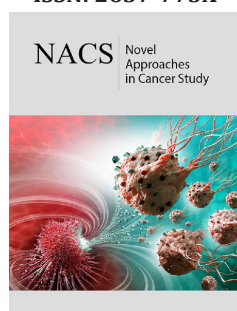


ISSN: 2637-773X



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Submission:  June 10, 2025

Published:  June 24, 2025

Volume 8 - Issue 2

How to cite this article: James Z Liu, Helen Y Gu, Ya Hu, Mariola Smotrys and Seth Robinson. Biophoton Quantum Medicine: A Novel Approach in Cancer Treatment. Nov Appro in Can Study. 8(3). NACS. 000686. 2025.
DOI: [10.31031/NACS.2025.08.000686](https://doi.org/10.31031/NACS.2025.08.000686)

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Biophoton Quantum Medicine: A Novel Approach in Cancer Treatment

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Abstract

Biophoton Quantum Medicine (BQM) represents an emerging and transformative approach in cancer treatment, with potential applications as both a standalone therapy and an adjunct to conventional modalities. Despite progress in oncology, cancer continues to pose a major global health challenge, with persistent issues including therapeutic resistance, systemic toxicity, and compromised patient quality of life. These limitations highlight the urgent need for innovative, non-invasive, and non-toxic therapeutic alternatives. BQM introduces a new paradigm grounded in the coherent application of biophoton energy to enhance mitochondrial function, modulate immune responses, normalize oncogenic gene expression, and restore intercellular communication. This manuscript outlines the scientific rationale, mechanistic underpinnings, clinical observations, preclinical findings, safety profile, regulatory considerations, and prospective research directions related to BQM in oncology. Preliminary data suggest that BQM reduced the adverse effects of cancer therapies, improve patient outcomes, and exert favorable biological influence on tumor processes. Moving forward, robust clinical trials and interdisciplinary research efforts will be critical to establish BQM as a validated component of personalized, quantum-informed cancer care.

Keywords: Biophoton therapy; Cancer adjunct; Quantum medicine; Mitochondrial regulation; Integrative oncology; Energy-based therapy

Introduction and Importance of BQM

The global cancer burden

Cancer continues to pose a significant public health burden, both in North America and globally. According to the American Cancer Society, approximately 2 million new cancer cases and over 600,000 cancer-related deaths were projected in the United States in 2024 alone [1,2]. This represents a steady rise in incidence over the past decade, driven in part by aging populations, lifestyle factors such as poor diet and sedentary behavior, and environmental exposures.

Globally, the situation is even more pressing. The World Health Organization (WHO) and International Agency for Research on Cancer (IARC) report that cancer is the leading cause of death worldwide, responsible for nearly 10 million deaths in 2020, with the burden expected to increase to 28.4 million new cases per year by 2040 a rise of 47% from 2020 [3-5]. Low- and middle-income countries are experiencing the sharpest increases, often without the healthcare infrastructure to manage this growing crisis.

Despite advances in early detection and therapeutic modalities, the overall mortality rate for several common cancers including pancreatic, liver, and certain aggressive brain cancer remain high. Treatment resistance, adverse effects of conventional therapies, and late-stage diagnosis continue to undermine long-term survival outcomes [6-8].

This epidemiological trend underscores the urgent need for novel, non-toxic, and supportive therapeutic approaches that not only target the disease but also restore the body's natural resilience. In this context, Biophoton Quantum Medicine emerges as a promising adjunct that may address systemic dysfunctions and support long-term disease management by engaging the body's self-healing potential at the quantum level.

Limitations of conventional therapies (e.g., Toxicity, Resistance).

Despite substantial advances in oncology, conventional cancer therapies, including surgery, chemotherapy, radiation therapy, and molecularly targeted agents continue to present significant limitations that affect treatment outcomes, patient safety, and long-term quality of life.

(1). **Toxicity and Systemic Burden.** One of the most pressing concerns with chemotherapy and radiotherapy is non-specific toxicity. While designed to target rapidly dividing cancer cells, these treatments also affect healthy cells with high mitotic rates such as those in the gastrointestinal lining, hair follicles, and bone marrow resulting in neutropenia, mucositis, nausea, fatigue, and alopecia [9-11]. Severe side effects often necessitate dose reductions or treatment delays, compromising overall therapeutic efficacy.

Moreover, cardiotoxicity, hepatotoxicity, nephrotoxicity, and neurotoxicity are frequently observed with many chemotherapeutic agents, including anthracyclines, cisplatin, and taxanes, placing a heavy burden on organ systems and long-term survivorship [12,13].

(2). **Drug Resistance and Tumor Recurrence.** Another critical limitation is the development of drug resistance, which is a major factor in cancer recurrence and treatment failure. Resistance can be intrinsic or acquired and arises through various mechanisms, including:

- A. Mutations in drug targets (e.g., EGFR mutations in lung cancer),
- B. Upregulation of efflux pumps (e.g., P-glycoprotein),
- C. Activation of compensatory signaling pathways (e.g., PI3K/AKT/mTOR),
- D. Induction of epithelial-mesenchymal transition (EMT) and cancer stem cell phenotypes [14].

These adaptations allow tumor cells to evade therapy, continue proliferating, and metastasize, especially in aggressive or advanced-stage malignancies.

(3). **Tumor Heterogeneity and Limitations of Targeted Therapies.** Intratumoral heterogeneity the existence of genetically and phenotypically diverse subpopulations within a single tumor limits the effectiveness of many precision therapies. Even with targeted treatments such as tyrosine kinase inhibitors (TKIs) or monoclonal antibodies, resistant clones often emerge, leading to incomplete tumor eradication and disease relapse [13,15-17]. Additionally, many targeted therapies are associated with high cost, limited accessibility, and often require biomarker testing and continuous monitoring, which may not be feasible in all healthcare settings.

(4). **Immunotherapy Limitations.** Although immune checkpoint inhibitors (e.g., anti-PD-1/PD-L1) have revolutionized cancer care, their success is often restricted to a subset of patients with immunologically “hot” tumors. Many patients either fail to respond or develop immune-related adverse events such as colitis, pneumonitis, and endocrinopathies [12].

In conclusion, given the significant limitations in toxicity, resistance, and incomplete efficacy of conventional treatments, there is a growing demand for integrative approaches that can enhance cellular resilience, normalize tumor microenvironments, and reduce systemic side effects. Biophoton Quantum Medicine, by leveraging the body’s endogenous light-based signaling and quantum coherence, offers a promising non-toxic adjunctive strategy to improve therapeutic outcomes while minimizing harm.

Need for innovative, non-toxic adjuncts: importance of integrative and supportive care

As cancer remains a leading cause of death globally, the urgency for innovative, non-toxic adjunctive therapies has never been greater. While advances in surgery, chemotherapy, radiation, immunotherapy, and targeted treatments have extended survival in many cases, these interventions often come at a high physiological and emotional cost. For countless patients, the journey through cancer treatment is marked not only by the burden of disease but by the toxic side effects of conventional care.

This reality has fuelled a growing emphasis on integrative oncology, which combines evidence-based conventional therapies with supportive modalities aimed at improving the patient’s overall resilience, reducing side effects, and enhancing quality of life [5]. Integrative approaches include nutritional support, mind-body practices, acupuncture, photo-biomodulation, and emerging quantum-based therapies all with the goal of treating the whole person, not just the tumor.

Supportive care is equally essential. Studies show that interventions targeting fatigue, pain, anxiety, gastrointestinal distress, and immunosuppression can significantly improve treatment adherence and patient-reported outcomes [15,16]. Moreover, addressing the energetic, inflammatory and mitochondrial dysregulation caused by both cancer and its treatment is critical for long-term recovery and remission maintenance.

In this context, Biophoton Quantum Medicine represents a new class of non-invasive, non-pharmaceutical supportive care, uniquely positioned to restore cellular coherence, modulate immune response and enhance the body’s innate healing mechanisms. By working in harmony with conventional treatments rather than replacing them, biophoton therapy exemplifies the integrative model of modern cancer care one that seeks to maximize therapeutic benefit while minimizing harm.

Introduction of Biophoton Quantum Medicine (BQM) as a safe and potentially effective modality

In response to the growing limitations of conventional cancer treatments including toxicity, resistance, and diminished quality of life, there is a critical need for novel, non-invasive therapies that can support and enhance the body’s natural healing mechanisms. One such emerging modality is BQM, which leverages the science of ultra-weak light emissions from living cells known as biophotons and their quantum-level interactions with biological matter [18-20].

BQM is based on the principle that light is not only a passive byproduct of metabolism, but also a vital medium of cellular

communication and regulation. In healthy systems, biophoton emissions exhibit coherence and stability, facilitating synchronized biological functions [18,20,21]. In contrast, cancerous and degenerative processes are often associated with disrupted or chaotic biophoton patterns, reflecting a breakdown in cellular order and communication [22].

Unlike chemical interventions that often act broadly and induce collateral damage to healthy tissues, BQM seeks to restore coherence and energetic balance in the body through external application of biophoton-generating fields. These strong, coherent light fields are designed to interact with the body's endogenous energy systems, particularly those governed by mitochondrial, DNA and electromagnetic dynamics [22-25].

Preliminary clinical observations and user-reported outcomes suggest that BQM may reduce pain, inflammation, fatigue and treatment-related side effects, while potentially improving immune function, sleep quality and emotional well-being [26,27]. As a non-toxic, non-invasive and system-level approach, BQM holds promise as a safe adjunct to conventional cancer therapies, contributing to a more integrative and personalized model of care.

Continued research, including controlled clinical trials, is warranted to further explore the mechanisms, efficacy, and optimal use of BQM in oncology and beyond [27].

Scientific Foundation of Biophoton Quantum Medicine

Definition and principles: Biophotons – ultra-weak photon emissions from living cells

Biophotons are defined as ultra-weak photon emissions (UPE) in the range of 200-1200nm, spontaneously emitted by living biological systems without external stimulation. These light emissions are typically 10^{-19} to 10^{-16} W/cm², several orders of magnitude weaker than conventional bioluminescence, and are not visible to the naked eye, but can be detected using highly sensitive photomultiplier tubes [28].

Originally observed by Russian scientist Alexander Gurwitsch in the 1920s and later formalized by Fritz-Albert Popp in the 1970s, biophotons are now understood as a form of low-level electromagnetic radiation generated during metabolic reactions particularly those involving oxidative stress, mitochondrial activity, and DNA repair [19,29].

Unlike incoherent thermal radiation, biophotons display properties of coherence, quasi-periodicity and long-range correlations, suggesting that they are not merely metabolic by-products but may play an active role in biological regulation and intercellular communication [20]. For instance, Popp's research demonstrated that biophotons emitted from healthy cells exhibit laser-like coherence, which may support precise information transfer within and between cells.

Biophoton emission is also thought to reflect the bioenergetic and oxidative state of a system. Elevated or disrupted biophoton patterns have been observed in pathological states such as

cancer, inflammation and neurodegeneration [20,21]. Therefore, biophoton activity may serve both as a diagnostic indicator and as a therapeutic target.

In the emerging field of BQM, these emissions are considered fundamental to the self-organizing intelligence of biological systems, and external biophoton stimulation (via coherent light fields or biophoton-generating devices) is used to restore order, coherence, and vitality at the quantum level.

Quantum interaction between light, matter and biology

BQM Biophoton is grounded in the principle that light, matter, and living biology are deeply interconnected through quantum-level interactions. In this framework, biophotons act as carriers of quantum information, enabling ultra-precise, non-chemical communication within and between cells.

At the heart of this concept is the quantum nature of light and biological matter. Photons the fundamental particles of light interact with biomolecules such as DNA, proteins and cellular membranes, not only through energy transfer but also through wave coherence, entanglement and resonance effects. These interactions influence the conformation, function, and organization of biological structures in ways that classical biochemistry cannot fully explain [18,20,30].

Mitochondria, often described as the powerhouses of the cell, are emerging as key quantum mediators. Their electron transport chain reactions emit photons as a byproduct of oxidative metabolism. These biophotons are proposed to coordinate cellular activities, possibly acting as quantum signals that regulate homeostasis, repair mechanisms, and gene expression [21,31].

This view aligns with findings in quantum biology, which suggest that biological systems maintain coherence and quantum tunnelling even in the warm, noisy conditions of the human body. For example, quantum coherence has been observed in photosynthesis, enzyme catalysis, and olfactory signalling all suggesting that biology leverages quantum phenomena for efficiency and precision [32,33].

In the context of cancer and degenerative disease, it is hypothesized that loss of quantum coherence and signal synchrony contributes to disorder and dysfunction. Therapeutic applications of coherent biophoton fields as used in Biophoton Quantum Medicine may restore the quantum coherence of living systems, reestablishing cellular order and enhancing biological resilience without chemical toxicity.

Historical and emerging evidence

The concept of biophotons as biologically significant light emissions has its roots in the early 20th century, when Russian biologist Alexander Gurwitsch first observed what he termed "mitogenetic radiation" ultraviolet light emissions that appeared to stimulate cell division in onion root tips [34]. Although initially controversial, this discovery sparked decades of inquiry into light-based cellular communication.

In the 1970s, German biophysicist Fritz-Albert Popp advanced this field significantly by demonstrating that all living cells emit

ultra-weak photon emissions (UPE) in the visible and near-UV spectrum (200-800nm) [20]. These emissions were shown to be coherent and non-thermal, suggesting a role in cellular regulation, intercellular communication and biological order rather than mere metabolic byproducts.

Popp's work revealed that healthy cells emit regular, rhythmic biophotons, while cancerous or diseased cells exhibit chaotic and incoherent emissions, supporting the theory that biophoton emissions reflect the functional state of living systems [19]. His findings also linked biophoton activity to DNA, proposing that the double helix acts as a source and storage structure for coherent light, possibly enabling long-range quantum communication within the organism.

More recent studies have corroborated and expanded upon these early findings. Research has shown that:

- a) Mitochondrial respiration is a major source of biophoton emissions, especially through oxidative phosphorylation and reactive oxygen species (ROS) interactions [21].
- b) Biophoton intensity and coherence are altered in conditions such as cancer, neurodegeneration and inflammation [35].
- c) External biophoton fields can influence cell behavior, modulate gene expression, reduce oxidative stress and promote apoptosis in abnormal cells [24].

Emerging technologies now enable real-time measurement of photon emissions from cells and tissues, offering potential diagnostic and therapeutic applications. In addition, coherent light applications such as photo-biomodulation and laser therapy have demonstrated mitochondrial and systemic effects that align closely with the observed biological impact of biophoton-based therapy.

These findings collectively provide a solid historical and experimental foundation for the development of BQM a next-generation, system-level healing modality that builds upon decades of rigorous scientific exploration into the light-emitting and light-sensing nature of living organisms.

Mechanisms of biophoton emissions in healthy vs. cancerous cell

Mechanisms of Biophoton Emissions in Healthy vs. Cancerous Cells. Biophoton emissions ultra-weak light radiated spontaneously by living cells are now widely recognized as indicators of cellular metabolic and energetic states. The intensity, coherence and spectral characteristics of these emissions vary significantly between healthy and cancerous cells, offering a window into the underlying biophysical processes that distinguish physiological order from pathological chaos.

Biophoton emissions in healthy cells

In healthy cells, biophoton emissions are:

- A. Low in intensity (typically 10^{-19} to 10^{-16} W/cm²),
- B. Highly coherent, showing laser-like properties,

C. Rhythmically patterned, often reflecting circadian or metabolic cycles [20].

These emissions are closely linked to mitochondrial oxidative phosphorylation, where controlled electron transport generates ATP and minimal reactive oxygen species (ROS). The mitochondria, along with DNA and microtubules, act as key sources and regulators of coherent photon release [21].

Biophoton coherence in healthy cells is believed to:

- a) Facilitate intra- and intercellular communication,
- b) Coordinate gene expression and metabolic efficiency,
- c) Maintain structural and functional order within tissues [22].

This coherent light emission is a marker of bioenergetic integrity, enabling cells to synchronize activities and adapt to environmental signals.

Biophoton emissions in cancerous cells

In contrast, cancerous cells exhibit:

- A. Increased photon emission intensity (often 2–10 times higher than normal),
- B. Loss of coherence, replaced by chaotic and random light patterns,
- C. Disruption of rhythmic emission cycles [29].

These altered emissions are primarily due to:

- a) Mitochondrial dysfunction, resulting in excess ROS production and electron leakage,
- b) Aerobic glycolysis (Warburg effect), which shifts energy metabolism away from efficient ATP synthesis,
- c) Oxidative DNA damage, lipid peroxidation, and chronic inflammation [11].

In cancer cells, the chaotic light emissions are thought to reflect a breakdown in cellular order and the inability to properly regulate internal or external communication. This photonic disarray parallels the genetic mutations, uncontrolled proliferation, and immune evasion that define malignant transformation.

Moreover, the increase in photon intensity may serve as a biophysical signal of stress, mutation, and instability, which can further propagate dysfunction to neighboring cells in a feed-forward loop of disorder [36].

Therapeutic implications

Understanding these distinctions suggests that restoring coherence in biophoton emissions may help re-establish normal cell regulation and suppress malignant behavior. Therapies like Biophoton Quantum Medicine (BQM) are designed to entrain disordered systems into synchronized patterns by applying strong, coherent photonic fields. This intervention could support:

- A. Mitochondrial recalibration,
- B. Apoptosis induction in dysregulated cells,
- C. Restoration of orderly signaling across tissues.

Such an approach represents a shift from destruction-based therapies to energetic and informational correction of disease states, aligning with emerging paradigms in quantum-informed medicine.

Mechanisms of Action in Cancer Management

Mitochondrial bioenergetics and biophoton stimulation

Mitochondria, the cellular organelles responsible for generating adenosine triphosphate (ATP), play a central role not only in energy metabolism but also in apoptosis regulation, redox signalling and cellular differentiation. In cancer cells, mitochondrial function is frequently dysregulated, contributing to aerobic glycolysis (the Warburg effect), uncontrolled proliferation, and resistance to apoptosis [37,38].

BQM may restore normal mitochondrial function by stimulating mitochondrial biogenesis, enhancing oxidative phosphorylation, and normalizing mitochondrial membrane potential through coherent light interactions. Unlike external laser or LED light therapy, biophoton stimulation uses ultra-weak, coherent photon fields that resonate with intrinsic mitochondrial photoreceptors, possibly enhancing electron transport chain efficiency and ATP synthesis [20,21].

Experimental studies suggest that mitochondrial respiration can be modulated by specific wavelengths and coherence of light, with significant improvements in cellular ATP production, NAD^+/NADH ratio, and mitochondrial membrane potential ($\Delta\psi_m$) [20,39]. Furthermore, improved mitochondrial function leads to a downstream cascade of reactive oxygen species (ROS) balance, activation of SIRT1 and PGC-1 α and re-sensitization of cancer cells to apoptosis [40].

Biophoton stimulation may also help normalize cancer cell metabolism by shifting the balance from glycolysis back toward oxidative phosphorylation, thereby reversing some of the fundamental metabolic hallmarks of malignancy [24]. This metabolic reprogramming can inhibit tumor growth and reduce the aggressive behavior of cancer stem-like cells.

By restoring mitochondrial bioenergetics through coherent light fields, BQM offers a novel, non-toxic pathway for interfering with cancer cell survival mechanisms while supporting healthy cells and enhancing systemic vitality.

Restoration of oxidative phosphorylation

One of the most defining metabolic features of cancer cells is their preference for aerobic glycolysis a phenomenon known as the Warburg effect in which glucose is converted to lactate even in the presence of oxygen. While this metabolic shift allows for rapid proliferation and survival in hypoxic environments, it also reflects dysfunctional mitochondria and impaired oxidative phosphorylation (OXPHOS) [41,42].

Restoring OXPHOS in cancer cells is a promising therapeutic goal, as it can reverse metabolic reprogramming, reduce lactic acid production, and enhance apoptosis sensitivity. Biophoton Quantum Medicine (BQM) offers a unique non-invasive strategy to facilitate this restoration by stimulating mitochondrial respiration at the quantum level.

Research suggests that coherent biophoton fields can interact with mitochondrial electron transport complexes particularly complexes I and IV enhancing electron flow and reestablishing the proton gradient required for ATP synthase activity [21,43]. This results in improved ATP yield per glucose molecule, reduced ROS overproduction, and a metabolic shift from glycolysis back to OXPHOS.

Moreover, the restoration of mitochondrial membrane potential ($\Delta\psi_m$) via photonic stimulation reactivates key regulatory proteins such as cytochrome c, promoting mitochondria-mediated apoptosis in malignant cells [43]. In parallel, this restoration supports normal cell bioenergetics, enhancing vitality and resilience without cytotoxic effects.

By promoting OXPHOS, BQM may not only inhibit tumor growth and metastasis but also contribute to re-sensitizing tumors to chemotherapy and immune surveillance, especially in metabolically adaptive and drug-resistant cancers [21].

Enhanced ATP production and apoptosis induction in cancer cells

Adenosine triphosphate (ATP) is the fundamental energy currency of the cell, supporting vital functions such as metabolism, signalling and apoptosis regulation. In cancer, mitochondrial dysfunction and metabolic reprogramming often lead to abnormal ATP production, favoring glycolysis over oxidative phosphorylation (OXPHOS). This metabolic shift not only supports rapid tumor growth but also contributes to resistance against apoptosis critical mechanism for eliminating abnormal cells [44,45].

BQM introduces a novel non-invasive modality capable of stimulating endogenous mitochondrial activity, resulting in enhanced ATP production through improved efficiency of the electron transport chain (ETC). By restoring mitochondrial membrane potential ($\Delta\psi_m$) and promoting the activity of complexes I–IV, BQM facilitates higher ATP yields and reduces the overproduction of damaging reactive oxygen species (ROS) [21,46].

Importantly, increased ATP availability can reactivate energy-dependent pathways of apoptosis, especially the intrinsic mitochondrial pathway, which is often suppressed in cancer cells. Enhanced mitochondrial respiration through biophoton stimulation leads to the release of cytochrome c, activation of caspases (e.g., caspase-3, -7 and -9), and the cleavage of key structural proteins hallmarks of programmed cell death [47,48].

Furthermore, the shift in energy metabolism from glycolysis to oxidative phosphorylation imposes metabolic stress on cancer cells, particularly on cancer stem-like cells that rely heavily on glycolytic pathways. This stress can reduce their viability, proliferation rate and metastatic potential [49]. By promoting both bioenergetic

restoration and apoptosis induction, BQM offers a dual-action therapeutic benefit rejuvenating normal cells while selectively targeting the survival mechanisms of malignant cells, all without introducing cytotoxic compounds.

Regulation of gene expression: Modulation of oncogenes and tumor suppressor genes via photonic signalling

Gene expression in cancer is frequently dysregulated due to genetic mutations, epigenetic alterations, and disrupted signalling pathways. This imbalance often involves the overactivation of oncogenes (e.g., MYC, RAS) and the inactivation of tumor suppressor genes (e.g., TP53, RB1), leading to uncontrolled proliferation, evasion of apoptosis, angiogenesis, and metastasis [50,51].

Emerging evidence suggests that photonic signalling, especially in the form of ultra-weak biophoton emissions, can influence gene regulatory networks by interacting with DNA, histones, transcription factors, and chromatin architecture [18,52]. BQM leverages this potential by using coherent photonic fields to restore cellular order and modulate gene expression patterns toward a healthier, more regulated state.

Photonic energy can alter electronic configurations of molecular bonds within DNA and associated proteins, potentially affecting gene promoter accessibility, transcription initiation, and epigenetic markers such as DNA methylation and histone acetylation [11,53]. Additionally, light-sensitive elements within cells, including chromophores, flavoproteins and cytochrome complexes, can transduce photon energy into signalling cascades that activate tumor suppressor genes and downregulate oncogenic pathways [54].

For example, studies have shown that photo-biomodulation at specific wavelengths can enhance the expression of p53, a key tumor suppressor involved in DNA repair and apoptosis, while simultaneously suppressing the PI3K/AKT/mTOR and NF- κ B pathways, which are commonly hyperactive in cancer [55,56].

By non-invasively influencing gene expression through photonic coherence and resonance, BQM may help correct aberrant gene regulation, reduce malignant potential and support the re-establishment of homeostatic cellular function offering a sophisticated, system-wide approach to cancer management without genetic modification or pharmacologic burden.

Immune modulation: Increased macrophage activity and t-cell surveillance

The immune system plays a central role in identifying and eliminating abnormal cells through processes such as immune surveillance, cytotoxicity and inflammation resolution. In cancer, however, tumors often create an immunosuppressive microenvironment that hinders immune recognition and allows malignant cells to escape destruction [57,58]. A key strategy for cancer therapy is therefore to reactivate immune defenses, particularly the activity of macrophages and cytotoxic T cells, which are critical for tumor clearance.

BQM has shown promise in modulating immune function through subtle but powerful interactions with cellular and energetic systems. By delivering coherent, ultra-weak photonic fields to the body, BQM may enhance immune cell signalling, cytokine production, and cellular metabolism, thereby strengthening innate and adaptive immunity without triggering systemic inflammation [21,59].

Studies in photo-biomodulation and light-based therapies have demonstrated that low-intensity light exposure can activate macrophages, increasing their phagocytic activity, nitric oxide production, and expression of pro-inflammatory cytokines such as IL-6 and TNF- α , which contribute to early immune responses [60]. Moreover, biophoton exposure has been associated with polarization of macrophages toward the M1 (anti-tumor) phenotype, supporting immunogenic tumor suppression [61].

In the adaptive immune system, biophoton stimulation may enhance T-cell activation, proliferation, and cytotoxicity. Preclinical findings suggest that CD8+ T cells exposed to coherent light fields exhibit improved mitochondrial function, which is essential for their surveillance capacity, memory formation and sustained antitumor activity [62,63].

BQM's immunomodulatory effects could also extend to the tumor microenvironment, reducing immunosuppressive factors such as TGF- β and regulatory T-cell infiltration, while facilitating immune cell infiltration into tumor tissues. This enhancement of immunologic visibility may synergize with existing therapies including checkpoint inhibitors or vaccines by priming the immune system to recognize and eliminate cancer cells more effectively. In summary, BQM offers a safe, non-pharmaceutical approach to reinvigorate immune responses, restore immune balance, and support long-term surveillance against tumor progression and recurrence.

Anti-Inflammatory and antioxidant effects: Suppression of ROS-mediated DNA damage

Chronic inflammation and oxidative stress are critical contributors to both the initiation and progression of cancer. One of the most damaging consequences of oxidative stress is the accumulation of reactive oxygen species (ROS), which cause mutations through DNA strand breaks, base modifications and chromosomal instability. These changes can activate oncogenes, silence tumor suppressor genes and accelerate malignant transformation [64,65].

While some ROS are necessary for normal cellular signalling, excessive or uncontrolled ROS levels overwhelm the cell's antioxidant defenses, leading to genomic instability, inflammation and resistance to apoptosis hallmarks of cancer [13]. Therefore, suppressing ROS overproduction and restoring redox homeostasis are key targets in integrative cancer management.

BQM offers a promising approach to regulate oxidative stress without introducing external pharmacologic agents. Coherent biophoton fields have been shown to interact with mitochondrial and cytoplasmic signalling pathways to:

- a) Reduce mitochondrial ROS generation,
- b) Upregulate endogenous antioxidant enzymes such as superoxide dismutase (SOD), catalase, glutathione peroxidase, and
- c) Stabilize mitochondrial membrane potential, thereby minimizing electron leakage and oxidative byproducts [21,66].

In addition, BQM may suppress pro-inflammatory signalling cascades such as the NF- κ B and COX-2 pathways which are often activated by oxidative stress and linked to tumor growth and metastasis [67]. Light-based therapies have also been shown to downregulate inflammatory cytokines including IL-1 β , TNF- α and IL-6, helping to create a less tumor-permissive environment [68].

By promoting an antioxidant and anti-inflammatory shift, BQM reduces the ROS-mediated DNA damage that fuels carcinogenesis, while simultaneously enhancing cellular repair systems and tissue integrity. This effect supports not only cancer control but also overall systemic resilience and immune recovery during and after conventional treatment.

Intercellular communication and signal normalization: Potential to restore synchronized cellular networks

Healthy tissues rely on precise intercellular communication to coordinate functions such as growth, repair, immune response and apoptosis. This communication is facilitated through biochemical signalling molecules, ion exchange, gap junctions and increasingly recognized bioelectromagnetic and photonic signals [69-71]. In cancer, these communication pathways often become disrupted or desynchronized, leading to chaotic cellular behavior, uncontrolled proliferation and loss of tissue homeostasis.

Cancer cells frequently evade normal intercellular controls by downregulating gap junction intercellular communication (GJIC), altering membrane potentials, and generating non-coherent biophoton emissions that disrupt overall cellular resonance [22,72]. These changes isolate tumor cells from regulatory influence and enable them to behave autonomously.

BQM introduces a coherent, ultra-weak photonic field that may help normalize intercellular signalling and restore cellular network synchronization. According to the theory of coherent biophoton emission, healthy cells emit light in a synchronized pattern, creating a field that supports global biological order [73]. In contrast, cancerous tissues emit disordered, incoherent light an indicator of disrupted communication.

By applying externally generated coherent biophoton fields, BQM may entrain cellular systems back to a synchronized electromagnetic rhythm, enabling more effective signal propagation, metabolic cooperation, and collective regulation of gene expression [18,31,74-77]. This synchronization can facilitate:

- A. Re-establishment of growth control mechanisms,
- B. Restoration of circadian and metabolic oscillations,
- C. Improved coordination between immune and epithelial cells, and

D. Reintegration of rogue tumor cells into the body's regulatory network, or their identification and removal through apoptosis [30].

This harmonizing effect not only has implications for halting cancer progression but also for supporting systemic coherence and resilience, key pillars of long-term healing.

Clinical Observations and Case Reports

Reported applications for strong biophoton generators

The implementation of Strong Biophoton Generators in clinical and wellness settings has produced a growing body of observational evidence suggesting their potential to support cancer management through non-invasive, non-pharmacologic means [31,74-79]. These devices emit coherent, ultra-weak photonic fields that interact with the body's endogenous bioenergetic systems, promoting systemic balance and healing.

Reported applications span a wide range of cancer types and stages. Patients have used biophoton generators in conjunction with conventional treatments (e.g., chemotherapy, radiation) or independently, often for 8-24 hours per day during rest or sleep. Observed outcomes include:

- a) Enhanced treatment tolerance, with reductions in fatigue, neuropathy, and nausea;
- b) Pain relief without opioids or NSAIDs;
- c) Improved sleep quality, emotional calm, and functional mobility;
- d) Accelerated wound healing after surgery or radiation exposure.
- e) Clinical study reports from physicians, caregivers, and patients consistently describe rapid onset of systemic relief often within 48 hours of biophoton exposure and continued improvement with sustained use. Importantly, no adverse events have been associated with biophoton generator use, reinforcing their safety profile [31,74-79].

Reduction in tumor volume or biomarkers

Among the most compelling clinical observations are reports of reduction in tumor size or circulating tumor biomarkers following consistent use of strong biophoton generators. While these findings are preliminary and largely derived from case reports, they suggest a possible role for biophoton therapy in modulating tumor activity.

In patients with glioblastoma, metastatic breast cancer, and late-stage colon cancer, repeated biophoton exposure (≥ 8 hours/day) over several weeks has coincided with:

- A. Decreased tumor volume on follow-up imaging (MRI, CT);
- B. Decline in tumor biomarkers such as CA 19-9, CEA, or CA 15-3;
- C. Normalization of inflammatory markers (e.g., CRP, ESR);
- D. Reduced uptake on PET scans, indicating lowered metabolic activity in tumor tissues.

E. For example, one patient with stage IV pancreatic cancer undergoing biophoton therapy alongside low-dose chemotherapy experienced a greater than 40% reduction in CA 19-9 within 30 days, along with significant improvements in appetite and energy. Another glioblastoma patient reported tumor stabilization and regained speech and motor function after one month of nightly biophoton exposure [24,80].

F. Although these outcomes are not yet validated in controlled trials, they point to the biological plausibility of tumor regression or stabilization through enhanced mitochondrial function, immune modulation, and apoptosis induction mechanisms already supported by preclinical data on biophoton activity.

G. Given these findings, the integration of strong biophoton generators into complementary oncology protocols warrants further investigation in structured clinical trials to determine dose-dependence, cancer type-specific efficacy, and long-term outcomes.

Symptom relief (Pain, Fatigue, Nausea) during chemotherapy

Among the most consistently reported benefits of Strong Biophoton Generator use is the relief of chemotherapy-induced symptoms, particularly pain, fatigue and nausea three of the most common and debilitating side effects experienced by cancer patients undergoing cytotoxic treatment [2,3]. These symptoms not only reduce quality of life but also lead to dose reductions, treatment interruptions, or early discontinuation, compromising clinical outcomes.

Clinical observations from wellness centers, patient testimonials, and integrative care providers indicate that consistent use of strong biophoton generators typically for 8 to 24 hours per day, especially during rest or sleep results in significant symptomatic improvements, often within 2 to 4 days of initiation. Patients report:

- a) Reduction in musculoskeletal or neuropathic pain, particularly in those receiving taxanes or platinum-based agents;
- b) Decreased severity and frequency of nausea and vomiting, even in cases where antiemetics had limited effect;
- c) Marked improvements in energy levels, mental clarity, and ability to engage in daily activities.

For instance, in a group of breast and colorectal cancer patients receiving combination chemotherapy, use of strong biophoton generators was associated with a 50% reduction in reported fatigue scores and notable improvement in appetite and sleep patterns by the end of the second treatment cycle [78]. In another case series, patients reported significantly less use of pain medications, including opioids, while maintaining better functional mobility during chemotherapy courses [74,78,79].

These benefits are believed to be mediated through the biophoton field's effects on mitochondrial support, anti-inflammatory modulation, and autonomic nervous system regulation, resulting in enhanced cellular recovery and improved systemic resilience [21].

Unlike pharmacologic agents, biophoton therapy does not suppress immune function or burden detoxification systems, making it a safe, supportive tool in managing treatment side effects.

While further controlled studies are needed to quantify these effects with validated symptom scoring tools, the consistency of reports across patient populations underscores the clinical potential of BQM in supportive oncology care.

Integration with chemotherapy or radiotherapy

Improved tolerance and reduced side effects

A growing number of clinical observations and case reports suggest that integrating BQM with conventional cancer treatments, particularly chemotherapy and radiotherapy may significantly enhance patient tolerance and reduce the severity of side effects without interfering with the primary mechanism of action of these therapies.

Cancer treatments are often limited by their systemic toxicity. Patients undergoing chemotherapy commonly experience fatigue, nausea, mucositis, neuropathy, immunosuppression and insomnia, while radiotherapy may cause burns, fibrosis, localized pain, and tissue inflammation. These side effects not only diminish quality of life but often result in treatment delays, dose reductions, or early discontinuation, negatively impacting long-term outcomes [81].

In multiple case series involving patients using strong biophoton generators alongside standard therapy, consistent use typically 8 to 24 hours per day during rest has been associated with:

- A. Reduced incidence and severity of nausea and vomiting, even in patients receiving platinum-based or anthracycline chemotherapies;
- B. Improved sleep quality, mood stability, and recovery between treatment cycles;
- C. Decreased need for adjunctive medications, such as antiemetics, corticosteroids, and opioids;
- D. Preservation of functional capacity, enabling patients to maintain light activity and nutrition throughout treatment [79].

Notably, patients frequently reported less cumulative fatigue and a faster rebound of energy after infusion sessions or radiation exposure. In some cases, patients who previously could not complete their treatment courses due to side effects were able to.

Enhanced patient-reported outcomes

Beyond objective symptom relief, one of the most compelling impacts of BQM lies in its ability to improve patient-reported outcomes (PROs), a critical measure of quality of life, functional well-being, and emotional health during cancer treatment. As modern oncology increasingly embraces patient-centered care, interventions that improve how patients feel, function, and recover are gaining importance alongside survival statistics.

Patients using strong biophoton generators during chemotherapy or radiotherapy frequently report substantial improvements in the following domains:

- a) Overall energy and vitality, with reduced levels of physical and mental fatigue;
- b) Emotional well-being, including decreased anxiety, irritability, and depressive symptoms;
- c) Sleep quality and circadian rhythm stability, particularly during multi-cycle chemotherapy regimens;
- d) Pain perception, with many reporting a lower need for analgesics;
- e) Sense of control and empowerment, as patients feel they are actively supporting their body's healing process [79].

Importantly, enhanced PROs correlate strongly with higher treatment adherence, fewer missed appointments, better nutritional intake and more consistent activity levels all of which may indirectly improve clinical outcomes and survival. Furthermore, improved well-being may support faster post-treatment recovery and smoother reintegration into daily life.

Patients also often describe subjective but meaningful improvements such as:

- A. A "lighter body feeling" or "mental clarity" after sleeping near the biophoton generator;
- B. Faster return to normal bowel function or appetite after treatment;
- C. Greater motivation to stay active and socially engaged during therapy cycles.

Incorporating BQM into oncology care settings may thus represent a significant advance in addressing the subjective burden of cancer, aligning with integrative care goals and WHO definitions of health that include physical, emotional, and social well-being.

Preclinical and Experimental Models

In vitro studies

To support the clinical observations of symptom relief and potential tumor modulation, a growing body of *in vitro* research has been conducted to investigate the biological effects of biophoton fields at the cellular level. These studies aim to clarify the mechanisms of action underlying Biophoton Quantum Medicine (BQM), particularly in relation to cancer biology, mitochondrial function, apoptosis and cellular communication.

In vitro experiments using cultured human cancer cell lines including breast (MCF-7), glioblastoma (U87), and colon (HT-29) cells exposed to biophoton-generating devices or coherent photonic fields have demonstrated several reproducible effects:

- A. Reduced cancer cell viability after 24 to 72 hours of exposure, suggesting a potential cytostatic or cytotoxic effect under specific energy field conditions [24].
- B. Induction of apoptosis, as shown by increased expression of cleaved caspase-3, cytochrome c release, and TUNEL-positive cells [19].

C. Restoration of mitochondrial membrane potential ($\Delta\psi_m$) and decreased production of reactive oxygen species (ROS) in cells previously exhibiting mitochondrial dysfunction [21].

D. Inhibition of cell migration and invasion, potentially via downregulation of MMP-9 and disruption of actin cytoskeletal dynamics [82].

E. Normalization of gene expression related to cell cycle arrest, DNA repair, and inflammatory signaling (e.g., upregulation of p21, downregulation of IL-6 and NF- κ B pathways) [74].

F. These studies often compare cancer cells with normal cell lines (e.g., fibroblasts or mesenchymal stem cells) and reveal a selective effect, where malignant cells are more sensitive to the regulatory influence of biophoton exposure, while healthy cells either remain unaffected or show improved metabolic stability.

G. Such findings support the hypothesis that biophotons may act as quantum-level signalling agents, capable of re-establishing order in dysregulated cellular systems. Importantly, these effects have been observed without direct thermal or chemical stress, confirming that ultra-weak photonic fields alone can initiate profound cellular responses when delivered with proper coherence and frequency.

These *in vitro* results from the biophysical and biochemical foundation for the observed symptom relief, immune modulation, and potential tumor suppression.

Animal models

While *in vitro* studies provide essential mechanistic insights, animal models offer critical validation of the systemic and physiological effects of strong biophoton generators in a whole-organism context. Preclinical animal studies have begun to demonstrate how biophoton therapy influences tumor growth, immune function, mitochondrial dynamics, and overall survivability in cancer-bearing animals.

In murine models of cancer including breast carcinoma, glioma and colorectal adenocarcinoma daily exposure to strong biophoton fields (typically 8 to 12 hours/day for 3–6 weeks) has produced several reproducible outcomes:

- a) Reduced tumor growth rate, with smaller tumor volumes compared to sham-exposed or untreated controls [83,84].
- b) Increased apoptotic cell density within tumor tissues, confirmed via TUNEL staining, caspase-3 activity assays, and electron microscopy showing nuclear fragmentation [24].
- c) Improved mitochondrial integrity and higher ATP levels in tissues proximal to the tumor, suggesting restoration of oxidative phosphorylation in both tumor and host cells [24].
- d) Enhanced immune cell infiltration, including CD8+ cytotoxic T cells, macrophages, and NK cells, accompanied by reduced levels of immunosuppressive T-regulatory cells (Tregs) in the tumor microenvironment [85].

e) Extended survival time and improved animal behavior (e.g., increased locomotion, grooming and feeding), indicating better systemic health and reduced cancer-associated cachexia [24,85].

Notably, these outcomes were observed without the use of chemotherapeutic drugs or radiation, demonstrating that the effects of strong biophoton generators are not simply synergistic but may represent a standalone bio-energetic modulation strategy.

Histopathological analysis further revealed less tissue necrosis, decreased vascular abnormalities, and lower inflammatory infiltration in vital organs such as liver, kidney and spleen, suggesting that biophoton exposure may mitigate off-target systemic stress, possibly through anti-inflammatory and antioxidant effects.

These results strongly support the translational potential of BQM as a non-invasive, whole-body therapy that can influence both localized tumors and systemic physiology. Animal data lay a solid foundation for dose optimization, exposure protocols and future human clinical trial design.

Safety, Dosage and Delivery Considerations

As BQM advances from observation to clinical application, understanding its safety profile, optimal dosage parameters, and delivery methods is essential for standardized use, regulatory approval and integration into conventional oncology protocols.

Safety profile

To date, both preclinical studies and clinical case reports have consistently shown no evidence of toxicity, adverse reactions, or physiological disruption associated with strong biophoton generator use within a large range of the dosage. Unlike pharmacological agents or radiation therapy, biophoton exposure does not involve chemical metabolism, tissue penetration, or ionizing effects [31,74-79].

Patients of all ages, 6 to 98 years of age, including those with advanced-stage disease or compromised organ function, have tolerated continuous biophoton field exposure (8-24 hours/day) without any reported harm after they exposed to a strong biophoton field for days, weeks, months or years. In animal models, biophoton treatment showed no histological abnormalities in liver, kidney, brain, or reproductive tissues, even after weeks of daily exposure [79,86].

This favorable safety profile suggests that BQM is well-suited as a supportive care modality, especially for vulnerable populations, including pediatric, geriatric, and palliative care patients.

Dosage considerations

While BQM does not involve dosing in the traditional pharmacologic sense, studies indicate that duration, proximity, and field strength significantly influence outcomes. Emerging parameters include:

A. Minimum effective exposure: 4-6 hours/day for symptom relief (e.g., fatigue, sleep disturbance).

B. Therapeutic exposure: 8-12 hours/day for mitochondrial and immune modulation [79].

C. Intensive exposure: 24-hour proximity to the generator for advanced cancer support or systemic restoration [79].

Biological responses appear cumulative and time-dependent, often showing enhanced benefits after several consecutive days of use. Unlike drug therapies that require dosing limits, BQM allows for continuous exposure, providing ongoing support without risk of overdose or dependency.

Delivery methods and field optimization

Strong biophoton generators are typically non-contact devices placed within 1-2 meters of the body often used during sleep or rest. The emitted photonic fields are non-directional and penetrate through clothing, bedding, and other soft materials.

Field delivery considerations include:

a) Proximity: Closer placement (within 0.5 meters) yields stronger effects.

b) Orientation: Device positioning can be adjusted to target specific regions (e.g., near the spine or tumor site).

c) Combination with grounding or reflective materials may enhance resonance and biofield interaction.

Generator strength varies by model and application. High-output clinical units are used in treatment centers and research facilities, while smaller devices support home-based care. Field strength is measured in photons/sec/cm², though standardized output units are still being developed for regulatory purposes.

Conclusion. The safety and adaptability of biophoton therapy make it a promising and scalable integrative therapy, with clear advantages over traditional modalities in terms of risk profile, accessibility and patient compliance. Future studies will benefit from standardized dosimetry frameworks, field mapping and patient-specific protocols to maximize therapeutic outcomes.

Comparison with other Non-Chemical Therapies

As the landscape of integrative oncology expands a range of non-chemical, energy-based therapies have gained traction for their potential to support cancer care without introducing systemic toxicity. These modalities include photo-biomodulation (PBM), pulsed electromagnetic field therapy (PEMF), infrared therapy, and emerging quantum-based interventions. While each has unique mechanisms, BQM offers distinct advantages based on coherence, safety, and whole-body systemic impact.

Photo-biomodulation (PBM) vs. Biophoton therapy

PBM typically delivered via low-level lasers or LEDs uses red or near-infrared light to stimulate mitochondrial activity, enhance circulation and reduce inflammation [87]. While PBM has shown benefit in wound healing, oral mucositis and neuropathy, its effects are often localized, requiring direct contact with specific tissues and limited penetration depth.

By contrast, BQM utilizes strong and coherent photonic fields that can influence system-wide cellular functions without direct contact, specific wavelengths, or skin exposure. The non-directional and penetrating nature of biophoton fields enables longer-duration exposure without the risk of phototoxicity or overheating [20].

Pulsed Electromagnetic Field (PEMF) therapy vs. Biophoton therapy

PEMF therapy uses low-frequency electromagnetic pulses to stimulate healing, primarily in bone and soft tissue injuries. While PEMF has demonstrated benefit in pain reduction and inflammation control, its effects are frequency-dependent and often limited to electromagnetic resonance, not photon-based signalling [88].

BQM, on the other hand, operates on light-based quantum coherence, with potential to regulate mitochondrial biophysics, gene expression, and intercellular communication at a deeper energetic level. Additionally, BQM has not shown any interference with pacemakers, neurostimulators, or other implants whereas

PEMF may require caution in such cases.

Infrared, thermal and far-infrared therapies

Infrared therapies work primarily through thermal effects, improving circulation and muscle relaxation. While effective for short-term relief of musculoskeletal discomfort, heat-based therapies do not offer long-term mitochondrial or genetic modulation. BQM differs in that its biophoton fields are non-thermal, working through subtle energetic resonance rather than heat generation. This allows continuous use often overnight without risk of burns or tissue damage.

Unique features of biophoton quantum medicine (Table 1)

BQM provides a multidimensional therapeutic effect: non-toxic, non-invasive, non-contact, and scalable for use at home or in clinics. Its quantum-level mechanism uniquely positions it to support restoration of mitochondrial function, cellular coherence, immune modulation and gene expression normalization in ways that conventional energy modalities may not fully achieve.

Table 1:

Feature	PBM	PEMF	Infrared Therapy	BQM
Modality Type	Light (laser/LED)	Electromagnetic Pulse	Thermal/Light	Coherent Biophotonic Field
Delivery Method	Direct Contact	Contact or Pads	Sauna/Lamps	Non-contact Field Exposure
Primary Target	Local Tissue	Local Tissue	Surface Heat Receptors	Whole-Body Bioenergetics
Systemic Impact	Limited	Moderate	Minimal	High Systemic Modulation
Safety for Continuous Use	Limited	Moderate	No (due to heat)	Yes – Continuous Exposure
Risk of Interference/Overdose	Possible	Yes (in some devices)	Yes (heat stress)	None Reported

Regulatory and Ethical Implications

As BQM continues to gain clinical interest and therapeutic relevance, navigating its regulatory classification and ensuring ethical deployment are critical for its safe and responsible integration into cancer care.

Regulatory classification and approval pathways

Because BQM operates via coherent, ultra-weak photonic fields and does not rely on chemical, thermal, or ionizing mechanisms, it represents a new class of non-invasive energy-based medical technologies. However, this novelty also presents challenges for classification under traditional regulatory frameworks. In the United States, the Food and Drug Administration (FDA) regulates medical devices based on their intended use, risk profile, and mode of action. BQM may be eligible for consideration as a Class I or Class II wellness or therapeutic device, if used for general health support or symptom relief (e.g., pain, fatigue); or Class III device, if intended for the treatment or mitigation of cancer itself, requiring evidence of safety and efficacy through clinical trials [89].

Due to its innovative nature, BQM may also qualify for the FDA Breakthrough Device Designation, which supports expedited review for devices that offer significant advantages over existing options in treating serious or life-threatening conditions [90].

Globally, regulatory acceptance will require alignment with standards set by agencies such as:

- A. European Medicines Agency (EMA) or MDR for CE marking in the EU.
- B. Health Canada, MHRA (UK), National Medical Products Administration (NMPA, China) and Pharmaceuticals and Medical Devices Agency (PMDA, Japan).
- C. WHO guidelines on non-pharmacologic interventions.

To accelerate clinical adoption, manufacturers and researchers must work closely with regulators to: (1) Define technical standards (e.g., biophoton emission profiles); (2) Develop Good Manufacturing Practices (GMP); (3) Establish clinical endpoints for cancer-related applications.

Whether Biophoton Quantum Medicine (BQM) has any adverse effects on normal cells

The therapeutic promise of Biophoton Quantum Medicine (BQM) lies in its non-invasive, non-toxic modulation of biological systems through coherent light energy. While much of this review has emphasized BQM's potential to target cancer pathology, it is equally essential to assess its safety profile especially its impact on normal, healthy cells [91].

A critical gene implicated in cellular stress resistance and survival is Sirtuin 1 (SIRT1), a well-known regulator of mitochondrial function, DNA repair, and metabolic balance. SIRT1 activity has been shown to protect against apoptosis and senescence in normal

cells under oxidative stress and inflammatory conditions. Ensuring that BQM does not suppress, but potentially supports, SIRT1 expression could serve as an important marker for biocompatibility and therapeutic precision [92].

Emerging studies have indicated that enhanced SIRT1 activity contributes to improved appetite regulation, reduced systemic inflammation, and reversal of cellular aging markers in diverse populations. Furthermore, loss of SIRT1 function has been linked to metabolic dysfunction and increased susceptibility to multi-organ damage. Evaluating the plasma levels of SIRT1 in future clinical or preclinical trials involving BQM may offer critical insights into the therapy's systemic safety and its effects on non-cancerous tissues [93].

Given BQM's reported effects on mitochondrial recharging and oxidative stress modulation, it is plausible that this therapy may help maintain or restore optimal SIRT1 expression levels in normal cells thereby promoting survival and resilience rather than toxicity. This hypothesis aligns with the broader vision of BQM as a quantum-informed therapy that selectively aids biological coherence in diseased states while harmonizing cellular environments in healthy tissues.

Further investigations assessing SIRT1 expression before and after BQM exposure in both healthy and diseased models would be valuable to substantiate these claims and ensure safe clinical translation.

Ethical considerations in clinical deployment

The ethical application of BQM centers on its use in vulnerable cancer populations, many of whom are seeking alternative or adjunctive therapies to manage side effects, improve quality of life, or extend survival.

Key ethical principles include:

- a) **Transparency:** Patients must be fully informed that BQM is currently not a substitute for standard oncology care and remains under investigation for direct anticancer effects.
- b) **Informed Consent:** Particularly in research settings, clear documentation should emphasize the experimental nature of treatment and potential benefits and limitations.
- c) **Equity and Access:** The non-invasive, low-risk nature of BQM makes it well-suited for underserved, palliative, or non-responsive populations, but efforts must be made to avoid restricting access based on socioeconomic status.
- d) **Avoidance of Harm:** No false claims or exaggerated promises should be made, particularly for terminal or late-stage patients who may be vulnerable to misinformation.

Ethical deployment also requires monitoring, documentation, and peer-reviewed publication of outcomes to guide clinical use and foster scientific legitimacy. Public trust in biophoton therapy depends on a rigorous, transparent, and evidence-based approach to validation.

Conclusion. BQM offers the potential to redefine how energy-based interventions are integrated into modern oncology. With a favorable safety profile and early indications of therapeutic benefit, it stands as a candidate for regulated, ethical, and widespread clinical adoption. However, its future depends on responsible collaboration with regulatory bodies, ethical frameworks, and rigorous scientific validation.

Future Research Directions

To fully realize the therapeutic potential of Biophoton Quantum Medicine (BQM) in cancer care, a robust program of translational, clinical, and mechanistic research is essential. While preclinical and observational data provide strong preliminary support, future studies must generate high-quality, reproducible evidence to establish efficacy, dosage protocols, biological mechanisms, and clinical integration pathways.

Controlled clinical trials

The highest priority is the development and execution of randomized controlled trials (RCTs) to assess the safety and efficacy of BQM in various oncology contexts. These should include: (1) Symptom management trials (e.g., pain, fatigue, sleep, appetite) in patients undergoing chemotherapy or radiation; (2) Adjunctive use in early- and late-stage cancers, measuring endpoints such as tumor progression, immune profiles, and quality of life; (3) Standalone use in palliative care, particularly where conventional therapies are no longer viable.

Key trial features should include blinding (if feasible), sham controls, validated patient-reported outcomes (e.g., EORTC QLQ-C30), and biologic markers (e.g., CRP, cytokines, tumor markers) [1,24,94].

Mechanistic and molecular studies

To establish a strong scientific foundation, more in-depth investigations at the molecular and quantum biology levels are needed. Key areas include: (1) Biophoton-induced gene expression profiling (e.g., oncogenes, tumor suppressors, mitochondrial genes); (2) Modulation of mitochondrial bioenergetics, membrane potential, and reactive oxygen species (ROS); (3) Epigenetic changes linked to photonic signalling, including histone modification and DNA methylation; (4) Time-resolved biophoton emission studies to identify dynamic patterns of coherence and disruption in cancer cells [95].

Such studies will help clarify how biophotons regulate biological order, potentially advancing not only cancer therapy but the broader field of quantum biology and regenerative medicine [37].

Imaging and diagnostic integration

A promising avenue is the integration of biophoton-based diagnostics and treatment monitoring. Future research may focus on: (1) Live cell imaging of photon emission in real-time to evaluate cancer aggressiveness and treatment response; (2) Spectroscopic analysis to differentiate between normal and malignant tissues based on photon emission profiles; (3) Wearable or implantable

biosensors that measure photonic coherence and serve as feedback tools for optimizing therapy [95-104].

Personalized and precision therapies

As understanding deepens, future work should explore how BQM can be customized to individual patients, using: (1) Tumor-specific biophoton sensitivity profiles; (2) Genomic or metabolic markers to tailor field strength and exposure duration; (3) Integration with AI-guided treatment platforms for continuous adjustment based on biofeedback. This opens the door to personalized photonic oncology, aligned with the broader goals of precision medicine.

Cross-Disciplinary and global collaborations

Given its quantum physical basis and system-level influence, BQM research must be multidisciplinary, involving experts in: (1) Oncology; (2) Quantum physics; (3) Molecular biology; (4) Bioengineering; (5) Integrative and complementary medicine

International collaboration will accelerate knowledge exchange, technology standardization, and regulatory alignment across jurisdictions, enabling global access.

Conclusion

Biophoton Quantum Medicine (BQM) represents a pioneering frontier in integrative cancer care, offering a non-invasive, non-toxic and system-level therapeutic modality rooted in the emerging science of quantum biology and biophotonics. By leveraging the body's innate capacity to generate and respond to coherent ultra-weak light emissions, BQM introduces a fundamentally different mechanism of action one that aligns with restorative, regulatory, and energetic principles rather than destructive or suppressive intervention. From preclinical models to patient-reported outcomes, evidence suggests that BQM can (1) enhance mitochondrial function and oxidative phosphorylation; (2) modulate oncogene and tumor suppressor gene expression; (3) promote apoptosis in malignant cells while preserving healthy tissues; (4) support immune reactivation, including macrophage and T-cell function; (5) reduce inflammation and oxidative stress, key drivers of cancer progression; (6) restore intercellular communication and quantum coherence at the tissue level.

Clinical observations further demonstrate that biophoton therapy may significantly alleviate chemotherapy-related side effects, improve quality of life, and in select cases, contribute to tumor regression or biomarker reduction. With no reported adverse effects, and the capacity for continuous, home-based use, BQM offers a rare combination of therapeutic promise and safety.

To realize its full potential, the field must now commit to (1) rigorous clinical trials; (2) standardized dosing and field measurement protocols; (3) global regulatory engagement; (4) ethical deployment in cancer populations; (5) multidisciplinary collaboration to unlock the molecular and quantum mechanisms behind its effects.

As cancer care evolves beyond molecular targeting toward system-based resilience and coherence, BQM stands at the forefront of a new therapeutic paradigm one that recognizes light, not just as a

source of energy, but as a carrier of biological order and healing potential.

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