Original Article

# A MINI REVIEW ON PHOTO- BIOMODULATION- Novel approach

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## Abstract

This research is aimed to look at the existing literature on the effects of photobiomodulation (PBM) on a variety of medical illnesses with a high severity rate. Photobiomodulation, also known as non-thermal laser treatment, is an approaching field in the technology of medicine that involves exposing tissues to precise wavelengths of light to generate therapeutic effects. Photomedicine is based on the outcomes of coherent and noncoherent visible light on cells and tissues, like low-level lasers and light-emitting diodes (LEDs). This therapy method has an impact on cell function, proliferation, and migration, as well as tissue regeneration. Thus, this therapy's mechanism is particularly effective in displaying favorable benefits in neurological, pulmonary, inflammatory, dermatological, and wound healing illnesses and oncology. Using the biphasic dose-response technique, each ailment is addressed with a specific type of laser and within a defined wavelength range to produce the required effect of the therapy.

**Keywords:** low-level laser therapy, non-invasive treatment, Photobiomodulation.

## INTRODUCTION

Photobiomodulation therapy is a treatment which involves a source of light that requires non-ionizing light rays within the visible and near-infrared range, for-instance LASERS is defined as light amplification by stimulated emission of radiation, LEDs i.e., light-emitting diodes, and broadband light. Autogenous chromophores induce photophysical and non-radiative processes at varying biological scales in the following non-thermal mechanism.

Photobiomodulation therapy (PBMT) is a therapy using red or near-infrared (NIR) light that heals, restores, as well as promotes various physiological mechanisms, as well as cures the repairable harm caused by injury or disease. The application of a non-ionized type of light, such as LASER and LED from the visible (400 – 700 nm) to the infrared (700 – 1100 nm) spectrum, is a non-pharmaceutical and non- radiative intervention[1]. PBMT was first introduced in the late 1960s as 'low-level light therapy or LLLT, for tissue repair and pain reduction in a variety of orthopedic diseases[2]. PBMT is commonly used to treat musculoskeletal problems including lumbar region pain, however, the imposed mechanism according to which PBMT reduces pain severity and impairment in such patients is uncertain[1]. PBMT can stimulate cell proliferation and differentiation in stem cells. Laser treatment is a non- invading treatment that helps in relieving pain and inflammation while also promoting faster healing and tissue restoration. These qualities have been used to treat a variety of illnesses and ailments, including diabetes, brain injury, spinal cord injuries, dermatology-related issues, and dental exasperation[3].

According to what is currently known in the scientific literature, the underlying concepts that govern photobiomodulation (PBM) treatment are quite simple. The delivery of a therapeutic dosage of light to defective or malfunctioning tissue causes a biological response mediated by mitochondrial processes, according to the agreement[4]. PBM/LLLT differs from other light-based therapies in that it does not degrade the skin and has no heating impact. It also varies from photodynamic treatment (PDT), which uses light to activate exogenously supplied chromophores, resulting in the generation of harmful reactive oxygen species (ROS). PBM has a wide range of uses, from pain management to supporting the rehabilitation of tendon injuries, neural

injuries, osteoarthritis, and wound repairing, owing to its non-invasive nature[5]. PBMT works on a biphasic exposure-response mechanism that involves low amounts of light that stimulate the brain while a high amount of rays block it.

Lasers with wavelengths normally varying between 600- 700 nm and 780-1100 nm, with irradiance or power density, generally ranging from 5 mW cm2 to 5 W cm2 are used. This form of irradiation is either uninterrupted wave or interrupted light with a fairly low-density beam (0.04 to 50 J cm2), yet the product power varies from 1 mW to 500 mW to avoid heating consequences[5].

EFFECTS OF PHOTOBIOMODULATION THERAPY

Maintaining the Integrity of the Specifications Photobiomodulation is currently widely employed as a therapy or rehabilitation for a variety of illnesses. The primary essential mechanism found in therapy is the stimulation of the cytochrome C complex. It then stimulates the electron chain transport, resulting in a large increase in adenosine triphosphate (ATP) synthesis, as well as increased stimulation of nitric oxide (NO) and control of reactive oxygen species (ROS) and cell regeneration.

Brain Photobiomodulation therapy: PBMT is used in the treatment of neurological as well as psychological disorders such as brain trauma injury, stroke, Parkinson's disease, dementia, depression, and anxiety. Photobiomodulation (PBM) treatment has been developed as a novel approach to improving brain function by stimulating neural activity. This light-based technique includes exposing brain tissue to a modest emittance of light (varying from 1 to > 20 J/cm2) with wavelengths fluctuating between red and NIR (600 and 100 nm) using a variety of light delivery methods[6].

PBMT related to oncology: complications of treatment of oral cancers are very challenging, and oral mucositis (OM) is one of them. PBMT is now the most preferred technique in the prophylaxis of OM in patients with cervical cancer who are receiving chemoradiotherapy (CRT) and in recipients undergoing transplantation of stem cells, receiving high-dose cytoreductive drugs PBM is also effective for the treatment of soft tissue death and therapy- induced bone necrosis in cases with cervical cancer. It has also been suggested that PBM might be used to treat dry mouth, allotriogeustia, radiodermatitis, post- RadiationTherapy fibrosis, chronic oral graft-versus-host disease (GVHD), and mammary gland carcinoma associated lymphedema[7]. There are some contradictory statements regarding the proliferation of several malignant cells with the use of PBMT in cancer. It was reported that a particular type of laser and its significant range of wavelength was successful in preventing complications and inhibiting the growth of malignant cells.

LLLT in wound healing: It is broadly acknowledged that wounds have a biphasic exposure-response to single or multiple wavelengths, which can be used to sterilize the injured area, kill tumor cells, encourage remarkably quicker healing of huge chronic venous wounds caused due to diabetes, sports abuses, reduce ache in arthritic inflamed joints, the posterior trunk and cervical, reduce swelling by growing the number of fibroblasts, myofibroblasts, and wound desquamation, and to reduce inflammation by raising the population of fibroblasts, myofibroblasts. Wavelengths between 500 and 700 nm are effective for outermost tissue injuries, whereas wavelengths ranging from 800 to 1000 nm are beneficial for underlying deep tissue damage[8].

Photobiomodulation for managing inflammation: PBM has the ability to boost antioxidant defenses and lower oxidative stress. By suppressing cyclooxygenase 2 and thereby reducing PGE2 markings in cell culture, PBMT can control inflammation [9]. PBM was demonstrated for activation of NF-kB in typical quiescent cells, whereas erythrogenic levels were reduced in activated inflammatory cells[10]. The connection between the light emitted and photoreceptors found in mitochondria in various tissues is how PBMT works[11]. Hence this mechanism helps in the reduction of inflammation along with pain relief.

Effect of PBMT on hair cells: PBM has recently been discovered to increase the production of ligands in the Wnt/B-catenin route, that is implicated in the commencement of hair follicle maturation and evolution[12].PBMT is hypothesized to extend the anagen and prevent an early transformation into catagen in hair regrowth. PBMT devices, when used to promote hair regrowth, use wavelengths that can penetrate underlying tissue, often in the 600 to 700 nm range[13]. The following are the several types of low-level laser therapy devices: (a) stationary hoods, (b) handy combs or brushes, (c) headbands, and (d) caps or helmets[12]. It is based on the dose-response feature. At the above-mentioned wavelength, it shows a hair growth effect whereas it has anomalous effect on hair follicles which is used in hair removal treatment.

Effect of PBM on COVID-19: Immune system damage results in cytokine release syndrome, which progresses to acute respiratory distress syndrome (ARDS) in severe COVID-19 patients [14]. PBM is an alternate technique for treating regionalized inflammation that promotes tissue regeneration while also reducing inflammation and pain. PBM has the ability

to alter cellular and molecular metabolism, signaling, inflammation, and the release of chemical messengers. Because they project great capability to improve the local regulation of immune feedback, they have demonstrated promising benefits in decreasing acute pulmonary inflammation. As a result, PBM could be a useful therapeutic option for COVID-19 patients with ARDS. PBM has been shown to have anti-inflammatory and regenerative benefits in the management of allergic bronchitis, upper airway injuries, periodontal inflammation, and oral ailments. The rate of neutrophil activation and apoptosis is inversely related to the severity of the disease. PBM dramatically reduced neutrophilic migration to lung tissue, resulting in a reduction in disease severity[15].

A. Use of photobiomodulation therapy in dermatology: Despite widespread criticism, nonthermal laser treatment has evolved as a well-developed method for providing non-invasive body contouring. Cellulite is an unsightly ailment that affects the majority of post-adolescent females. The efficacy of a green 532 nm non-thermal laser device for enhancing the impression of cellulite in the thighs and buttocks. Dermatophytes, yeasts, and non- dermatophyte fungi cause onychomycosis, a nail infection. The effect of non-thermal lasers on human neutrophils may be responsible for their favorable effect in the management of onychomycosis. In this scenario, a double-diode laser modality having wavelengths of 635 nanometres and 405 nanometres is employed to provide efficient results[16-25].

## FUTURE PERSPECTIVE

Photobiomodulation therapy (PBMT) appears to have therapeutic merit in the treatment of skin and mucosal wounds, according to new research. Because of future applications in tissue engineering, stem cells have piqued researchers' curiosity. Irradiating stem cells with low-level laser therapy, also known as Photobiomodulation Therapy (PBMT), which causes the stimulation of intracellular and extracellular chromophores and the beginning of cellular signalling, has recently shown to boost multiplication. There has also been an incredible surge in evidence about the effectiveness of PBMT for improving performance and expediting post-exercise recovery in recent time [26-45].

## SUMMARY

As previously stated in this section, photobiomodulation is a commonly utilized modality for treating diseases such as musculoskeletal conditions, inflammatory conditions, and dermatological conditions, as well as preventing and curing some diseases' consequences like post-cancer effects of chemotherapy. It has shown significant results in all such conditions though the exact mechanism was inadequate. It is a non-thermal mechanism that produces a low risk of complications. It modulates pro-inflammatory cytokines to reduce inflammation and results in pain relief. In the above article, various effects of LLLT are mentioned which describes its efficacy on the given conditions.

Evidence was previously disputed due to a paucity of studies and shards of verifications on the success of PBMT on pain reduction. In comparison to pharmaceutical therapies, recent researches show that non-pharmacological approaches like LLLT have reduced rates of post-therapy problems. Photobiomodulation has even been recommended as a medicine equivalent due to its vast spectrum of positive and non-invasive effects. With the growing body of evidence and study on the subject, LLLT will soon be employed as the primary treatment for a wide range of illnesses.

## REFERENCES


1. S. S. Tomazoni et al., “Effects of photobiomodulation therapy on inflammatory mediators in patients with chronic non-specific low back pain,” Medicine (Baltimore), vol. 98, no. 15, p. e15177, Apr. 2019, doi: 10.1097/MD.0000000000015177.
2. “Photobiomodulation and Cancer: What Is the Truth? - PubMed.” https://pubmed.ncbi.nlm.nih.gov/29466089/ (accessed Apr. 23, 2022).
3. C. Dompe et al., “Photobiomodulation— Underlying Mechanism and Clinical Applications,” J. Clin. Med., vol. 9, no. 6, Art. no. 6, Jun. 2020, doi: 10.3390/jcm9061724.
4. “Photobiomodulation | How Does Laser Therapy Work? | LightForce,” LightForceTherapy Lasers. https://lightforcemedical.com/photobiomodulation-therapy- pbm/ (accessed Apr. 23, 2022).
5. L. F. de Freitas and M. R. Hamblin, “Proposed Mechanisms of Photobiomodulation or Low-Level Light Therapy,” IEEE J. Sel. Top. Quantum Electron., vol. 22, no. 3, pp. 348–364, May 2016, doi: 10.1109/JSTQE.2016.2561201.
6. F. Salehpour, J. Mahmoudi, F. Kamari, S. Sadigh- Eteghad, S. H. Rasta, and M. R. Hamblin, “Brain Photobiomodulation Therapy: a Narrative Review,” Mol. Neurobiol., vol. 55, no. 8, pp. 6601–6636, Aug. 2018, doi: 10.1007/s12035-017-0852-4.

7. R.-J. Bensadoun et al., “Safety and efficacy of photobiomodulation therapy in oncology: A systematic review,” Cancer Med., vol. 9, no. 22, pp. 8279–8300, 2020, doi: 10.1002/cam4.3582.
8. “Photobiomodulation in promoting wound healing: a review - PubMed.” https://pubmed.ncbi.nlm.nih.gov/26681143/ (accessed Apr. 24, 2022).
9. S. S. Tomazoni et al., “Photobiomodulation Therapy is Able to Modulate PGE2 Levels in Patients With Chronic Non-Specific Low Back Pain: A Randomized Placebo-Controlled Trial,” Lasers Surg. Med., vol. 53, no. 2, pp. 236–244, 2021, doi: 10.1002/lsm.23255.
10. M. R. Hamblin and M. R. Hamblin, “Mechanisms and applications of the anti-inflammatory effects of photobiomodulation,” AIMS Biophys., vol. 4, no. 3, pp. 337–361, 2017, doi: 10.3934/biophy.2017.3.337.
11. “Photobiomodulation therapy does not decrease pain and disability in people with non-specific low back pain: a systematic review | Elsevier Enhanced Reader.” https://reader.elsevier.com/reader/sd/pii/S183695532030064 3?token=20E434BDDED67260C16E5D08197C342942BA 6C037B38810C95DD3B57A2EE1E4FC59D1CA83D6F461 FAE3EAE608457D80E&originRegion=eu-west- 1&originCreation=20220421185104 (accessed Apr. 22, 2022).
12. A. E. Torres and H. W. Lim, “Photobiomodulation for the management of hair loss,” Photodermatol. Photoimmunol. Photomed., vol. 37, no. 2, pp. 91–98, Mar. 2021, doi: 10.1111/phpp.12649.
13. E. M. Dodd, M. A. Winter, M. K. Hordinsky, N. S. Sadick, and R. S. Farah, “Photobiomodulation therapy for androgenetic alopecia: A clinician’s guide to home-use devices cleared by the Federal Drug Administration,” J. Cosmet. Laser Ther. Off. Publ. Eur. Soc. Laser Dermatol.,
14. vol. 20, no. 3, pp. 159–167, Jun. 2018, doi: 10.1080/14764172.2017.1383613.
15. Y. Shi et al., “COVID-19 infection: the perspectives on immune responses,” Cell Death Differ., vol. 27, no. 5, pp. 1451–1454, May 2020, doi: 10.1038/s41418- 020-0530-3.
16. S. Soheilifar, H. Fathi, and N. Naghdi, “Photobiomodulation therapy as a high potential treatment modality for COVID-19,” Lasers Med. Sci., vol. 36, no. 5, pp. 935–938, Jul. 2021, doi: 10.1007/s10103-020-03206-9.
17. “Photobiomodulation with non-thermal lasers: Mechanisms of action and therapeutic uses in dermatology and aesthetic medicine: Journal of Cosmetic and Laser Therapy: Vol 19, No 4.” https://www.tandfonline.com/doi/full/10.1080/14764172.20 17.1293828 (accessed Apr. 24, 2022).
18. Nirmal, Apoorva, Gajendra Agrawal, Sunil Kumar, Sourya Acharya, Akshay Dafal, and Dwivedi Bhushan. “Echocardiographic Assessment of Cardiac Function in Liver Cirrhosis: A Cross-Sectional Study.” JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH, 2021. https://doi.org/10.7860/JCDR/2021/45792.14881.
19. Nisargandha, Milind Abhimanyu, and Shweta Dadarao Parwe. “Evaluation of Spermatogenic Action in the Management of Oligospermia.” International Journal of Pharma and Bio Sciences 11, no. 2 (April 15, 2021): 218–23. https://doi.org/10.22376/ijpbs/lpr.2021.11.2.P218-223.
20. “[No Title Found].” INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH 12, no. 1 (n.d.).
21. Padmane, Ekta, and Samruddhi Gujar. “Case Report on Hydatid Cysts with Hydropnemonothorax.” Journal of Pharmaceutical Research International, November 15, 2021, 1–5. https://doi.org/10.9734/jpri/2021/v33i50A33375.
22. Padmawar, Shubham, Dr. Suhas Landge, Prateek Upadhyay, and Mitali Madhusmita. “A Functional and Radiological Outcome Analysis of Hip Forage Procedure, Done for Early Stages(Ficat and Arlet Grade 1 and 2A) of Avascular Necrosis of Head of Femur.” Journal of Pharmaceutical Research International, December 11, 2021, 97–105. https://doi.org/10.9734/jpri/2021/v33i54B33770.
23. Palkrit, Sakshi, Waqar M. Naqvi, and Tasneem Burhani. “Physiotherapeutic Approach in Stress Urinary Incontinence with Prolapsed Uterus: A Case Report.” Journal of Pharmaceutical Research International, June 30, 2021, 54–59. https://doi.org/10.9734/jpri/2021/v33i34A31822.
24. Panbude, Mahima Dipak, Mayuri Manikrao Paropate, Mansi Vinod Pande, Priyanka Dayaram Pal, Chatur Kamlakar Patil, and Ranjana Premnath Sharma. “Evaluation of Effectiveness of Information Booklet Regarding Self-Care among Patients Receiving Chemotherapy in Selected Hospitals of Wardha and Nagpur, India.” Journal of Evolution of Medical and Dental Sciences 10, no. 18 (May 3, 2021): 1329–33. https://doi.org/10.14260/jemds/2021/280.
25. Pandey, Aishvarya. “Neuroligical Disorders Due To Malnourishments.” Bioscience Biotechnology Research Communications 14, no. 6 (June 15, 2021): 45–48. https://doi.org/10.21786/bbrc/14.6.10.
26. Pandey, Milind, Sunita Vagha, Raunak Kotecha, and Anchal Manchanda. “Primary Gastric Lymphoma (Diffuse Large B Cell Type).” Journal of Pharmaceutical Research International, July 13, 2021, 54–57. https://doi.org/10.9734/jpri/2021/v33i37A31979.
27. Pandey, Milind, Sunita Vagha, Gaurav Mahajan, and Anchal Manchanda. “A Brief Study on Retroperitoneal Paraganglioma.” Journal of Pharmaceutical Research International, July 31, 2021, 64–66. https://doi.org/10.9734/jpri/2021/v33i39B32184.
28. Pandey, Vidya Bhushan, Renu Bharat Rathi, Bharat Rathi, and Jitesh Verma. “Evaluation of Comparative Efficacy of Brahmi vs. Haritaki Extract in the Management of Academic Stress in Adolescent Students- A Prakriti Based Double-Blind Randomized Controlled Trial.” Journal of Pharmaceutical Research International, November 6, 2021, 159–69. https://doi.org/10.9734/jpri/2021/v33i48A33233.
29. Pandya, Naman Kirit, and Utsav Umang Bhatt. “Inflammatory Myofibroblastic Tumor of Hard Palate: A Lesion of Extreme Rarity.” Pan African Medical Journal 38 (2021). https://doi.org/10.11604/pamj.2021.38.267.28236.
30. Pandya, Naman Kirit, and Anendd Arroon Jadhav. “Descending Necrotising Fasciitis of Head and Neck Secondary to Insect Bite: Report of a Rare Case.” Pan African Medical Journal 38 (2021). https://doi.org/10.11604/pamj.2021.38.271.28594.
31. Parate, Ashutosh, Vasant Gawande, Suvarn Gupta, Ankit Jaiwal, Ashwin Chavan, and Kunal Saoji. “A Comparative Study of Functional Outcome of Olecranon Fractures Managed with Tension Band Wiring Using K Wires with Tension Band Wiring Using Cancellous Screws Fixation.” Journal of Pharmaceutical Research International, July 15, 2021, 193–98. https://doi.org/10.9734/jpri/2021/v33i37A31996.
32. Pardasani, Rajiv, and Sohan Lohiya. “Study of Changes in Corneal Thickness and Corneal Endothelial Cell Density after Phacoemulsification Cataract Surgery.” Journal of Evolution of Medical and Dental Sciences 10, no. 12 (March 22, 2021): 866–72. https://doi.org/10.14260/jemds/2021/187.
33. Pardhekar, Ashvini Dineshrao, Sadhana Misar(Wajpeyi), and Vinod Ade. “Protocol on Comparative Clinical Efficacy of Tryushanadi Guggul and Navaka Guggul in Sthoulya (Overweight).” Journal of Pharmaceutical Research International, June 2, 2021, 169–75. https://doi.org/10.9734/jpri/2021/v33i30A31628.
34. Parihar, Pratapsingh Hanumantsingh, and Sharvari Shashikant Gulve. “Mediastinal Extension of Pancreatic Pseudocyst – A Case Report.” Journal of Evolution of Medical and Dental Sciences 10, no. 5 (February 1, 2021): 316–18. https://doi.org/10.14260/jemds/2021/70.
35. Parsodkar, Rucha P., Aliabbas A. Husain, Gargi D. Mudey, Lokendra R. Singh, and Rajpal S. Kashyap. “Diagnosis of Bacterial Meningitis and AMR Profile Using Molecular and Immunological Techniques.” Journal of Pharmaceutical Research International, July 22, 2021, 89–105. https://doi.org/10.9734/jpri/2021/v33i38A32063.
36. Parveen, Sana, Shraddha Jain, Sunil Kumar, Sourya Acharya, and Dhruv Talwar. “Evolution of Middle Ear Modelling Techniques: A Review.” Cureus, December 30, 2021. https://doi.org/10.7759/cureus.20829.
37. Parwe, Shweta, Poonam Ashtankar, Piyush Bhagwat, and Milind Nisargandha. “Study the Efficacy of Rodhradigana Vasti in the Management of Sthaulya (Overweight).” Journal of Pharmaceutical Research International, July 2, 2021, 158–66. https://doi.org/10.9734/jpri/2021/v33i34B31858.
38. Parwe, Shweta, Sandip Jadhav, and Milind Nisargandha. “Comparative Clinical Trial on Aragwadha Erand and Trivrutta Eranda Nitya Virechana in

Gridhrasi (Lumbago Sciatica Syndrome): A Study Protocol." Journal of Pharmaceutical Research International, July 29, 2021, 68–74. https://doi.org/10.9734/jpri/2021/v33i39A32143.
39. Parwe, Shweta, Manju Mohan, Piyush Bhagwat, and Milind Nisargandha. "Effect of Rodhradi Gana Udavartana in the Management of Sthaulya (Overweight) with Special Reference to Obesity." International Journal of Pharma and Bio Sciences 11, no. 3 (May 4, 2021). https://doi.org/10.22376/ijpbs/lpr.2021.11.1.L30-37.
40. Parwe, Shweta, Swati Tikale, Puja Shrivastav, and Milind Nisargandha. "A Critical Review on Formulations Used in the Management of Malavstambha (Constipation)." Journal of Pharmaceutical Research International, June 30, 2021, 92–100. https://doi.org/10.9734/jpri/2021/v33i34A31828.
41. (Pate), Meenakshi Yeola, Kushagra Singh, Darshana Tote, Azeem Javed Aalam, and Pankaj Gharde. "Metastatic Carcinoma Breast Presenting as Appendicular Abscess." JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH, 2021. https://doi.org/10.7860/JCDR/2021/44398.14412.
42. Patel, Abhi, Swarupa Chakole, and Neha Bhatt. "Psychological Stress Due to Covid-19 on Pregnant Women in Post Partal Period." Journal of Pharmaceutical Research International, December 16, 2021, 458–61. https://doi.org/10.9734/jpri/2021/v33i58B34225.
43. Patel, Aditya, Samrudhi Gujar, Savita Pohekar, Ruchira Ankar, Arati Raut, Sheetal Sakharkar, Vaishali Tembhare, and Pranali Wagh. "Non-Hodgkin's Lymphoma: A Case Report." Journal of Pharmaceutical Research International, December 8, 2021, 264–67. https://doi.org/10.9734/jpri/2021/v33i53B33705.
44. Patel, Divyank, Zainab Gandhi, Rupak Desai, Jilmil Raina, Vikram Itare, Fariah Asha Haque, Taha Saeed, et al. "Impact of Alcohol Use Disorder on Stroke Risk in Geriatric Patients with Prediabetes: A Nationwide Analysis." International Journal of Clinical Practice 75, no. 9 (September 2021). https://doi.org/10.1111/ijcp.14477.
45. Patel, Drashti. "Covid-19 In Pregnant Women." Bioscience Biotechnology Research Communications 14, no. 6 (June 15, 2021): 275–79. https://doi.org/10.21786/bbrc/14.6.58.
46. Patel, Leksha Atul, Vaishnavi Dilip Yadav, Moli Jai Jain, and Om C. Wadhokar. "Positive Outcomes of Comprehensive Exercise Program on Restoration of Functional Level and Quality of Life in a Patient with Rheumatic Heart Disease Undergone Mitral Valve Replacement: A Case Report." Journal of Pharmaceutical Research International, October 15, 2021, 379–84. https://doi.org/10.9734/jpri/2021/v33i46A32879.