Title

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Publication Date

2025-04-01

DOI

10.1016/j.jaad.2025.04.031

ORIGINAL ARTICLE

Evidence-based consensus on the clinical application of photobiomodulation

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Background: There is a lack of evidence-based consensus to assist clinicians in using photobiomodulation (PBM).

Objective: To create a consensus on the safe and effective use of PBM.

Methods: A systematic literature review of Embase and MEDLINE was conducted in June 2022 to identify publications reporting research on PBM. An international multidisciplinary panel was convened to draft recommendations informed by the systematic search; they were refined through 2 rounds of Delphi survey, 2 consensus meetings, and iterative review by all panelists until unanimous consensus was achieved.

Results: A multidisciplinary panel of experts (n = 21) was assembled based on publication history. The key findings that informed the consensus developed by the expert panel were as follows: PBM is a safe treatment modality for adult patients and red light PBM does not induce DNA damage. PBM is an effective treatment option for peripheral neuropathy, androgenic alopecia, wound ulcers due to multiple etiologies, decubitus ulcers, pain attributed to diabetic foot ulcers, and acute radiation dermatitis.

Conclusion: The systematic literature search and structured Delphi consensus approach culminated in an evidence-based clinical practice guideline for safe and effective use of PBM in medical and aesthetic

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Funding sources: None.

Patient consent: Not applicable/Not needed as this study did not involve patients.

IRB approval status: Not applicable.

Accepted for publication April 14, 2025.

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Published online May 18, 2025.

0190-9622/$36.00

https://doi.org/10.1016/j.jaad.2025.04.031

applications. Future research will further bolster our understanding of this evolving noninvasive technique. (J Am Acad Dermatol https://doi.org/10.1016/j.jaad.2025.04.031.)

Key words: acute radiation dermatitis; androgenic alopecia; cognition; cytochrome c oxidase; decubitus ulcers; LLLT; low-level light therapy; musculoskeletal; near-infrared light; PBM; peripheral neuropathy; photobiomodulation; red light; sports performance; stroke; wound healing.

INTRODUCTION

Photobiomodulation (PBM), previously known as low-level laser light therapy (LLLT), represents a form of phototherapy that uses wavelengths in the red light (RL) (620-700 nm) and near-infrared (NIR) (700-1440 nm) spectrum.[1] The stimulating effects of PBM were initially discovered following irradiation with a low-power ruby laser resulting in hair regrowth.[2] Thereafter, there has been a substantial increase in the number of published reports describing the clinical applications of PBM.[1,3] The therapeutic efficacy of PBM is primarily attributed to the modulation of mitochondrial cytochrome c oxidase (COX) activity.[3] Although PBM has gained significant attention in the medical, athletic, and aesthetic communities, its efficacy on target tissue relies on optimization of several parameters including light source (eg, light emitting diode [LED], laser), wavelength, energy density, light structure, and duration of laser application. There is a marked heterogeneity in PBM protocols used in published reports making interstudy comparison and translation in clinical practice challenging. This lack of consensus on standardized treatment parameters for PBM limits its applicability in clinical practice and hinders standardized research. The objective of the study is to develop a structured consensus among interdisciplinary, recognized experts for definitions, clinical applicability, and safety of PBM.

CAPSULE SUMMARY

- Evidence-based consensus regarding photobiomodulation is sparse.
- Photobiomodulation is a safe treatment modality for adult patients, and it is an effective treatment option for peripheral neuropathy, androgenic alopecia, wound ulcers due to multiple etiologies, decubitus ulcers, pain attributed to diabetic foot ulcers, and acute radiation dermatitis.

METHODS

The study was deemed exempt from the institutional review board. The primary objective of the study is to develop a structured consensus among clinical experts regarding the use of visible RL and NIR in the management of various medical and skin conditions.

Consensus questions

This aim of the Delphi consensus is to meticulously address the ensuing key questions:

1. What are the indications and contraindications for PBM?
2. What is the main mechanism of action of RL-induced and NIR-induced PBM?
3. What are the key parameters to report for PBM?
4. What are the important safety considerations for PBM?

Guideline development process

Study management.

The study was conceptualized and spearheaded by the Steering Committee (D.O., J.J., H.W.L., I.K., J.M., and J.M.). The database was managed through Google Forms, leveraging its integrated web development services for configuration and maintenance of the hosting environment. This web-based platform enabled the anonymous submission and subsequent rating of content by participants.

The steering committee conducted a systematic review of PBM. The comprehensive literature search was performed using OVID Medline, Embase, and Web of Science databases in June 2022 according to Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines. Criteria for inclusion included clinical (eg, observational and randomized controlled trials) studies investigating the utility of LLLT/PBM and/or RL therapy in the treatment of conditions across all specialties. Reports identified for inclusion were systematically evaluated to generate an item list, employing the Grading of Recommendations Assessment, Development and Evaluation approach for quality assessment. A multidisciplinary panel of expert stakeholders composed of medical and cosmetic dermatologists, neurologists, physical medicine and rehabilitation physicians, dentists, and pulmonologists which was assembled based on publication history (including prior publication of guidelines related to PBM or low-level laser/light therapy), clinical and scientific expertise, peer nomination, and recognition as expert leaders in related areas of research. To build this panel of experts to participate in the Delphi, all senior, first, and corresponding authors for each

Abbreviations used:

COX: cytochrome c oxidase
LED: light emitting diode
LLLT: low-level laser light therapy
NIR: near-infrared
PBM: photobiomodulation
RL: red light

clinical article from the systematic review were identified. The number of PBM papers for each author was determined based on a PubMed search using the terms "(photobiomodulation) OR (low level laser therapy) AND (author)." Experts with the highest number of publications in the field were prioritized and subsequently invited to participate in the Delphi. Of the 21 panelists, 4 (19%) declared conflicts of interest. Of the 4, 2 reported receiving funds exclusively for research.

Through the systematic review, accompanied by panel deliberations, we generated an extensive list of items pertinent to PBM. This list underwent meticulous revision and refinement through 2 rounds of Delphi surveys and a pair of virtual consensus meetings, with all panel members actively participating as Delphi respondents.

Statistical analysis

During Round 1 and 2 of this e-Delphi study, participants were asked to independently rank statements using a 7-likert scale ("strongly agree," "agree," "neutral," "disagree," "strongly disagree," and "decline to answer as this is outside my area of expertise"). There was also an option for participants to type in their own responses as free text. Consensus was defined as $\geq$ 80% agreeing/strongly agreeing or $\geq$ 80% disagreeing/strongly disagreeing.

Delphi questionnaires

This study, encompassing more than the administration of questionnaires, involved a comprehensive process including the development of questions and the selection of panel members. It consisted of 2 electronic questionnaire rounds.

Following a virtual gathering of all panelists in May 2023, the first round's statements were developed to establish consensus on key aspects such as physiology, parameters, safety, and efficacy across medical specialties represented in the literature. For each question, we provided corresponding article references, enabling participants to access full-text articles for in-depth review and informed evaluation. Those who selected "disagree," "strongly disagree," and "unable to answer" were prompted to provide a written explanation. Analysis of the responses and feedback were taken into consideration to create the iterative questionnaire with the goal of reaching consensus opinions from experts. Participants were asked to complete a set of questions using a 7-likert scale and free text response options.

After Round 1, questionnaire results and data response rates for each statement were distributed to all participants. Participants were then asked to complete the next iteration of the Delphi. A second virtual meeting was held in September 2023 with the goal to refine initial statements from Round 1 that did not meet the threshold for consensus. Following a collective discussion among committee members, additional statements derived from the free text responses (based on panelists' expert input) to Round 1 were included in Round 2. The 7-likert scale and free text response options remained the same.

After Round 2, the results were distributed to the participants. A 14-day period was given to all Delphi participants to submit any comments before the next phase of the Delphi which included the final analysis and manuscript write-up.

RESULTS

The steering committee was comprised of 8 members. An initial review of the literature identified 526 PBM authors. Subsequent analysis narrowed this to 62 candidates for potential inclusion, which included 4 members of the steering committee. These individuals were extended invitations, with 21 accepting to contribute to the Delphi study. This cohort of contributors spanned a diverse spectrum of expertise, encompassing fields such as dermatology, dentistry, neuroscience, physical medicine and rehabilitation, and physical therapy, primarily hailing from the United States (76.2%). International expertise was also represented by specialists from Egypt, Japan, Brazil, and Sweden.

In addition, the 21 Delphi panelists constituted national and internationally recognized experts in medicine and dermatology with more than half (13 [61.9%]) being dermatologists. The remaining Delphi participants represented other specialties within medicine and health sciences including physical sciences (2 [9.5%]), dentistry (2 [9.5%]), internal medicine and geriatric care (2 [9.5%]), physical therapy (1 [4.76%]), anatomist and physiologist (1 [4.76%]), and neurology (1 [4.76%]).

Between May and September 2023, the 21 selected participants engaged in the initial Delphi survey, with a subsequent follow-up survey achieving a retention rate of 100%. These contributors boasted an average publication count of 207.4 (ranging from 30 to 512), including an average of 13.75 publications specifically focusing on PBM,

with individual contributions varying from 1 to 58. Their scholarly impact, as measured by the h-index, averaged at 41.3, with a span from 8 to 137.

Round 1

Overall, 63 statements were presented in the first round, during which 2 additional items were proposed by the Delphi participants. There were 19 statements addressing PBM core principles and parameters. Statements regarding the following clinical safety and efficacy topics were included: pediatrics (1), musculoskeletal system (2), cardiovascular system (2), pulmonary system (2), central and peripheral nervous systems (5), cognitive and neurodegenerative system (2), wound healing (4), ulcers (3), maxillofacial and oral condition (5), medical dermatology (5), alopecia (2), autoimmune conditions (2), radiation dermatitis (1), cutaneous infections (2), and cosmetic dermatology (6).

Consensus was achieved for 26 (41.2%) statements. Of these, 14 (53.8%) statements related to the core principles and parameters of PBM.

Round 2

Following the steering committee discussion, 12 statements were removed from the Delphi. Of those, 7 were removed due to limited expertise by panelists. These statements pertained to the clinical application of PBM in various disciplines of medicine (eg, dermatology, cardiovascular system, pulmonary system, cognitive function, central nervous system, and peripheral nervous system).

Of the remaining statements, those with a Round 1 consensus agreement of less than 80% and 1 statement with a disagreement of 40% were included in Round 2 (n = 24). Round 2 included 2 additional statements derived from the free text responses to Round 1 for a total of 26 statements. There were 6 statements addressing PBM core principles and parameters. Statements regarding the following clinical safety and efficacy topics were included: pediatrics (1), musculoskeletal (1), cardiovascular (1), pulmonary (1), cognitive and neurodegenerative (1), wound healing (1), maxillofacial and oral conditions (5), medical dermatology (4), alopecia (1), cutaneous infections (1), and cosmetic dermatology (3).

During Round 2, consensus was achieved for 12 (42.9%) statements. Of these, 6 (50%) statements related to the core principles and parameters of PBM. During the 14-day comment period, none of Delphi participants had additional comments.

CONSENSUS FOR USE OF PBM

A total of 38 statements regarding core principles and parameters, clinical safety, and efficacy of PBM reached consensus (Table I). Based on these expert consensuses and level of evidence (Table II), the authors make the following statements and recommendations regarding PBM.

Definition and principles

Consensus 1: definition of photobiomodulation. Prior to its use in clinical practice, it remains essential for clinicians to understand the fundamental principles and basic definition of PBM. Despite the heterogeneity identified in published reports, our recommendation for PBM definition is as follows:

1. PBM is defined as a form of light therapy that uses nonionizing forms of light sources including lasers, LEDs, and broadband light in the visible (400-700 nm) and NIR (700-1100 nm) spectrum.[4]
2. RL (600-700 nm) and NIR light (780-1100 nm) represent the most commonly used wavelengths in PBM.[5]

Consensus 2: mechanism of action of photobiomodulation.

1. The expert panel recognized that COX is the primary but not the sole biological photoacceptor and transducer of signals activated by light in the red and NIR regions of the spectrum.[5,6] PBM improves the generation of adenosine triphosphate, a central cellular metabolite, through the activation of COX.[5-7]
2. Clinicians must also recognize that PBM can result in either a stimulatory or inhibitory effect, which is primarily dependent on the parameters used.[8-13] Lower fluences are generally associated with stimulation and higher fluences are associated with inhibition.[8-13]

Consensus 3: photobiomodulation parameters.

1. The results from this Delphi exercise further highlight the importance of measuring and reporting of PBM parameters. There was a significant heterogeneity in the reporting of PBM parameters in the included published reports. The following PBM parameters were deemed essential. These include fluence (J/cm^2), distance (from the light source to the target area), wavelength, irradiation (measured in minutes/seconds), beam area/spot size, treatment frequency, and treatment duration.[3] In PBM, the treatment period describes the administration time (seconds to minutes to hours) and the frequency of treatments (eg, days to weeks). Treatment can be performed using either lasers or LEDs. Distance (mm) measures the space between the light source and the treatment target. As the light source moves further from

Table I. A total of 38 statements regarding core principle and parameters and clinical safety and efficacy of photobiomodulation reached consensus, defined as ≥80% agreeing/strongly agreeing or disagreeing/strongly disagreeing

Statement category	Statement
Core principles and parameters	Photobiomodulation is defined as a form of light therapy that uses nonionizing forms of light sources including lasers, LEDs, and broadband light in the visible (400-700 nm) and near-infrared (700-1100 nm) spectrum.
Core principles and parameters	Red light (600-700 nm) and near-infrared light (780-1100 nm) represent the most commonly used wavelengths in photobiomodulation.
Core principles and parameters	Cytochrome c oxidase is the primary but NOT sole biological photoacceptor and transducer of signals activated by light in the red and near-infrared regions of the spectrum.*
Core principles and parameters	The biological effects of photobiomodulation are primarily, but not soley, mediated by cytochrome c oxidase.*
Core principles and parameters	Photobiomodulation improves the generation of adenosine triphosphate, a central cellular metabolite, through the activation of cytochrome c oxidase.*
Core principles and parameters	Photobiomodulation can be stimulatory or inhibitory based on the parameters used, with lower fluences generally associated with stimulation and higher fluences associated with inhibition.
Core principles and parameters	Photobiomodulation therapy is generally safe to use when applied as directed by physician, provider, or home-based device instructions.
Core principles and parameters	Photobiomodulation, with red and near-infrared light, does not generate DNA damage associated with cancer and aging.
Core principles and parameters	Photobiomodulation dose is measured by fluence (J/cm^2), which represents irradiance ($Watt/cm^2$) and time (s).
Core principles and parameters	Fluence should be measured and reported in PBM clinical studies and practice.
Core principles and parameters	Distance, from the light source to the target area, should be measured and reported in PBM clinical studies and practice.
Core principles and parameters	Wavelength should be measured and recorded in PBM clinical studies and practice.
Core principles and parameters	Irradiation, measured in minutes/seconds, should be measured and reported in PBM clinical studies and practice.
Core principles and parameters	Beam area/spot size should be measured and reported in PBM clinical studies and practice.
Core principles and parameters	Side effects from photobiomodulation therapy are generally mild, limited to mild sensation of pain/discomfort, burning, blistering, edema, and erythema.
Core principles and parameters	Mild side effects from photobiomodulation therapy are generally temporary and self-resolving.
Core principles and parameters	Photobiomodulation therapy rarely causes severe side effects, such as second-degree and third-degree burns, scarring, sepsis, carcinogenesis, and death.
Core principles and parameters	Without ocular safety data, it is advisable to wear wavelength-specific eye protection for patients and providers when receiving or administering photobiomodulation treatment.*
Core principles and parameters	Data on the long-term effects of prolonged use of photobiomodulation are limited.*
Core principles and parameters	Photobiomodulation treatment frequency and treatment duration should be recorded in photobiomodulation clinical studies and practice.*
Clinical safety & efficacy: pediatrics	Short-term and long-term safety data on the use of photobiomodulation therapy in pediatric patients are lacking.*
Clinical safety & efficacy: musculoskeletal	Photobiomodulation therapy is generally a safe treatment for musculoskeletal conditions.

Continued

Table I. Cont'd

Statement category	Statement
Clinical safety & efficacy: musculoskeletal	Depending on the energy dose, photobiomodulation may have inhibitory or stimulatory effects on skeletal muscle performance and fatigue.
Clinical safety & efficacy: central & peripheral nervous systems	Photobiomodulation therapy is generally a safe treatment for peripheral nervous system conditions.
Clinical safety & efficacy: cognitive & neurodegenerative	Photobiomodulation can be used as an adjunct therapy in the treatment of peripheral neuropathy.
Clinical safety & efficacy: cognitive & neurodegenerative	Photobiomodulation therapy is generally a safe treatment for improving cognition.*
Clinical safety & efficacy: wound healing	Photobiomodulation can accelerate wound healing.
Clinical safety & efficacy: wound healing	Photobiomodulation can be considered as an adjunct therapy in the treatment of wounds due to multiple etiologies.
Clinical safety & efficacy: wound healing	Photobiomodulation therapy is an effective adjunct therapy in the management of patients with moderate to severe burns.*
Clinical safety & efficacy: ulcers	Photobiomodulation can be used as an adjunct therapy in the treatment of pain attributed to diabetic foot ulcers.
Clinical safety & efficacy: ulcers	Photobiomodulation can be considered as an adjunct therapy in the treatment of decubitus ulcers.
Clinical safety & efficacy: maxillofacial & oral conditions	Photobiomodulation therapy is generally well tolerated when used in the treatment of maxillofacial conditions.*
Clinical safety & efficacy: dermatology	Photobiomodulation therapy is generally safe when used appropriately for the treatment of dermatologic conditions.
Clinical safety & efficacy: dermatology	Due to lack of data, photobiomodulation therapy needs to be used with caution in patients with a known history of photosensitivities or photodermatoses.*
Clinical safety & efficacy: alopecia	Photobiomodulation can be effective at promoting hair regrowth in patients with androgenic alopecia.*
Clinical safety & efficacy: radiation dermatitis	Photobiomodulation can be used to reduce the incidence and severity of acute radiation dermatitis.
Clinical safety & efficacy: dermatology aesthetics	Photobiomodulation can improve aesthetic outcomes of scars.
Clinical safety & efficacy: dermatology aesthetics	Photobiomodulation can be used for skin rejuvenation.

LEDs, Light emitting diodes; *PBM*, photobiomodulation.
*Consensus was reached in Round 2.

the target tissue, power density decreases. Systematic reporting of the aforementioned parameters may facilitate replication of successful treatments.

Consensus 4: photobiomodulation safety.

1. PBM is regarded as a safe treatment option when used as directed for the treatment of dermatologic conditions, maxillofacial conditions, peripheral nervous system conditions, musculoskeletal conditions, and for improving cognition.[14-96] Given that none of identified reports in the systemic literature search included pediatric (<18 years of age) patients, the safety of PBM in pediatric populations cannot be assessed and that PBM application should be restricted to adult individuals at this time.
2. Cyclobutene pyrimidine dimers or 6-4 photoproducts are biproducts historically associated with other forms of photodamage, including ultraviolet and blue light exposure. RL does not induce DNA damage in the form of cyclobutene pyrimidine dimers or 6-4 photoproducts in human dermal fibroblasts.[97] Even at fluences up to 1280 J/cm^2, RL has not been shown to induce DNA damage.[97] However, there was lack of data regarding ocular safety. As such, the steering committee recommends wearing wavelength-specific eye protection when receiving or administering PBM treatment. While blue light is known to cause photosensitivity and exacerbate certain photodermatoses, PBM induced by RL needs to be used with caution in patients with a known history of photosensitivities or photodermatoses.

Table II. Level of evidence for PBM as treatment for dermatologic conditions

Clinical application consensus statement	Level of evidence*
Musculoskeletal conditions	IV
Cognitive and neurodegenerative conditions	IB
Wound healing	IB
Burns	IB
Ulcers	
Diabetic foot ulcers	IA
Decubitus ulcers	IB
Androgenic alopecia	IA
Radiation dermatitis	IA
Dermatology aesthetics	
Scars	IB
Skin rejuvenation	IB

PBM, Photobiomodulation.
*Level of evidence: Level IA evidence includes evidence from meta-analysis of randomized controlled trials; level IB evidence includes evidence from at least 1 randomized controlled trial; level IIA evidence includes evidence from at least 1 controlled study without randomization; level IIB evidence includes evidence from at least 1 other type of experimental study; level III evidence includes evidence from nonexperimental descriptive studies, such as comparative studies, correlation studies, and case-control studies; and level IV evidence includes evidence from expert committee reports or opinions or clinical experience of respected authorities, or both.

Clinical application

Consensus 5: photobiomodulation side effects.

1. Side effects from PBM therapy are generally mild, limited to mild sensation of pain/discomfort, and erythema.[28-32] These side effects are generally temporary and self-resolving and may also be dependent on an individual skin phototype.[28-32] PBM therapy rarely causes severe side effects, such as second-degree and third-degree burns, scarring, sepsis, carcinogenesis, and death.

Consensus 6: clinical application of photobiomodulation for musculoskeletal conditions (LOE, IV).

1. Depending on the energy dose, PBM may have inhibitory or stimulatory effects on skeletal muscle performance and fatigue.[98] However, this consensus was based on low-quality published reports. Further high-quality studies are needed to accurately assess PBM impact on musculoskeletal conditions.

Consensus 7: clinical application of photobiomodulation for cognitive and neurodegenerative conditions (LOE, IB).

1. PBM can be used as an adjunct therapy in the treatment of peripheral neuropathy.[35,99] Delphi participants were also asked to evaluate PBM for cognition, including attentional performance, cognitive performance after brain injury, memory, and cognitive performance in depression, dementia, chronic migraines, Gulf War illness, Parkinson's disease, and Alzheimer's disease.[83-96] No consensus was reached for these conditions, highlighting the need for additional research.

References were additionally provided for studies that investigated PBM for the treatment of peripheral nervous system conditions, including nerve injury, nerve postoperative recovery, drug-induced sensitization, overactive bladder, diabetic sensorimotor polyneuropathy, postherpetic neuralgia, baroreflex sensitivity, and poststroke complications including shoulder-hand syndrome, pain, and spastic muscle activity.[33-43,100] References were also provided for studies that investigated the treatment of central nervous system conditions, including spinal cord injury, acute ischemic stroke and stroke recovery, and cortical excitability.[101-107] PBM for peripheral neuropathy was the only nervous system condition for which consensus was achieved. Further clinical research is needed before experts can reasonably assess the efficacy for other central and peripheral nervous system conditions.

Consensus 8: clinical application of photobiomodulation for wound healing (LOE, IB).

I. PBM can accelerate wound healing.[108-110]
II. PBM can be considered as an adjunct therapy in the treatment of wounds due to multiple etiologies.[111-127]
III. PBM therapy is an effective adjunct therapy in the management of patients with moderate to severe burns.[108-110]

Consensus 9: clinical application of photobiomodulation for ulcers (LOE, IA & IB).

I. PBM can be used as an adjunct therapy in the treatment of pain attributed to diabetic foot ulcers.[35,99,128-139]
II. PBM can be considered as an adjunct therapy in the treatment of decubitus ulcers.[131,135,140]

Consensus 10: clinical application of photobiomodulation for alopecia (LOE, IA).

I. PBM can be effective at promoting hair regrowth in patients with androgenic alopecia.[1,141-155] The participants were asked to evaluate PBM for alopecia areata but there was insufficient evidence to reach consensus.[156,157]

Consensus 11: clinical application of photobiomodulation for radiation dermatitis (LOE, 1A).

I. PBM can be used to reduce the incidence and severity of acute radiation dermatitis.[158-165]

Consensus 12: clinical application of photobiomodulation for cosmetic dermatology (LOE, IB).

I. PBM can improve aesthetic outcomes of scars.[2,166-170]

II. PBM can be used for skin rejuvenation.[171-179]

DISCUSSION

Our study is pioneering in establishing consensus recommendations on the clinical application, efficacy, and safety of PBM. This initiative is timely and crucial, considering the swift proliferation of PBM across various domains. The iterative, interactive, and anonymous approach of the Delphi method was selected as the best method to collect and prioritize statements that reflect global expert opinion on PBM. In our study, consensus was reached for 38 statements. There was a strong unifying agreement (>90%) on the use of PBM as an overarching terminology encompassing LLLT. Nearly all statements within core principles and parameters section reached consensus after the first round. Based on the consensus of national and international experts, PBM is a safe treatment to use in clinical practice. Patients with darker skin phototype may be at higher risk for PBM side effects. As such, conservative parameters and dosing may mitigate the risks for these patients. Although our Delphi study focused on the spectrum of potential side effects, it is important to note that severe adverse events, such as second-degree and third-degree burns, scarring, sepsis, carcinogenesis, and death, have not been reported with PBM therapy. Our methodology did not include an option for "never occurring"; hence, the absence of such a response option should not be construed as an indication of the frequency or inevitability of these severe events.

Furthermore, the statements of greatest uncertainty were related to the assessment of clinical efficacy of PBM in the treatment of various medical conditions: 7 statements pertaining to dermatologic conditions were omitted from Round 2 due to insufficient evidence; due to the lack of representation of experts from cardiovascular, pulmonary, and neurologic systems, 7 statements from these disciplines were removed from Round 2. Nonetheless, the results of this Delphi process provide a structured framework to clinicians for the safe and effective use of PBM in medical and dermatologic settings.

LIMITATIONS

PBM is an evolving technology, which may result in substantial changes over time in how it is used, and consequently, in its safety and effectiveness. As such, the current guidelines may need to be revised in the future. In addition, there was a lack of panelists' expertise in certain topics resulting in the removal of a selected number of statements.

CONCLUSION

PBM is a safe treatment modality for adult patients and RL PBM does not induce DNA damage. As there continues to be a shift toward the use of innovative and minimally invasive and individualized procedures, PBM will play an important role. Future research will bolster understanding of PBM optimized for clinical effectiveness while maintaining a high level of therapeutic safety.

Conflicts of interest

Dr Siegel serves as a member of the advisory scientific board of Omnilux. Dr Goldman is an investigator for Biofrontera and Accure. Dr Kelly was a formal primary investigator of Biophotas. Dr Arany serves as a consultant for Summus Medical Laser, founder of Directed Energy Therapeutics, and OptiMed Technologies Inc. The remaining authors have no relevant conflicts of interest to declare.

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