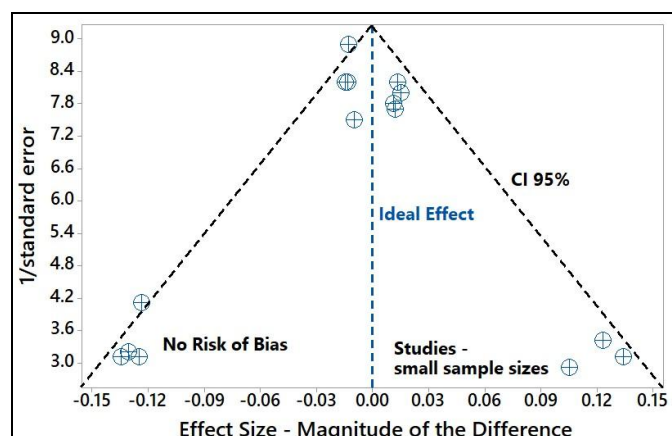


Figure 2. The symmetric funnel plot suggests no risk of bias among the small sample size studies that are shown at the

bottom of the graph. High confidence and high recommendation studies are shown above the graph (n= 15 studies). Source: Own authorship.

Major Clinical Findings

Given the debilitating and uncomfortable nature of oral mucositis, the last decade has seen a surge in research aimed at better understanding this condition and developing new, effective therapeutic approaches. Initially, oral mucositis was believed to be merely an inflammation of the oral and gastrointestinal mucosa caused directly by the non-specific toxic effects of chemotherapy agents. However, it is now recognized as the result of a complex sequence of biological events involving various cell types across all layers of the mucosal tissue. Furthermore, factors such as the immune system, oral microbiota, and environmental conditions play pivotal roles in its pathogenesis [1-3].

In patients with head and neck neoplasms, cancer treatments—whether chemotherapy or radiotherapy—frequently lead to significant changes in the oral cavity. These manifestations can be severe, significantly affecting quality of life and compromising the continuity and efficacy of antineoplastic treatment. Oral mucositis (OM) is one of the most common and troublesome adverse effects associated with antineoplastic therapy [4,5]. Its incidence and severity vary depending on the intensity and frequency of treatment, as well as individual patient factors. Key determinants include the type and combination of chemotherapy agents used, the total administered dose, the therapy interval and duration, and personal characteristics such as age, systemic condition, clinical diagnosis, and oral health status both before and during treatment [4-6].

In severe cases, mucositis can impair essential functions such as chewing, swallowing, speech, and oral hygiene, drastically impacting the patient's well-being. In more severe cases, it can lead to the temporary or permanent interruption of cancer treatment, compromising the prognosis and increasing the need for prolonged hospital care, in addition to causing intense pain and significant suffering [1,4,6].

Given this scenario, various therapeutic strategies have been recommended to minimize the adverse effects of oral mucositis. Among these, laser therapy stands out as a non-invasive technique capable of reducing pain and lesion severity. Scientific evidence demonstrates that the use of low-level laser therapy (LLLT) for oral mucositis significantly reduces lesion severity and plays a key preventive role regarding the onset of new ulcerations [1,2,7,8].

Photobiomodulation parameters using low-level lasers or light-emitting diodes (LEDs) for cancer patients typically involve wavelengths in the red to near-infrared

range (600–1,000 nm) and power densities between 5 and 150 mW/cm². Application time usually ranges from 30 to 60 seconds per point, although shorter durations (2–10 seconds) can also be effective due to the cumulative dose effect. The applied energy typically falls between 0.1 and 12 J/cm². Various laser types are employed—such as HeNe, Nd: YAG, GaAlAs, InGaAlP, and non-thermal CO₂—and the use of LEDs has grown due to their safety, accessibility, and suitability for home use [1,2].

The biological response to photobiomodulation depends on factors such as cell type, tissue microenvironment, wavelength, application mode, and exposure time. The therapy follows a biphasic dose-response pattern: very low doses may have a limited effect, whereas excessive doses can be ineffective or cause unwanted effects, making the careful definition of parameters for each tissue and condition essential [9,10].

The impact of low-level laser therapy on the treatment of oral mucositis has been extensively documented in the literature, demonstrating consistent and significant benefits. Numerous studies confirm its efficacy in reducing pain, accelerating lesion healing, and improving patient comfort, thereby directly contributing to the maintenance of nutrition and hydration and the continuity of cancer treatment. Furthermore, this therapeutic approach stands out for its minimal adverse effects and good tolerability, making it particularly valuable in managing cancer-related complications. The favorable difference observed between patients treated with laser therapy and those receiving only conventional measures highlights the growing role of this technology in supporting cancer patients, establishing it as an essential complementary strategy to minimize the impact of oral mucositis on quality of life [1-4].

Discussion

Despite continuous advances in cancer treatment, the side effects resulting from antineoplastic therapies remain a significant challenge, profoundly impacting patients' quality of life. The severity of these complications depends on both treatment-related factors and individual patient characteristics, affecting daily activities and well-being. Consequently, effective supportive care strategies are essential [1,11,12].

Among these complications, OM is considered one of the most debilitating. It begins as an inflammatory process in the basal epithelium of the oral mucosa and progresses to erythema and ulceration [1,13,14]. The intense pain associated with the lesions can impair basic functions such as speaking and swallowing, leading to feeding difficulties, a risk of malnutrition, and the need

for nutritional support and potent analgesics, such as opioids [1-3]. Disruption of the epithelial barrier also predisposes patients to secondary and systemic infections, increasing antibiotic use. Oral mucositis frequently leads to the interruption or dose reduction of cancer treatments, which can result in poorer clinical outcomes, higher costs, and increased mortality [2-5].

The oral mucosa is highly vulnerable to the cytotoxic effects of chemotherapy and radiotherapy due to its rapid rate of cell turnover [3-6]. Thus, factors such as age, type of neoplasm, and therapeutic regimen directly influence the risk of developing the condition. The incidence of OM is nearly universal—reaching approximately 100%—in patients undergoing head and neck radiotherapy, and it affects about 80% of individuals receiving high-dose chemotherapy before hematopoietic stem cell transplantation (HSCT) [13]. In children, this complication occurs in approximately 52% to 80% of cases, being more common in hematological malignancies than in solid tumors. Certain chemotherapy agents—such as methotrexate, whether used alone or in combination with other drugs—exhibit higher cytotoxic potential and are frequently employed in the treatment of acute lymphoblastic leukemia and in HSCT conditioning regimens [2,3].

Given the impact of oral mucositis on quality of life and clinical outcomes, careful prevention and treatment are essential. Various strategies can reduce its incidence, severity, and duration, including oral hygiene protocols, topical anesthetics, analgesics, antimicrobial and anti-inflammatory agents, cytoprotective agents, growth factors, cryotherapy, and photobiomodulation [2-5]. Therefore, there is a substantial body of evidence supporting the efficacy of photobiomodulation in preventing oral mucositis in patients undergoing radiotherapy for head and neck cancer, chemotherapy, or hematopoietic stem cell transplantation (HSCT) [13]. Photobiomodulation has been shown to alleviate pain and inflammation, modulate the immune response, and promote tissue repair and regeneration. This occurs through a series of photophysical and photochemical reactions, beginning with the absorption of laser light energy by endogenous photoreceptors located on the mitochondrial membrane. Consequently, light photons are converted into a form of energy that cells can utilize during states of high metabolic demand. The products of these reactions are involved in modulating gene transcription, blood flow, lymphatic drainage, and peripheral nerve activity. These results—combined with the absence of side effects, feasibility, and significant reductions in the incidence, duration, and pain associated with the condition—justify the rapidly growing interest in PBM within oncology [1,3,8].

In this context, studies have shown that

photobiomodulation can play a role not only in stimulating the local immune system and enhancing phagocytic capacity but also in exerting antibacterial activity [11-15]. PBM not only accelerates tissue repair and reduces inflammation but is also capable of alleviating pain. Its analgesic properties stem from the direct inhibition of peripheral nervous system functions. By inhibiting the transmission of pain signals and reducing action potentials, PBM contributes to decreasing the extent of neurogenic inflammation. Thus, it may offer a non-pharmacological alternative for pain management [1].

One issue worth noting is dosimetry and the variations among PBM protocols, which can complicate the comparison of results from seemingly similar studies. One of the primary parameters is wavelength. Literature suggests that safe and effective wavelengths range from 600 to 1070 nm; however, the greatest biological utility is found within the near-infrared spectrum, as these wavelengths are more readily absorbed by chromophores such as cytochrome c oxidase (812 to 846 nm) [1,2]. Nevertheless, studies using wavelengths outside this optimal range have also shown positive results; therefore, the efficacy of PBM treatment does not depend solely on a single parameter [1].

The most common light sources used by the majority of healthcare professionals are diode laser devices, which emit coherent light at various wavelengths. Unfortunately, there are many inconsistencies in the literature regarding the optimal energy dose for treating oral mucositis. The interaction between soft tissue and laser light energy is highly complex. It is frequently described as a biphasic dose-response relationship, meaning that when the administered energy dose is too high or the irradiation time is too long, a phototoxic response involving cellular inhibition—rather than stimulation—occurs. The reverse also holds: if laser light exposure is too brief or the energy dose is too low, there is no biological effect [1-4].

Some studies indicate that children may be at a higher risk of developing oral mucositis than adults. They possess a higher percentage of rapidly dividing cells and a faster rate of cell turnover [1-3,5-7]. When receiving the same treatment, the incidence is higher in the pediatric population than in the adult population. Children are also more frequently exposed to chemotherapy, which is associated with greater stomatotoxicity. PBM has come to be used not only for treating oral mucositis but also as a preventive strategy [1,2].

Also, authors observed that the incidence of oral mucositis is linked to the primary cancer diagnosis and

treatment options. A higher occurrence of oral mucositis was observed in patients with osteosarcoma, acute lymphoblastic leukemia (ALL), and those undergoing HSCT, as well as in patients treated with methotrexate (MTX). Once again, they agreed that PBM is capable of preventing oral mucositis, as patients undergoing this prophylactic therapy were less likely to develop the condition, and its occurrence was lower compared to rates reported in the literature. Unfortunately, the data were obtained retrospectively and the studies lacked a control group, which reduced the quality of the results [13].

Finally, as can be seen, the studies presented demonstrated the beneficial effect of photobiomodulation in reducing the adverse effects of cytostatic agents on the oral mucosa—mitigating inflammation and pain, preventing fibrosis, and promoting wound healing and tissue regeneration.

Conclusion

It was concluded that the analyzed literature confirms the efficacy of low-level laser therapy in treating oral mucositis, a significant complication of antineoplastic treatment. This condition causes intense pain and functional limitations, negatively affecting patients' quality of life by compromising nutrition and increasing the risk of infection. Low-level laser therapy stands out among available treatments, offering analgesia, reduced inflammation, and accelerated healing, in addition to being a cost-effective and easy-to-apply technique. Therefore, its incorporation into clinical care protocols is essential, as is the training of healthcare professionals—particularly dentists—in the management of this condition.

CRedit

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Not applicable.

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References

1. O'Hara J, Iqbal MS. The Evidence for Low-level Laser Therapy for Oral Mucositis in Head and Neck Cancer Radiotherapy. *Clin Oncol (R Coll Radiol)*. 2025 Feb;38:103731. doi: 10.1016/j.clon.2024.103731.
2. Redman MG, Harris K, Phillips BS. Low-level laser therapy for oral mucositis in children with cancer. *Arch Dis Child*. 2022 Feb;107(2):128-133. doi: 10.1136/archdischild-2020-321216.
3. Andriakopoulou CS, Yapijakis C, Koutelekos I, Perdikaris P. Prevention and Treatment of Oral Mucositis in Pediatric Patients: Systematic Review and Meta-Analysis of Randomized Controlled Trials. *In Vivo*. 2024 May-Jun;38(3):1016-1029. doi: 10.21873/invivo.13535.
4. Arany PR. Photobiomodulation therapy. *JADA Found Sci*. 2025 Mar 26;4:100045. doi: 10.1016/j.jfscie.2025.100045.
5. Barati S, Motevasseli S, Saedi HS, Amiri P, Fekrazad R. Effectiveness of Photobiomodulation (low-level laser therapy) on treatment of oral mucositis (OM) induced by chemoradiotherapy in head and neck cancer patients. *J Photochem Photobiol B*. 2025 Mar;264:113115. doi: 10.1016/j.jphotobiol.2025.113115.
6. Biala M. Low-Level Laser Therapy: A Literature Review of the Prevention and Reduction of Oral Mucositis in Patients Undergoing Stem Cell Transplantation. *Clin J Oncol Nurs*. 2022 Jun 1;26(3):293-299. doi: 10.1188/22.CJON.293-299.
7. Ma Y, Yang M, Sun J, Qu X, Qu Z, Qu W. The effectiveness of lower-level laser therapy on the treatment of minor recurrent aphthous ulcers: a systematic review and meta-analysis. *Lasers Med Sci*. 2025 Nov 25;40(1):493. doi: 10.1007/s10103-025-04700-8.
8. Shirazian S, Mohseni A, Pourshahidi S, Alaeddini M, Etemad-Moghadam S, Vatanpour M. The effect of different parameters of low-level laser used in the treatment of oral mucositis, on the viability and apoptosis of oral squamous cell carcinoma cells: In vitro study. *Photochem Photobiol*. 2025 Mar-Apr;101(2):330-337. doi: 10.1111/php.13997.
9. Walinski CJ, Mellusi SM, Brodeur AE, Marchick E, Katz D, Van Putten M. Review of oral mucositis treatment guidelines with an emphasis on laser therapy. *Gen Dent*. 2022 Mar-Apr;70(2):22-26. PMID: 35225799.
10. Rodrigues I, Machado V, Lopes LB, Trancoso P, Azul AM, Mendes JJ, Zagalo C, Botelho J. Photobiomodulation therapy on chemo- and radiotherapy induced oral conditions: an umbrella review. *BMC Oral Health*. 2024 Sep 18;24(1):1106. doi: 10.1186/s12903-024-04793-7.
11. Bourbonne V, Otz J, Bensadoun RJ, Dissaux G, Lucia F, Leclerc JC, Pradier O, Schick U. Radiotherapy mucositis in head and neck cancer: prevention by low-energy surface laser. *BMJ Support Palliat Care*. 2022 Dec;12(e6):e838-e845. doi: 10.1136/bmjspcare-2019-001851.
12. Kuhn-Dall'Magro A, Zamboni E, Fontana T, Dogenski LC, De Carli JP, Dall'Magro E, Fornari F. Low-level Laser Therapy in the Management of Oral Mucositis Induced by Radiotherapy: A Randomized Double-blind Clinical Trial. *J Contemp Dent Pract*. 2022 Jan 1;23(1):31-36. PMID: 35656654.
13. Nishi H, Horikoshi S, Ohta K, Yoshida T, Fukushima N, Oshita K, Munenaga S, Edahiro T, Ureshino H, Shigeishi H, Yoshioka Y, Konishi M, Ide N, Ogawa Y, Marukawa R, Shintani T, Ino N, Kajiya M, Kakimoto N, Ohge H, Ichinohe T, Kawaguchi H. Efficacy of Low-Level Laser Therapy for Oral Mucositis in Hematologic Patients Undergoing Transplantation: A Single-

- Arm Prospective Study. J Pers Med. 2023 Nov 13;13(11):1603. doi: 10.3390/jpm13111603.
14. Cotomacio CC, Yshikawa BK, Calarga CC, Arana-Chavez VE, Simões A. Red, infrared, and simultaneous laser-wavelengths irradiation effects on 5-fluorouracil-induced oral mucositis in hamsters. J Biophotonics. 2023 Oct;16(10):e202300156. doi: 10.1002/jbio.202300156.
 15. Baek JY, Yang K, Lee TH, Lee SU, Moon SH, Jo IY, Eom KY, Oh D. Feasibility Study of a Novel Stent-Based Low-Level Laser Therapy Device for Reducing Severe Radiation-Induced Oral Mucositis. Lasers Surg Med. 2025 Dec;57(10):771-776. doi: 10.1002/lsm.70069.