



Integrative Oncology Approaches Beneficial to Patients in Radiation Therapy

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Received: 17 August 2025 / Accepted: 22 September 2025 / Published online: 14 October 2025
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Abstract

Purpose of Review Radiation therapy (RT) remains a cornerstone of multidisciplinary cancer treatment but is frequently associated with acute and chronic toxicities that negatively impact patient quality of life and treatment adherence. This review examines evidence-based integrative oncology interventions—encompassing nutrition, phytochemicals, mind-body therapies, acupuncture, and homeopathy—and their role in mitigating RT-related side effects and supporting patient-centered care.

Recent Findings Emerging clinical trials and meta-analyses have demonstrated that specific integrative strategies can significantly reduce common toxicities associated with RT. Probiotic supplementation lowers the incidence of radiation-induced diarrhea, while high-fiber diets and omega-3 fatty acids may enhance gastrointestinal tolerance and limit therapy resistance. Acupuncture has shown efficacy in managing chronic xerostomia, and calendula-based topical treatments have been effective for radiation dermatitis. Mind-body interventions—including cognitive behavioral therapy, hypnosis, yoga, and mindfulness-based stress reduction—have consistently improved fatigue, anxiety, and overall well-being. Importantly, many of these interventions are low risk, feasible to implement, and increasingly incorporated into supportive oncology care.

Summary Integrative oncology offers a valuable complement to modern RT by reducing treatment-related toxicity and enhancing quality of life. As precision medicine advances the ability to tailor RT based on clinical and genomic risk, the integration of evidence-based supportive therapies aligns treatment with patient goals and promotes resilience. Ongoing research will further clarify best practices for incorporating these interventions into routine care, ensuring radiation oncology evolves to meet the dual goals of disease control and holistic patient well-being.

Keywords Radiation therapy · Complementary medicine · Integrative oncology · Cancer care · Patient centered care · Supportive care

Introduction

Radiation therapy (RT) has long been a cornerstone of multidisciplinary cancer care, offering both curative and palliative benefits across a wide range of malignancies. Its

positive impact on survival is well established: a comprehensive review by Hanna et al. demonstrated that evidence-based RT confers an approximate 2.4% improvement in 5-year overall survival across cancers, with the greatest gains observed in head and neck (16%) and cervical cancers (18%)^[1]. These findings underscore RT's critical role in cancer treatment.

However, the benefits of RT must be weighed against its potential toxicities and the need for thoughtful patient selection. Modern RT has evolved from a crude technique developed over a century ago into a sophisticated, precision-targeted modality incorporating advances such as intensity-modulated RT, stereotactic body RT, and image-guided RT. These innovations allow highly conformal treatments that spare adjacent healthy tissues. Despite this progress, RT can still cause acute and chronic toxicities—including

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dermatitis, mucositis, fibrosis, vascular injury, and second malignancies—that may compromise quality of life, treatment adherence, and outcomes[^] [3].

Emerging evidence also highlights the growing role of clinical and genomic risk stratification in determining whether RT is necessary at all. For example, the PRIME II trial demonstrated that in older women (≥ 65 years) with low-risk, hormone receptor–positive early breast cancer treated with breast-conserving surgery and endocrine therapy, omission of RT led to an increased risk of local recurrence but did not adversely affect long-term overall survival[^] [2]. More recently, the IDEA study extended this observation to a broader age range (50–69 years) and incorporated genomic profiling, showing that carefully selected patients with node-negative, unifocal tumors and favorable genomic features could safely forgo RT without compromising early survival outcomes[^] [2]. Together, these studies illustrate the increasing movement toward precision oncology, aligning treatment decisions with individual patient characteristics and disease biology.

At the same time, a growing body of evidence supports integrative interventions to help patients tolerate RT and manage its side effects. Nutritional approaches have shown particular promise: high-fiber diets reduce gastrointestinal toxicity during pelvic irradiation[^] [4], while omega-3 fatty acid supplementation may help limit therapy resistance, toxicity, and the risk of metastasis when combined with RT[^] [5]. Similarly, traditional Chinese medicinal formulations such as Astragalus have been associated with a reduced incidence and severity of radiation-induced lung injury[^] [6]. Other natural compounds can also help protect normal tissues from the oxidative damage caused by ionizing radiation[^] [3].

Behavioral strategies have emerged as valuable adjuncts for symptom management and recovery. Fatigue is among the most common and debilitating side effects of RT and is highly predictive of long-term quality of life and treatment adherence. Randomized trials have demonstrated that cognitive behavioral therapy combined with hypnosis can significantly reduce both acute and persistent fatigue in patients receiving RT for breast cancer[^] [7]. Other mind–body practices, including movement and relaxation techniques, have shown similar benefits in supporting psychological well-being.

Additional integrative modalities such as acupuncture and homeopathy have demonstrated efficacy in addressing specific RT-related toxicities. Randomized trials have shown that acupuncture significantly reduces chronic xerostomia in patients with head and neck cancer undergoing RT[^] [8]. Homeopathic treatments have also been associated with improvements in radiation-induced skin toxicity, providing a viable option in appropriately selected patients[^] [9].

As integrative oncology and personalized medicine continue to advance, ongoing research will be essential to refine patient selection, optimize treatment protocols, and elucidate the biological mechanisms underlying these approaches. The future of RT lies not only in technological innovation and rigorous clinical trial design but also in its thoughtful integration with nutrition, behavioral medicine, natural compounds, and other supportive strategies. In this way, RT can fulfill its dual mission: to eradicate disease while preserving the quality of life and dignity of those it serves.

Nutrition During Radiotherapy

Nutrition is a vital component of recovery and resilience during radiotherapy (RT) and one of the pillars of integrative oncology. Yet many patients fail to adhere to evidence-based dietary recommendations. In a cross-sectional survey, authors identified significant deficiencies in fruit, vegetable, and whole-grain intake in women receiving RT for breast cancer, underscoring the need for routine nutrition screening and counseling[^] [10].

The side effects of RT vary significantly based on the site treated, total dose, and fractionation schedule. Patients receiving thoracic RT may experience esophagitis and dysphagia, making swallowing challenging and leading to significant weight loss. Abdominopelvic RT often causes gastrointestinal toxicity — including diarrhea, bloating, and discomfort — that can affect appetite and nutrition. Similarly, patients treated for head and neck cancers may develop mucositis, xerostomia, dysgeusia, and odynophagia, severely impacting oral intake. These side effects can precipitate malnutrition and cachexia, reducing treatment tolerance and negatively affecting clinical outcomes.

Nutrition, Phytochemicals, and Radioprotection in Radiotherapy

Evidence increasingly supports targeted nutritional and natural interventions to reduce RT–induced toxicity and support patient recovery. A randomized trial by Wedlake et al. found that a high-fiber diet (≥ 18 g/day) mitigated gastrointestinal toxicity and supported long-term bowel health for patients receiving pelvic RT, challenging traditional restrictions on fiber intake[^] [4]. Similarly, omega-3 fatty acids — available in fatty fish (e.g., salmon, mackerel), walnuts, and chia seeds — have demonstrated benefits for reducing therapy-induced toxicity and resistance and slowing metastasis, mediated via anti-inflammatory and antioxidant pathways[^] [5].

Phytochemicals Many patients undergoing radiation therapy seek complementary ways to mitigate toxicity and enhance treatment efficacy. Phytochemicals including flavonoids, polyphenols, and polysaccharide-rich plants — have long been valued for their antioxidant, anti-inflammatory, and immunomodulatory properties, making them promising adjuncts in the RT setting.

Among the most researched natural compounds are plant-derived phytochemicals, which possess antioxidant, anti-inflammatory, and radioprotective properties. These include curcumin (from turmeric), epigallocatechin gallate (EGCG, from green tea), resveratrol (from grapes), and sulforaphane (from cruciferous vegetables).

While the theoretical concern exists that antioxidants might interfere with ROS-mediated tumor damage from radiation, emerging preclinical studies suggest that certain phytochemicals may selectively protect normal tissues without impairing anti-tumor effects. For example, curcumin has demonstrated the ability to reduce radiation-induced skin and mucosal toxicity while sensitizing tumor cells to radiation through modulation of NF- κ B and STAT3 signaling.

Patients often self-initiate use of these compounds, drawn by their perceived “natural” safety. Clinicians should be prepared to discuss potential benefits and risks, ideally guiding patients toward evidence-based use (e.g., standardized extracts, appropriate dosing) and ensuring no interference with concurrent therapies.

A meta-analysis of 25 randomized trials (1,762 patients) found that treatments based on *Astragalus membranaceus* significantly reduced the incidence and severity of radiation-induced lung injury, including pneumonitis and pulmonary fibrosis, suggesting a favorable role for traditional Chinese medicine formulations[^] [6]. Additional natural compounds — catechins from green tea, curcumin from turmeric, resveratrol from grapes and berries, quercetin from apples and onions, and lycopene from tomatoes — have also been identified for their potential radioprotective and mitigatory effects. These bioactive compounds reduce DNA damage, scavenge reactive oxygen species, down-regulate NF- κ B, and limit secretion of pro-inflammatory and fibrogenic cytokines within irradiated tissue[^] [3].

In clinical practice, medical-grade honey has emerged as one of the best-supported natural interventions for RT-induced oral mucositis. A systematic review of 36 trials (~2,400 patients) confirmed its efficacy in reducing the severity, pain, and associated symptoms of mucositis in patients with head and neck cancers[^] [11]. The MASCC/ISOO 2020 guideline recommends topical application and swallowing of natural honey to lower the risk and severity of RT-induced mucositis, making it one of the few natural treatments with formal clinical endorsement[^] [12]. In contrast, evidence

for herbal treatments for RT-induced skin toxicity remains inconclusive. A meta-analysis of 16 trials ($n = 1,886$) found no definitive benefit for popular treatments such as aloe vera for acute radiation skin toxicity[^] [13].

Similarly, a systematic review and meta-analysis of 22 trials (1,819 patients) focusing on oral Chinese herbal formulations for RT-induced pneumonitis[^] [14]. In this review, traditional Chinese herbal formulations were administered orally alongside radiation therapy for lung cancer patients. These formulations varied across studies, but common ingredients included, among others:

- **Astragalus membranaceus** (Huang Qi) – an adaptogenic root with immunomodulatory and anti-inflammatory properties.
- **Glycyrrhiza uralensis** (Licorice root) – used for its anti-inflammatory and antioxidant effects.

Each trial included in the review used a slightly different combination of these and other traditional medicinal herbs, making it challenging to pinpoint a single standardized formulation. The review concluded that, despite this variability, patients receiving these traditional Chinese herbal medicine treatments experienced roughly a 50% reduction in the risk of overall pneumonitis and a five-fold decrease in severe pneumonitis compared with controls (although quality varied across trials).

Calendula officinalis (marigold) has been widely studied as a topical treatment to prevent or reduce acute radiodermatitis during radiotherapy. It shows promise as a low-risk, cost-effective topical intervention. Its anti-inflammatory and healing properties are biologically plausible. However, results vary, and not all studies show superiority over standard care. A randomized trial by Pommier et al. (2004) found that *Calendula officinalis* ointment significantly reduced the incidence of acute dermatitis of Grade 2 or higher in patients with breast cancer receiving radiotherapy, compared with trolamine (41% vs. 63%; $p < 0.001$). Patients using *Calendula* also reported less pain and better tolerance of radiotherapy treatments.[^] [15].

A 2020 integrative review analyzing five clinical and pre-clinical studies across major databases (CINAHL, Cochrane, Medline, Embase, LILACS, Web of Science) found that *Calendula* ointment or cream outperformed trolamine and essential fatty acids in reducing the incidence and severity of radio-dermatitis. Another double-blind randomized clinical trial in Brazil ($n = 51$) compared *Calendula* to essential fatty acids in patients undergoing head and neck radiation. The *Calendula* group showed significantly lower radiodermatitis grades ($p = 0.004$), supporting its potential benefit.[^] [17] Other studies, including comparisons with aqueous placebo creams, have shown no significant differences,

suggesting that while *Calendula* may be effective in some settings, results are inconsistent. ^ [18].

The Role of Medicinal Mushrooms

Medicinal mushrooms — Medicinal mushrooms—particularly *Ganoderma lucidum* (Reishi), *Coriolus versicolor* (Turkey Tail), *Lentinula edodes* (Shiitake), and *Grifola frondosa* (Maitake)—are widely used by cancer patients, including those undergoing radiation therapy. These fungi contain β -glucans and other polysaccharides known to modulate immune activity and support hematologic recovery.

Several clinical trials and observational studies suggest that mushroom extracts may enhance immune surveillance, reduce treatment-related fatigue, and improve tolerance to chemotherapy and radiation. For instance, *Trametes versicolor* has been associated with improved quality of life and NK cell activity in patients receiving concurrent oncologic treatments.

Though large randomized trials are lacking, the consistent low toxicity profile of medicinal mushrooms makes them attractive as supportive agents. Radiation oncologists should be aware of their widespread use and engage patients in shared decision-making regarding their integration.

Medicinal mushrooms are rich in polysaccharides (such as β -glucans) and antioxidant compounds, these mushrooms have demonstrated a range of benefits:

- **Immune Modulation:** A Cochrane review confirmed that Reishi extract administered alongside RT increased CD3+, CD4+, and CD8 + lymphocyte counts, natural killer (NK) activity, and overall immune recovery^ [19]. Similar benefits were observed with Turkey Tail (PSK/PSP), which improved lymphocyte counts and NK activity in clinical trials^ [20].
- **Radioprotection and Toxicity Mitigation:** Animal studies have demonstrated that Cordyceps extracts protect bone marrow and gastrointestinal tissue from RT-induced injury, preserving hematopoiesis, restoring spleen and thymus recovery, and promoting DNA repair^ [21].
- **Enhanced Clinical Outcomes:** Lentinan (derived from *Lentinula edodes*) has been associated with improved one-year survival, objective response rates, and quality of life when administered alongside chemoradiation, especially in lung and gastrointestinal cancers^ [22].

While the clinical evidence is promising, trials remain relatively small or are conducted primarily in Chinese patient

populations. The favorable toxicity profiles of medicinal mushrooms and their observed benefits for patient-reported outcomes justify further research to define their role and optimize dosing within RT protocols.

Cannabinoids

Many studies estimate that 20–40% of cancer patients utilize cannabis or cannabinoid products during or after their cancer treatment. While studies highlight the benefit of cannabinoid products on cancer-associated pain, nausea, vomiting, appetite, and sleep disturbances, there are limited studies looking at the effects, benefits, and risks of cannabis use during RT. One review of 8 ($n = 188$) trials found that low-dose cannabinoid products may improve anxiety, nausea, and vomiting symptoms^ [23]. As there is limited data to support its use and no evidence of long-term safety, it is not a recommended practice to suggest cannabis use during RT unless within the context of a clinical trial [24].

The Impact of Probiotics and Other Nutritional Approaches

Probiotics are live microorganisms that confer health benefits when administered in adequate amounts. They have emerged as a well-supported intervention to reduce gastrointestinal toxicity, particularly diarrhea, during pelvic and abdominal RT.

The mechanism involves restoring gut microbiota diversity, enhancing mucosal barrier function, and modulating local immune responses.

Commonly studied strains include *Lactobacillus acidophilus*, *Bifidobacterium bifidum*, and multi-strain formulations like VSL#3. Given their low cost, ease of use, and growing evidence base, probiotics can be reasonably recommended for patients undergoing pelvic RT, barring contraindications such as severe immunosuppression.

One of the most compelling nutritional interventions for patients receiving radiation therapy is the use of probiotic supplements to prevent radiation-induced diarrhea (RID). Pelvic and abdominal radiotherapy—commonly used for cervical, endometrial, prostate, and rectal cancers—often damages the intestinal mucosa and disrupts gut flora, leading to diarrhea and cramping.

Probiotics, which are beneficial live bacteria, have been evaluated in multiple trials for their ability to maintain gut health during RT. A 2019 meta-analysis published in *Nutrients* pooled data from eight randomized trials involving 1,116 patients and demonstrated a clear benefit: probiotics significantly reduced the incidence of radiation-induced diarrhea compared to placebo (pooled risk ratio ~ 0.62 ; 95% CI, 0.46–0.83) [25]. In practical terms, patients taking

probiotics were approximately 40% less likely to experience serious diarrhea. The analysis also showed that probiotic use reduced the need for anti-diarrheal medications (risk ratio ~ 0.54).

Interestingly, subgroup analysis indicated that the protective effect was most pronounced in patients receiving RT without concurrent chemotherapy, likely because chemotherapy itself contributes to diarrhea and further disrupts gut microbiota.

The probiotic strains and dosing regimens varied across studies, though many trials used combinations of *Lactobacillus* and *Bifidobacterium* species. For example, one study administering daily *Lactobacillus acidophilus* and *Bifidobacterium bifidum* reported a significant reduction in Grade ≥ 2 diarrhea (13% incidence vs. 37% with placebo) and improved stool consistency. Another trial using the multi-strain product VSL#3 showed that probiotics delayed the onset of diarrhea compared to placebo.

Based on these findings, probiotic supplementation is considered an effective strategy to prevent and reduce radiation-related diarrhea, provided there are no contraindications. Because probiotics carry a rare risk of bloodstream infection in severely immunosuppressed patients, careful patient selection is essential. Patients receiving pelvic radiotherapy should discuss probiotic use with their healthcare team prior to and during treatment. Overall, current evidence suggests this simple intervention can meaningfully improve gastrointestinal tolerance to radiation [25].

Phytochemicals, Antioxidants, and Radiotherapy: Balancing Risks and Benefits

Many patients undergoing radiotherapy inquire about antioxidant supplements or foods rich in polyphenols and flavonoids, hoping to protect normal tissues and reduce inflammation. A recent systematic review of 39 RCTs found that vitamins and supplements high in antioxidants may have potential in managing oral mucositis, xerostomia, esophagitis, and radiation-induced dermatitis [26]. Supplements such as Vitamin C, Vitamin E, curcumin, and epigallocatechin-3-gallate (EGCG) may have benefits in certain circumstances. While some of these agents have been shown in preclinical studies to mitigate oxidative stress and modulate inflammation, their use during RT remains controversial due to concerns that antioxidants might neutralize the reactive oxygen species (ROS) essential for radiation-induced DNA damage in cancer cells.

However, the evidence base supporting this concern is limited. Most of the “avoidance” recommendations stem from theoretical models or early *in vitro* data. Few well-conducted clinical trials have demonstrated that antioxidant

supplementation reduces the efficacy of radiotherapy in humans [27]. In contrast, several studies suggest that specific phytochemicals may offer selective protection to healthy tissues without impairing tumor control [27, 28]. For example, curcumin is widely reported to act as both a radiosensitizer for tumors and a radioprotector for normal tissues, through mechanisms such as NF- κ B inhibition and antioxidant effects [29].

Given this nuance, a blanket recommendation to avoid all antioxidants during RT may be overly cautious. Instead, clinicians should individualize recommendations based on:

- Type of Antioxidant
- Dose and Formulation
- Site and Type of Cancer
- Concurrent treatments (e.g., chemotherapy)
- Patient Goals and Preferences

An open conversation with patients is essential. Encouraging whole-food sources (e.g., berries, turmeric, green leafy vegetables) is generally safe and beneficial. For high-dose supplements, guidance from a clinician experienced in integrative oncology can help assess benefit vs. theoretical risk.

We propose that certain antioxidant and phytochemical interventions may be considered reasonable in selected cases, especially for symptom relief (e.g., skin reactions, mucositis, fatigue), when the formulation, timing, and patient context are well understood. While caution is warranted, current evidence does not support a blanket contraindication for all antioxidant supplements during radiation therapy. Each agent should be evaluated for its mechanism, dosing, and context.

Limited Fasting

Patients are generally advised to maintain a balanced, whole-food-based diet and consult an oncology nutritionist before initiating any supplements [30]. Meanwhile, early phase- trials exploring limited fasting during RT have shown that it is feasible, safe, and may reduce treatment-related fatigue and gastrointestinal toxicity, while aiding weight and fat loss [31, 32]. Preliminary data also hint at potential benefits for immune function and enhanced DNA damage within tumors when limited fasting is combined with RT [32, 33]. At least one Phase II trial (the “TIDIER” study) is now ongoing to rigorously test time-restricted eating vs. regular diet during radiotherapy [34]. It is important to note, fasting during RT should be done under medical supervision, especially since weight loss can be harmful for cancer patients if uncontrolled. Fasting is an intriguing area of research, but not a standard recommendation yet.

Summary

Nutritional interventions play a key role in supporting patients undergoing radiation therapy by enhancing treatment tolerance, reducing inflammation, and improving outcomes. Evidence-based approaches—such as Mediterranean-style diets, high fiber diets and adequate protein intake—can mitigate malnutrition and sarcopenia, while select supplements like omega-3 fatty acids, curcumin, melatonin, and medicinal mushrooms have shown promise in modulating oxidative stress and supporting host defenses. Although concerns persist regarding antioxidant use during RT, emerging data suggest that certain phytochemicals may selectively protect normal tissues without impairing tumor control. Additionally, short-term or limited fasting around treatment sessions is gaining interest for its potential to sensitize tumor cells and reduce RT-related toxicity. A summary of nutritional interventions is presented in Table 1.

Mind–Body Interventions

Fatigue, anxiety, sleep disruption, and loss of control are common during radiation therapy. Mind–body interventions—such as mindfulness-based stress reduction (MBSR), cognitive behavioral therapy (CBT), hypnosis, and guided imagery—offer tools to help patients manage these challenges and regain a sense of agency [35–38].

These interventions are non-invasive, scalable, and increasingly integrated into cancer centers worldwide. Importantly, patients often feel empowered by these tools, which reinforce their active role in the healing process.

Despite advances in precision delivery, RT is associated with a host of acute and long-term effects that impact patients’ physical, psychological, and social wellbeing. Fatigue, pain, insomnia, depression, and anxiety are common and can persist long after treatment ends. Mind–body interventions have emerged as valuable adjuncts for alleviating treatment-induced distress and supporting overall quality of life [7, 35–38].

Rationale for Mind–Body Interventions

Mind–body interventions encompass practices such as cognitive behavioral therapy (CBT), hypnosis, relaxation training, yoga, movement therapies, meditation, and guided imagery. These approaches target the interplay between psychological state, neurological activity, and immune function. They modulate the hypothalamic-pituitary-adrenal (HPA) axis, autonomic nervous system activity, and

Table 1 Nutrition and supplements that can be beneficial in radiation therapy

Category	Specific Foods / Supplements	Mechanisms / Benefits	Reference(s)
Foods Rich in Omega-3 Fatty Acids	Fatty fish (salmon, mackerel, sardines), flax seeds, chia seeds, walnuts	Reduce therapy-induced toxicity, modulate NF-κB and PI3K/Akt pathways, anti-inflammatory effects	5
High-Fiber Foods	Whole grains, legumes, vegetables	Maintain bowel health, reduce RT-induced gastrointestinal toxicity, long-term benefits post-treatment	4
Medicinal mushrooms	Reishi, Turkey Tail, Cordyceps, Shiitake	Reduce RT-induced mucositis, support immune recovery, preserving hematopoiesis, promoting DNA repair.	19-22
Herbal Formulations	Astragalus membranaceus	Reduce incidence and severity of radiation-induced lung injury, improve patient outcomes	6
Other Nutritional Supplements	EPA/DHA (fish oil)	Anti-inflammatory effects, enhanced clinical outcomes when combined with RT	5
Limited fasting	Preliminary data also hint at potential benefits for immune function and enhanced DNA damage within tumors when limited fasting is combined with RT	Reduce DNA damage, scavenge ROS, down-regulate NF-κB, reduce fibrosis	31-34
Honey (Topical / Oral)	Medical-grade or natural honey	Reduces oral mucositis incidence, severity, and pain, endorsed by MASCC/ISOO guidelines	11, 12
Calendula officinalis	Calendula cream / ointment	Reduces severity of acute radiation dermatitis	15, 16, 17

proinflammatory cytokine release, yielding benefits for fatigue, pain, and emotional distress. Randomized trials have shown that CBT combined with hypnosis can significantly reduce acute and persistent fatigue in breast cancer patients undergoing RT [7]. Mindfulness practices and yoga have similarly demonstrated benefits in improving emotional regulation, sleep, and overall quality of life. These therapies work by modulating the hypothalamic–pituitary–adrenal (HPA) axis, autonomic tone, and inflammatory cytokine expression [35–38].

It has been shown that these interventions can reduce cortisol dysregulation and maintain a balanced inflammatory state, making them highly relevant for patients receiving RT [7, 35, 36].

CBT, Hypnosis, and Tai Chi for Fatigue Management

Fatigue is one of the most debilitating side effects of RT, affecting up to 90% of patients and often persisting long after treatment. In a landmark randomized clinical trial, CBT combined with hypnosis (CBTH) significantly reduced fatigue in women with breast cancer throughout RT and up to six months post-treatment [7]. Compared with attention and support controls, patients receiving CBTH experienced lower fatigue levels at treatment completion, four weeks, and six months later. These results underscore CBT and hypnosis as safe, feasible interventions for long-term fatigue relief. By addressing maladaptive thoughts, reducing physiological hyper arousal, and promoting relaxation, CBTH provides patients with coping strategies that can be internalized and used long after therapy concludes [7]. Tai Chi may also be a reasonable addition for patients with fatigue. A systematic review found that patients who practiced Tai Chi three times a week had lower levels of fatigue and improved sleep; however, the evidence was low, and further studies are needed [37].

Mindfulness-Based Interventions

Mindfulness practices — including meditation, mindfulness-based stress reduction (MBSR), and mindfulness-based cognitive therapy (MBCT) — emphasize present-moment awareness and acceptance, offering patients tools to tolerate the physical and emotional discomfort associated with RT. Systematic reviews have found that mindfulness interventions reduce fatigue, depression, and anxiety, making them valuable adjuncts for patients across clinical settings [36]. In one review of 163 studies focusing on complementary and integrative medicine (CIM) during RT, roughly 41% of high-quality trials assessing patient-reported outcomes

demonstrated favorable shifts in fatigue, emotional well-being, and quality of life. Mindfulness practices emerged as feasible, well tolerated treatments that can be implemented within RT departments, making them an ideal option for routine clinical practice [36].

Mind–Body Techniques for Managing Pain and Emotional Distress

Pain and discomfort are common during RT, arising from tissue damage, mucositis, and dermatitis. Mind–body interventions, including relaxation exercises, guided imagery, breathing techniques, yoga, and meditation, have demonstrated benefits for both pain and emotional distress. Thomas et al. reviewed the role of mind–body interventions in patients receiving RT, highlighting that relaxation exercises can reduce the perception of pain, mitigate treatment-related anxiety, and foster a sense of control [35]. Similarly, studies have shown that yoga and meditation reduce cortisol levels and modulate autonomic balance, leading to decreased symptom intensity and improved coping abilities throughout the treatment trajectory [35].

CBT-Based Techniques for Depression and Anxiety

The psychological toll of RT can be profound, with depression and anxiety affecting patients' quality of life, treatment adherence, and outcomes. CBT-based interventions have been implemented successfully across clinical settings, allowing patients to recognize and reframe maladaptive thoughts, tolerate uncertainty, and build resilience throughout the treatment course. Montgomery et al. emphasized CBT's role in reducing long-term psychological burdens associated with RT [7]. CBT promotes adaptive coping strategies, decreases feelings of helplessness, and improves emotional well-being, making it a highly adaptable tool for patients receiving RT, available through in-person, telehealth, or group-based platforms [7].

Group-Based Mind–Body Programs

Group interventions — including CBT, yoga, and mindfulness training — foster communal support and resilience. Patients benefit from shared experience, peer learning, and the camaraderie that develops within these settings. Group-based mind–body interventions have demonstrated significant benefits in alleviating fatigue, depression, and anxiety, while promoting belonging and empowerment throughout and beyond the treatment period [7, 35, 36].

Integrating Mind–Body Techniques into Standard RT Care

Incorporation of mind–body interventions into routine clinical practice offers a feasible and impactful approach for optimizing patient care across disciplines, including psychology, nursing, nutrition, and medical social work. Patients engaged in mind–body treatments such as MBSR and meditation, as well as yoga, relaxation techniques, music therapy, and reflexology, report better symptom control, improved emotional resilience, and higher satisfaction with their overall care. ^ [35–38] Notably, these interventions are low cost, have minimal risk of adverse effects, and can be practiced long after therapy has ended. Their clinical value has been recognized by national and international guidelines, including those published by the Society for Integrative Oncology (SIO) and the American Society of Clinical Oncology (ASCO), underscoring their role in comprehensive integrative oncology care [38].

Homeopathy and Acupuncture for Managing Radiation Therapy–Induced Toxicity

Homeopathy and acupuncture have gained increasing attention as adjunctive interventions for managing RT–induced skin toxicity, xerostomia, fatigue, and other common side effects. These approaches have been explored for their ability to reduce the patient symptom burden and support long-term recovery and quality of life [8, 9, 39–45].

Homeopathy

Homeopathy is a system of individualized medicine using ultra-diluted substances aimed at stimulating the body's self-healing response. Although controversial due to its mechanism and high dilutions, some studies have reported beneficial effects in managing radiation-induced skin toxicity, mucositis, and fatigue [9, 39–41].

Patients drawn to holistic or natural approaches often express interest in homeopathy. Radiation oncologists unfamiliar with this modality can consider referring to integrative physicians or reviewing the available data to support individualized decisions. While more high-quality trials are needed, current evidence suggests potential benefit with minimal risk when used as adjunctive care.

Several small clinical studies have examined the role of homeopathic treatments in alleviating RT-induced skin toxicity and other adverse effects. In a retrospective Italian observational cohort, Rossi et al. assessed the impact of a

preventive homeopathic protocol (Radium bromatum 6CH taken before each RT session and Belladonna 6CH taken after, plus topical Calendula ointment and an alkalinizing gel). The study involved 30 patients with breast cancer receiving RT. 17 patients received the protocol, compared with 13 controls treated with routine keratoplastic ointments. The homeopathy group developed significantly milder radiation dermatitis (15 of 17 patients had only Grade 1 erythema, and none had Grade 4 toxicity) compared with controls (5 of 13 patients with Grade 1, and three with Grade 4 toxicity) ($P \leq 0.01$)^ [39].

In a randomized, double-blind, placebo-controlled clinical trial conducted by Balzarini et al., patients receiving RT for breast cancer were administered homeopathic remedies Belladonna 7cH and X-Ray 15cH. The results demonstrated significant improvements in recovery and a reduction in discomfort related to skin warmth, suggesting clinical benefits for patient recovery^ [9].

Other small studies have evaluated homeopathy for managing RT-induced mucositis and fatigue. In a prospective, non-randomized matched-pair observational trial conducted by Steinmann et al., 20 patients with head-and-neck cancer received a Traumeel S solution (5 times daily) versus a placebo (sage tea) rinse for mucositis. No significant differences were observed in mucositis severity or healing between the groups, although there was a non-significant trend toward less pain in the Traumeel group, and fewer Traumeel patients reported loss of taste or swallowing difficulty. ^ [40].

An additional randomized controlled trial evaluated the effectiveness of homeopathic remedies in reducing anxiety and improving cognitive function among breast cancer patients. Fifty-seven patients with unilateral breast cancer who had undergone surgery and systemic chemotherapy participated in this double-blind, randomized study. The study was conducted during the radiation treatment phase and continued for one month afterward. Long-term significant improvement in attention performance was observed in patients who received homeopathic remedies, with a similar tendency in reduced anxiety levels. ^ [41].

Taken together, the available clinical evidence for homeopathy during RT is sparse and of variable quality. Small, often non-randomized studies hint at benefits for reducing skin toxicity and fatigue, but higher-quality trials are needed before firm conclusions can be drawn. Importantly, no serious adverse events related to homeopathy have been reported, supporting its consideration as a low-risk option for selected patients within a comprehensive, integrative care plan.

Acupuncture

Acupuncture is one of the most widely used integrative modalities among oncology patients. It involves the insertion of fine needles at specific points to regulate physiological function through neural, hormonal, and immune pathways.

In the context of RT, acupuncture has shown promise in managing xerostomia in head and neck cancer, radiation-induced nausea, and fatigue [8, 42]. Mechanistic studies suggest that acupuncture can stimulate salivary flow, modulate vagal tone, and enhance endogenous opioid release.

Multiple randomized trials have confirmed its safety and efficacy, particularly for chronic symptoms where pharmacologic options are limited. As a low-risk intervention with a favorable safety profile, acupuncture is a reasonable option for interested patients, especially when delivered by practitioners experienced in oncology care.

A pivotal phase III trial by Garcia et al. compared true acupuncture, sham acupuncture, and standard care for patients receiving RT for head and neck cancer. Patients receiving true acupuncture had a significantly lower incidence and severity of chronic xerostomia one year after RT (35% vs. 55%; $P < 0.001$) and reported improved dry mouth symptoms versus standard care ($P = 0.001$) [8].

A systematic review and meta-analysis by Ni et al. pooled data from eight randomized trials ($n = 725$), finding that acupuncture significantly reduced patient-reported xerostomia (mean difference ~ 3 points, $P = 0.02$), although salivary flow rates were comparable between acupuncture and sham treatments [43].

Balk and colleagues conducted a randomized, modified double-blind, placebo-controlled pilot trial to assess acupuncture for cancer-related fatigue in 54 patients treated with surgery, with or without chemotherapy, and eligible for radiation therapy. Participants received either true acupuncture once or twice weekly for 4 weeks or sham acupuncture mimicking the procedure without therapeutic intent. Of 27 patients in the verum acupuncture group, 26 completed treatment. Fatigue improved more in the true acupuncture group compared to controls. Although physical and mental distress and quality of life also improved, differences between groups were not statistically significant. The authors concluded that their findings suggest acupuncture may benefit cancer-related fatigue [44].

A recent multicenter RCT by Cohen et al. confirmed significant improvements in patient-reported dry mouth and quality of life for patients with chronic post-RT xerostomia receiving true acupuncture versus sham or oral care ($P < 0.001$) [45].

These trials support acupuncture as a safe, low-risk, patient-centered therapy that can reduce RT-induced toxicity and long-term side effects.

When and How To Integrate Complementary Therapies in the Radiation Oncology Setting

The integration of complementary therapies into the care of patients undergoing radiation therapy (RT) should be patient-centered, evidence-informed, and tailored to the timing of treatment, symptom burden, and individual preferences. While integration is becoming more common in leading academic and community cancer centers, the optimal approach requires collaboration between radiation oncologists and integrative medicine clinicians to ensure safety, feasibility, and therapeutic value (See Table 2).

Timing of Integration

Complementary modalities can be introduced at various phases of RT, with specific considerations:

- **Pre-treatment (Planning Phase):** Mind-body practices such as mindfulness meditation, guided imagery, and breathing techniques can be introduced early to prepare patients emotionally and improve coping. Nutrition counseling and physical activity recommendations may also begin here, especially for patients with poor baseline nutritional status or physical deconditioning.
- **During Radiation Therapy:** This is the most sensitive window due to the potential for acute side effects (e.g., mucositis, fatigue, dermatitis). Safe and beneficial interventions at this stage include:

Acupuncture: For fatigue, xerostomia, nausea, and anxiety.

Reflexology and massage: For symptom relief and emotional support.

Homeopathy: In centers with experienced providers, to manage mucositis, fatigue, or emotional distress.

Selective phytochemicals: With low antioxidant potential or radiosensitizing properties (e.g., curcumin, melatonin) — used with caution and under supervision.

- **Post-treatment (Recovery Phase)** The post-RT period is ideal for intensifying interventions aimed at recovery and long-term health:

Table 2 Integrative modalities in radiation therapy

Modality	Clinical Indications During RT	Integration Guidance	Safety & Caution	Level of Evidence	Key References
Acupuncture	Xerostomia (head & neck), cancer-related pain, fatigue, anxiety, nausea	<i>During & post RT</i> Weekly sessions often effective.	Generally safe when performed by licensed practitioner.	A	8, 42–45
Mind-Body Therapies (Mindfulness, Guided Imagery, Yoga)	Anxiety, fatigue, sleep disturbance, pain, QoL	<i>Before, during & after</i> Daily practice or weekly group sessions. Particularly effective for distress management.	Safe. Adapt yoga for physical limitations.	A	7, 35–38
Medicinal Mushrooms (e.g., Reishi, Turkey Tail)	Immune modulation, fatigue, QoL support	<i>During & post RT</i> Use only standardized extracts (e.g., hot water). Best introduced 1–2 weeks before RT. Continue during treatment.	Generally safe; ensure no interactions with immunotherapy if concurrent.	B	19–22
Probiotics	Prevention of diarrhea in pelvic/abdominal RT	<i>Before, during & after</i> Can begin 1 week prior to RT. Use well-studied strains (e.g., <i>Lactobacillus rhamnosus</i> , <i>Saccharomyces boulardii</i>).	Avoid in severely immunocompromised patients.	A	25, 35
Curcumin	Mucositis, dermatitis, radiosensitization, fatigue	<i>Before, during & after</i> Consider starting with 500–1000 mg/day standardized extract. Continue during RT under supervision.	Avoid high doses with certain chemotherapies. Consult with oncology team.	B	29
Homeopathy	Fatigue, mucositis, anxiety, xerostomia, sleep disturbance	<i>During & post RT</i> May reduce skin toxicity, fatigue, and attention disturbances in selected patients, under supervision by trained integrative clinician.	No known interactions; avoid in place of conventional care.	B	9, 39–41
Reflexology	Stress reduction, pain, fatigue	<i>During & post RT</i> 1–2 sessions/week during RT can support well-being.	Ensure sterile environment; avoid open wounds or radiation field areas.	B	35, 36, 38
Nutritional Counseling	Optimize intake, prevent malnutrition, support immunity	<i>Before, during & after</i> Start pre-RT when possible. Focus on whole foods, high antioxidant fruits/vegetables, adequate protein.	Monitor for weight loss, avoid unregulated supplements during RT.	A	3–6, 11,12, 19–22, 30–34

Rebuilding nutritional resilience (e.g., Mediterranean diet, probiotics, repletion of micronutrients). Continued physical activity, yoga, or tai chi to support functional recovery. Addressing emotional trauma or fear of recurrence with psychotherapy or spiritual counseling. Reintroduction of supplements previously withheld during RT.

Individualization and Shared Decision-Making

Integration should reflect:

- The **goals** of therapy (curative vs. palliative),
- The **tumor type and site** (e.g., head and neck patients may require more aggressive nutritional support),
- The **treatment plan and anticipated toxicities**, and
- The patient’s **values, preferences, and past experience** with complementary care.

Shared decision-making is essential. Clinicians should present options transparently, highlighting evidence, risks, and expected benefits. Ideally, an integrative oncology team member (physician, advanced practitioner, or trained nurse) should coordinate these discussions.

Institutional Infrastructure and Safety Considerations

Implementing integrative care during RT depends on infrastructure:

- Access to credentialed providers (e.g., acupuncturists, dietitians, mind-body therapists),
- Institutional policies around supplement use during RT,
- Documentation systems that support cross-disciplinary communication.

Safety should remain paramount. For example, herbal supplements with strong antioxidant effects (e.g., high-dose vitamin E, green tea extract) should be approached cautiously, particularly when taken concurrently with RT. Patients often self-prescribe such agents, and open communication can help clinicians guide safer alternatives.

Conclusion

The integration of complementary therapies into the field of radiation oncology is not only feasible and safe but also offers meaningful benefits when guided by clinical context and current evidence. Successful implementation depends on thoughtful timing, interdisciplinary collaboration, and alignment with patient values and preferences.

In an era increasingly defined by precision oncology, decisions surrounding radiation therapy (RT) must move beyond protocol alone and incorporate shared decision-making that reflects each patient's goals, concerns, and lived experience. When used judiciously, evidence-based integrative interventions may reduce toxicity, improve symptom management, and support recovery without compromising oncologic efficacy.

Modern radiation therapy strives to maximize tumor control while minimizing side effects and preserving long-term quality of life. A range of integrative approaches—including nutritional support, selected phytochemicals, medical acupuncture, homeopathy, and mind-body therapies such as mindfulness and guided imagery—have demonstrated benefit in managing both acute and late RT-related toxicities. These strategies may also enhance patient resilience and emotional well-being.

Most of these interventions are low-risk, relatively easy to implement, and increasingly supported by clinical trials and practice guidelines across diverse cancer populations. When applied appropriately, they can contribute to a more comprehensive and person-centered approach to cancer care—one that blends medical precision with humanistic care.

To guide clinical adoption, we recommend a tiered strategy:

- **First**, prioritize non-invasive modalities with a strong safety profile and supportive evidence—such as mind-body therapies, touch-based therapies (e.g., reflexology), and acupuncture—for managing symptoms and improving quality of life.
- **Second**, consider nutraceuticals and botanical agents (e.g., curcumin, melatonin, medicinal mushrooms) based on available evidence, patient interest, and practitioner expertise, particularly when these do not interfere with RT mechanisms or safety.

As the field evolves, more research is needed to establish robust guidelines on how best to personalize integrative strategies based on cancer type, treatment phase, and individual patient characteristics. Nevertheless, current evidence already supports the safe and effective inclusion of integrative therapies as part of modern radiation oncology care.

Level of Evidence

- **Level A:** Strong evidence from multiple RCTs or high-quality guidelines (e.g., ASCO-SIO).
- **Level B:** Moderate evidence from some RCTs or strong observational studies.
- **Level C:** Limited evidence (pilot studies, case series) or strong expert consensus.

Key References

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 - This large multicenter randomized trial provides robust evidence supporting acupuncture for chronic xerostomia after head and neck radiotherapy.

Author Contributions We affirm that the material is original and has not been previously published and is not under consideration by another journal. We certify that all listed authors are qualified for authorship and all who are qualified to be authors are listed as authors. We certify that to our knowledge, no conflict of interest whether financial or other, exist.

Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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