Study Protocol

Evaluation of photobiomodulation while preventing pressure injuries in COVID-19 patients: a randomised, controlled, double-blind, clinical protocol

**1. ABSTRACT**

Due to the high incidence, pressure injuries (PIs) are considered a serious public health problem and a negative indicator of the quality of nursing care. The aim of the present study is to investigate the preventive effects of photobiomodulation (PBM) applied to areas most susceptible to the development of PIs in patients hospitalised with COVID-19. This paper describes the protocol for a randomised, controlled, double-blind, clinical trial involving hospitalised participants at high or moderate risk of developing PIs. The participants were randomised into two groups: a control group (n = 70) submitted to the standard institutional procedures for PI prevention and a PBM group (n = 70) submitted to the same procedures as the control group, along with PBM applied once per day for 10 minutes to each of the three most commonly affected regions (sacral and bilateral calcaneal areas). PBM was administered using a 264-LED panel consisting of 132 LEDs at a wavelength of 660 nm and 132 at 850 nm. The incidence of PI was investigated every 48 hours after hospital admission for a period of one month. Statistical analysis will be performed considering α = 0.05.

**Keywords**: pressure ulcer, photobiomodulation, low-level laser therapy, primary prevention, bedsores, primordial prevention, sepsis, gangrene.

**2. INTRODUCTION**

Photobiomodulation is a form of light therapy that employs light sources, such as laser and LEDs, that has been shown to reduce inflammation, promote angiogenesis, enhance the formation of immature muscle fibres, and improve the deposition and organisation of collagen (Ribeiro et al., 2015). Applying a panel of LEDs to areas with a high incidence of pressure injuries (PIs), such as the sacral and calcaneal regions, may help prevent the development of bedsores. Studies have demonstrated a significant increase in microcirculation when LED therapy is applied at wavelengths of 625, 660, and 850 nm with an energy density of 2.4 J/cm² (Frangez et al., 2017). Growing evidence also supports the potential of PBM for accelerating the healing process and preventing tissue damage (Guimaraes et al., 2021; Jana Neto et al., 2023; Malavazzi et al., 2024).

Pressure injuries constitute a serious public health problem and are an indication of inadequate nursing care (Rogenski & Kurcgant, 2012; Hyun et al., 2014; Polancich et al., 2021). PIs are highly prevalent in both public and private hospitals, lead to increased hospitalisation stays and costs, and exert a significant impact on the quality of life of patients (Li et al., 2020). The incidence of PIs in patients with COVID-19 is strongly influenced by specific risk factors, such as inflammatory processes, a lack of an accompanier, staff restrictions, and prolonged sedation periods (Gefen & Ousey, 2020; Pokorná et al., 2022; Barja-Martínez et al., 2023; Narang et al., 2023). A systematic review on the incidence of PIs in this population, including nineteen studies with a total of 28,102 patients, found that 2.88% developed at least one PI during hospitalisation. The occurrence of PIs was significantly higher in patients submitted to invasive mechanical ventilation maintained in the prone position, those with insufficient support staff, and those with prolonged hospital stays. However, lower PI rates were found in settings with nursing teams specialised in wound and skin care and dedicated proning teams (Bourkas et al., 2023). Therefore, in addition to existing best practices implemented in healthcare institutions, exploring new strategies to reduce the incidence of PIs is essential.

This paper describes a study protocol for patients diagnosed with COVID-19 who have significant systemic complications and a high risk of developing PIs. Given the limited scientific evidence on the use of PBM with the dosimetric parameters tested for the prevention of PIs, the aim of the study is to offer valuable insights that could contribute to the administration of this treatment modality in clinical practice and serve as a basis for further randomised, controlled, double-blind, clinical trials.

**3.** **METHODS**

**3.1 Study Design**

The randomised, controlled, double-blind, clinical trial described in this paper received approval from the Human Research Ethics Committee of Nove de Julho University (certificate number: 48359121.0.0000.5511). The aim of the study was to evaluate the effects of photobiomodulation (PBM) for the prevention of pressure injuries (PIs) in patients hospitalised with COVID-19 infection.

**3.2 Participant Selection**

The participants were patients hospitalised at the Profª Lydia Storópoli Hospital, which has 180 beds in the wards and 30 in intensive care dedicated to the treatment of patients with COVID-19. This is a single-centre clinical trial with two parallel groups, each comprising seventy participants (total: 140 participants). The study was designed following the guidelines of the SPIRIT statement (<https://www.spirit-statement.org/>).

**3.3 Inclusion Criteria**

Male and female patients 18 years of age or older hospitalised at the Profª Lydia Storópoli Hospital with a confirmed diagnosis of COVID-19 were eligible for participation in the study. The participants needed to have a very high, high, or moderate risk of developing pressure injuries, as determined by the Braden Scale for Pressure Injury Risk Assessment (14 points or lower) (Jansen et al., 2020).

**3.4 Exclusion Criteria**

Patients with any condition affecting the lumbar or calcaneal regions, such as active neoplasms, established osteomyelitis, pre-existing deep tissue injuries, or necrotic or infected lesions were excluded from the study. Individuals with a history of photosensitivity, those with significant neurological or psychiatric disorders, and those diagnosed with diabetes mellitus were also excluded.

**3.5 Blinding**

The study was conducted by a team of researchers. The researcher in charge of supervising the interventions, which involved the administration of either active or sham PBM, was the only one aware of the intervention performed on each participant. Another researcher blinded to the allocation of the patients to the experimental and control groups performed the initial outcome assessment and reassessment. Statistical analysis was also performed in a blinded manner by a statistician who received de-identified data. Additionally, the patients were unaware of whether they were receiving active or sham PBM. The intervention was performed immediately after the daily bedside bath.

**3.6 Sample Description**

The sample size was calculated based on the results of the study conducted by Moore et al. (2011), the outcome of which was the incidence of pressure injuries. The calculation was based on a 3% incidence of PIs in the experimental group and 11% in the control group (Moore et al., 2011). The literature reports that the regions most affected regions by ulcers in patients with COVID-19 (gluteal region, calcaneus, nasal mucosa, tongue, lips, and urethra) develop PIs even under minimal pressure (Pezzarossa et al., 2021; Yu et al., 2021). These PIs initially manifest as inflammation and progress to thick eschars. The incidence of PI varies widely in patients with COVID-19 depending on the level of care provided. In those subjected to the prone position on mechanical ventilation and with limited assistance, incidence rates range from 38.7% to 92%. Conversely, incidence rates are lower in patients receiving specialised care from a proning team and specialists in skin and wound care, ranging from 0.99% to 47.6% (Bourkas et al., 2023).Thus, an effect of 15% was estimated for the control group in this study. The sample size was calculated using the G\*Power 3.1.9.4 software program with the following specifications: Z-test method, a significance level of 0.05 (5% type I error rate and 95% confidence interval), 5% absolute error rate, and 80% power. The required sample size was 140 individuals (70 in each group).

The sample size of 140 participants is expected to provide sufficient statistical power to detect potential differences in the incidence of PI between groups, considering an estimated 3% incidence in the experimental group and 11% in the control group based on previous studies (Moore et al., 2011). The purpose of this calculation is to minimise the risk of type I and type II errors, thus enhancing the reliability and potential generalisation of the findings.

**3.7 Randomisation**

The allocation sequence was prepared by an individual not otherwise involved in the study, who was also responsible for preparing the sealed envelopes. The website [www.sealedenvelope.com](http://www.sealedenvelope.com) generated a randomised sequence, ensuring a balanced (1:1) allocation of 140 participants into two groups. Sequentially numbered opaque envelopes contained a sheet of paper specifying the assigned experimental group (Group 1 or Group 2) according to the randomisation sequence. These envelopes were sealed and stored securely, remaining unopened until the beginning of active or simulated treatment. The researcher responsible for administering the intervention opened the envelope (without altering the numerical sequence of the remaining envelopes), performed the assigned procedure, and was the only researcher aware of the intervention applied to each participant.

**3.8 Study Protocol and Group Composition**

Data were collected for the characterization of the sample. Upon hospital admission, a skin assessment was performed, and the risk of pressure injury was assessed using the Braden Scale. The data were entered onto an Excel spreadsheet. The participants were assessed for the risk of PI every 48 hours. If risk was identified and the patient met the inclusion criteria, preventive measures were initiated, including barrier protection and the application of active or sham PBM according to the randomisation procedure. If a participant developed a pressure injury, an incident report was filed and the supervising nurse was informed to notify the researcher.

**3.9 Risk Assessment**

The Braden Scale for Pressure Injury Risk Assessment was used, which consists of six subscales addressing key risk factors: sensory perception, activity, mobility, moisture, nutrition, friction, and shear. The total score ranges from 6 to 23 points, determining the presence or absence of risk for PIs. Five subscales are scored from 1 to 4, while the sixth subscale is scored from 1 to 3. A score of 1 corresponds to the highest risk, whereas a score of 4 indicates a low risk of the development of PIs. Thus, lower total scores indicate a greater likelihood of developing PIs (Vieira, 2009; Gomes et al., 2011). Participants were classified according to the total score received upon admission and during reassessment every 48 hours. Those classified as being at very high, high, or moderate risk (14 points or less) were included in the study.

**3.10 Study groups**

Control/sham group (n = 70): The participants in this group received the preventive care protocol routinely performed at the hospital. The researcher in charge of administrating PBM simulated irradiation by positioning the devices in the exact locations as described for the PBM group, but the equipment remained off.

PBM group: The participants allocated to this group received the preventive care protocol routinely performed at the hospital plus PBM administered once daily. The irradiated sites were the bilateral calcaneal regions (10 minutes each) and sacral region (10 minutes). Irradiation was performed using a Sportllux (Cosmedical, SP, Brazil) LED panel (Figure 1), the specifications of which are detailed in Table 1.

**Table 1:** Dosimetric Parameters for Preventive PBM

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| **Technical Parameters** | **Sportllux** |
| Light Source | LED |
| Application Technique | Contact |
| Wavelength | 132 LEDs with 660nm |
| 132 LEDs with 850nm |
| Spectral Band | 20 nm |
| Beam Area at Target | 0.5 cm² |
| Average Power per LED | 8 mW |
| Irradiance | 16 mW/cm² |
| Application Time | 10 minutes |
| Energy per LED | 4.8 J |
| Radiant Exposure | 9.6 J/cm² |
| Light Emission Angle | 120°  |

The dosimetric parameters used in this study are within the range reported for tissue healing. PBM has been administered for tissue repair with radiant exposure ranging from 0.1 to 10 J/cm² and wavelengths between 405 and 1,000 nm (Mosca et al., 2019). A recent study on PBM for the prevention of diabetic foot ulcers reported radiant exposure of 6 and 7 J/cm² using light sources of 660 and 850 nm (Lourenço et al., 2025). However, no studies were identified on the prevention of bedsores in patients hospitalized with COVID-19.



Figure 1: SportLux LED panel used for preventive irradiation of areas most susceptible to development of pressure injuries.

**3.11 Intervention and Follow-Up**

All participants in both groups remained in assessment for 30 days or until discharge from hospital if occurring prior to 30 days. Data on patients who chose to withdraw from the study were statistically analysed following the intention-to-treat principle.

**3.12 Outcomes**

**Primary Outcome**

* Incidence of Pressure Injuries (PIs): The incidence of PIs was investigated every 48 hours after hospital admission for a total of 30 days or until discharge from hospital if occurring prior to 30 days. The number of cases positive for PI was recorded in both groups.

**Secondary Outcomes**

* Time Until Appearance of PI: The number of days from hospital admission until the first evidence of PI was recorded, considering even Stage 1 lesions, characterised by non-blanchable erythema with intact skin (Vieira, 2019).
* Correlation Between Incidence of PI and Anthropometric and Clinical Data: Demographic and clinical data of the participants were recorded upon inclusion in the study and were analysed for potential correlations with the risk of the development of PIs in the two study groups. All data were stored on an Excel spreadsheet.

**3.13 Statistical Analysis**

Statistical analysis will be conducted blindly by a statistician receiving the dataset without group identification. Normality (Shapiro-Wilk test) and homogeneity of variance (Levene's test) will be investigated. Numerical data will be analysed using the Mann-Whitney test and expressed as median and interquartile range (25-75%). Categorical data will be analysed using the chi-square test and Fisher's exact test will be applied when the expected value is less than 5. Categorical data will be expressed as absolute and relative frequencies. Spearman's correlation coefficients will be calculated for continuous numerical variables with non-Gaussian distribution. All statistical analyses will be performed using the SPSS software, with a significance level of α = 0.05. Randomisation and blinding will ensure unbiased treatment allocation and outcome assessments. Stratification of the participants based on key confounders (e.g., age, comorbidities, BMI, Braden Scale score, and disease severity) will help balance these factors between groups. Statistical adjustments, such as analysis of covariance, will control for confounders during the analysis. Additionally, standardising care protocols across both groups will help avoid care-related biases. Sensitivity analysis will enable the reassessment of data to determine the impact of potential confounders. Lastly, a Kaplan-Meier plot and log-rank test will be performed, accounting for patient losses during the analysis period.

**3.14 Ethical Considerations**

All individuals invited to participate in the study received verbal and written explanations of the study, as described in the statement of informed consent signed in two copies (one for the researchers and one for the participant) by the patients or their legal representative who agreed to participate. The study was conducted following the ethical precepts stipulated in the Declaration of Helsinki, was registered on Plataforma Brazil, was submitted to the Human Research Ethics Committee of Nove de Julho University, and commenced only after the research project was approved, following current resolutions.

**4.** **CONCLUSION**

Pressure injuries constitute a serious public health issue and a negative indicator of the quality of nursing care. Despite the existence of various preventive interventions, prophylactic dressings constitute the only intervention with scientifically proven effectiveness. Photobiomodulation has achieved significant benefits in terms of wound healing, the control of inflammation, and the prevention of inflammatory conditions in the skin and mucosa. Therefore, investigating the preventive effects of PBM on the development of PIs is warranted, particularly in patients hospitalized for the treatment of COVID-19.

**Data Availability Statement -** All data will be available to the readers.

**Ethical Approval**

The protocol for this study received approval from the Human Research Ethics Committee of Nove de Julho University (certificate number: 03645518030015511).

**Dissemination policy:** All trial results will be shared with the participants, healthcare providers, public, and relevant groups.

**Disclaimer (artificial intelligence)**

The authors declare that generative AI technologies, specifically OpenAI’s ChatGPT (version GPT-4o), were used during the editing process to enhance the quality of the English language of this manuscript.

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