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Annals of
Physical Medicine & Rehabilitation

ISSN 2770-4483

Review Article

Current Status and Future Perspectives of Cancer Rehabilitation in Palliative Care: A Systematic–Narrative Hybrid Review.

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Running Title: *Cancer Rehabilitation in Palliative Care.*

Abstract

Background: Advances in oncology have extended cancer patient survival, underscoring the importance of rehabilitation in maintaining quality of life (QOL). Rehabilitation spans physical, psychological, social, and spiritual domains, and is categorized as preventive, restorative, supportive, or palliative. In palliative care, rehabilitation helps alleviate symptoms and preserve dignity and autonomy, thereby supporting patients' values and preferences.

Objective: This review used a systematic–narrative hybrid approach. We drew from a structured literature search and thematic synthesis. Literature from 2010 to 2025 was identified through PubMed, Web of Science, and CINAHL. The keywords used included "cancer rehabilitation," "palliative care," "advance care planning," "multidisciplinary," and "prehabilitation." Representative studies, guidelines, and reviews were included in the analysis. Studies focused on pediatric oncology and non-cancer populations were excluded from the analysis. About 230 records were screened, and 96 studies and guidelines were included in the narrative synthesis. To ensure methodological rigor, the quality of the studies was assessed using a modified version of the Cochrane Risk of Bias tool, which examines factors such as sequence generation, allocation concealment, blinding, and incomplete outcome data. Standardized criteria were applied across all included studies, reinforcing the reliability of the synthesis.

Results: Five themes emerged: (1) evolving definitions of cancer rehabilitation; (2) the interface between rehabilitation and palliative care, especially in advance care planning (ACP); (3) disease-specific approaches for bone metastases, brain metastases, and lung cancer; (4) models of multidisciplinary collaboration; and (5) emerging innovations like prehabilitation, tele-rehabilitation, and AI-supported interventions. A Japan-specific perspective identifies barriers, including reimbursement limitations, resource allocation issues, and training gaps.

Conclusion: Cancer rehabilitation should be a core component of palliative care, not simply adjunct therapy. Rehabilitation professionals uniquely support patient goals and ACP. Key future steps include standardizing evidence, integrating technologies, and enacting reforms to ensure equitable access.

Keywords: Cancer Rehabilitation; Palliative Medicine; Advance Care Planning; Multidisciplinary Collaboration; Prehabilitation

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Received: 14-October-2025, Manuscript No. APMR-5180 **; Editor Assigned:** 15-October-2025 **; Reviewed:** 31-October-2025, QC No. APMR-5180 **;**
Published: 11-November-2025, **DOI:** 10.52338/apmr.2025.5180.
Citation: **Satoru Sagae, MD, PhD.** Current Status and Future Perspectives of Cancer Rehabilitation in Palliative Care: A Systematic–Narrative Hybrid Review. Annals of Physical Medicine & Rehabilitation. 2025 November; 14(1). doi: 10.52338/apmr.2025.5180.
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INTRODUCTION

Cancer remains a major global health challenge, with survival increasingly extended through advances in diagnosis and therapy. As patients live longer, maintaining physical function, autonomy, and quality of life has become a central concern in oncology care. Cancer rehabilitation—defined as a multidisciplinary process to optimize function, alleviate symptoms, and support participation in daily and social life—has emerged as a crucial component of comprehensive cancer management [1].

In recent years, the focus of cancer rehabilitation has expanded beyond restorative goals to encompass preventive, supportive, and palliative objectives. This paradigm shift reflects the growing recognition that rehabilitation contributes not only to physical recovery but also to psychological, social, and existential well-being. Within palliative care, rehabilitation plays a vital role in sustaining independence, reducing symptom burden, and fostering dignity and meaning even in advanced illness. Rehabilitation professionals, physicians, therapists, nurses, psychologists, and social workers collaborate to enable patients to live as actively and purposefully as possible throughout their lives, including the end of life [2].

However, the integration of rehabilitation into palliative care practice remains inconsistent worldwide. Clinical teams often face organizational barriers, limited resources, and conceptual ambiguity regarding the scope and goals of "palliative rehabilitation" [3]. Despite increasing evidence that rehabilitation improves quality of life and functional outcomes, systematic syntheses connecting these benefits to palliative care frameworks are scarce. Furthermore, variations in terminology, training, and service delivery hinder the development of unified guidelines and education systems.

Therefore, this review aims to provide a comprehensive yet clinically oriented synthesis of current evidence and practices in cancer rehabilitation within the context of palliative care. Combining systematic literature retrieval with narrative interpretation, it delineates key definitions, disease-specific applications, and emerging innovations such as prehabilitation and tele-rehabilitation. By integrating international evidence with the Japanese healthcare context, this review clarifies the evolving role of rehabilitation as a core pillar of palliative medicine. It identifies future priorities for research, clinical implementation, and policy development.

METHODS

A systematic–narrative hybrid approach was employed, combining structured evidence retrieval with thematic synthesis. This method is suitable for cancer rehabilitation in palliative care, as some interventions have been systematically studied, while others require an integrative approach.

Literature Search

- Databases searched: PubMed, Web of Science, CINAHL.
- Timeframe: January 2010 – May 2025.
- Keywords: "cancer rehabilitation," "palliative care," "advance care planning," "multidisciplinary," "prehabilitation," "telerehabilitation."
- Inclusion criteria:
  - Original research (clinical trials, cohort studies, qualitative studies).
  - Systematic and narrative reviews.
  - Clinical guidelines and consensus statements.
  - Focus on adult patients with cancer, in the context of palliative care or survivorship.
- Exclusion criteria:
  - Pediatric populations.
  - Non-cancer conditions without oncology relevance.
  - Case reports without generalizable insights.

Two reviewers independently screened titles and abstracts, followed by a full-text review. Discrepancies were resolved through discussion with a third reviewer.

Reporting was informed by the PRISMA 2020 statement to enhance transparency and accuracy [5].

Study Selection

The initial search yielded 230 records. After screening titles and abstracts, 134 were deemed potentially relevant. Following full-text review, 96 articles and guidelines were included.

Data Extraction and Synthesis

Data was collected on study design, cancer population, intervention type, outcomes, and links to palliative care. Results were sorted into main thematic categories: (1) definitions/classification, (2) palliative care interface, (3) disease-specific strategies, (4) multidisciplinary collaboration, (5) emerging topics, (6) Japan-specific issues. To develop these themes, we employed an iterative process involving initial coding of the data, followed by grouping similar codes to identify broader categories. During this process, disagreements were resolved through discussions among the review team until consensus was reached. Studies in each group were integrated narratively, which highlights clinical relevance, practice models, and theoretical frameworks. This method ensures transparent literature coverage and flexible interpretation, suitable for a developing field with uneven evidence.

To ensure methodological rigor, the quality of the studies was assessed using a modified version of the Cochrane Risk of Bias tool, which examines factors such as sequence generation, allocation concealment, blinding, and incomplete outcome data. Standardized criteria were applied across all included studies, reinforcing the reliability of the synthesis.

I. Definition and Classification of Cancer Rehabilitation

Cancer rehabilitation is fundamental to supportive and palliative oncology, shifting emphasis from cure to enhancing quality of life (QOL), dignity, and autonomy. Unlike standard rehabilitation, which aims to restore function after injury, cancer rehabilitation addresses changing needs across the cancer continuum. It incorporates preventive, restorative, supportive, and palliative aspects, aligns with the World Health Organization's International Classification of Functioning, Disability, and Health (ICF) [1,6], and provides the foundation for examining historical and conceptual developments. Recent meta-analytic evidence confirms that palliative rehabilitation interventions can significantly improve QOL outcomes in patients with advanced cancer [7].

Historical and Conceptual Foundations

By the 2000s, broader frameworks had integrated psychosocial and existential well-being into their approaches. Silver et al.1 emphasized that cancer rehabilitation is a continuum encompassing prevention, survivorship, and palliation. At the same time, Cheville emphasizes the importance of individualized approaches tailored to the specific characteristics of each cancer type, treatment stage, and prognosis [6].

Four Categories of Cancer Rehabilitation

Preventive Rehabilitation

Delivered before or during treatment, preventive rehabilitation (e.g., prehabilitation) aims to reduce anticipated complications and optimize baseline health. Interventions such as exercise, nutrition, and psychological support improve postoperative outcomes, reduce anxiety, and empower patients to participate actively in their care [6].

Restorative Rehabilitation

This form focuses on regaining pre-treatment function. Examples include physical therapy for post-mastectomy shoulder mobility or management of chemotherapy-induced neuropathy. Unlike conventional rehabilitation, oncology patients often face cumulative toxicities requiring adaptive, ongoing strategies [6].

Supportive Rehabilitation

Supportive approaches help manage chronic or irreversible impairments to preserve independence and QOL. This may involve fatigue management, adaptive devices, or vocational counseling. Survivorship care overlaps here, addressing long-term effects such as lymphedema or swallowing difficulties. Psychosocial support for body image, role changes, and uncertainty is central [8].

Palliative Rehabilitation

In advanced illness, the emphasis shifts to comfort, dignity, and autonomy. Interventions focus on promoting safe mobility, managing symptoms, and maintaining meaningful activities. Silver et al. noted that palliative rehabilitation enables patients to "live until they die," often revealing care goals that align closely with advance care planning (ACP) [1].

Integration and Overlap

In practice, these categories overlap. A patient undergoing chemotherapy may receive preventive (nutrition), restorative (neuropathy management), supportive (fatigue coping), and palliative (mobility aid) interventions simultaneously.

Prehabilitation as a Paradigm Shift

Prehabilitation has emerged as a leading proactive strategy for improving patient outcomes. Multimodal programs that integrate exercise, nutrition, and psychological support enhance physical outcomes, psychological resilience, and patient engagement. Evidence demonstrates reduced complications, decreased hospital stays, and improved function, particularly in gastrointestinal and lung cancers.

Relevance to Palliative Care

Ultimately, classification serves as both a framework and an essential tool in palliative care. By integrating preventive, restorative, supportive, and palliative elements, clinicians empower patients to live fully and underscore the vital role of rehabilitation for patients, families, and healthcare teams.

II. Intersection of Palliative Care and Cancer Rehabilitation

Integrating rehabilitation into palliative care is vital for sustaining function, dignity, and autonomy throughout the cancer journey. While palliative care focuses on symptom relief, psychosocial support, and communication, rehabilitation provides targeted interventions to maintain mobility, daily activities, and social participation. Combined, these approaches create a synergistic, patient-centered model. Rehabilitation enriches ACP by mapping values to concrete functional goals. Patients often value specific abilities—such as indoor walking or self-feeding—that shape care planning. Recent international work has also proposed a structured framework of "palliative rehabilitation" that defines its processes and outcomes, underscoring its role in advanced cancer care [9].

Shared Philosophies and Goals

Both disciplines value quality of life (QOL) above cure. Rehabilitation emphasizes participation in daily activities, while palliative care focuses on relieving suffering and making values-based decisions. Their intersection is crucial in advanced disease, where preserving function enhances

dignity and meaningful quality of life. Sekine et al. [10] demonstrated that targeted rehabilitation improves function and spiritual well-being, highlighting the role of rehabilitation in maintaining dignity and overall quality of life.

Maintaining Function and Autonomy

Functional decline in advanced cancer creates distress, isolation, and caregiver burden. Rehabilitation interventions, including mobility training, fatigue management, and support for activities of daily living, help patients retain their autonomy. Song et al. [2] found that tailored interventions improved mobility, reduced fatigue, and increased patients' sense of control.

Dignity and Existential Well-being

Dignity, central to palliative medicine, is tied to maintaining identity and control. Functional independence—such as walking to the bathroom, eating independently, or participating in family rituals—often carries greater dignity than pain relief alone. Rehabilitation professionals thus serve as partners in preserving both physical and psychological well-being [10].

Rehabilitation in Advance Care Planning (ACP)

Rehabilitation enriches ACP by mapping values to concrete functional goals. Patients often value specific abilities—such as indoor walking or self-feeding—that shape care planning. Habib et al. [11] showed that incorporating rehabilitation leads to more tailored and congruent ACP. Framing medical decisions in terms of daily function, rehabilitation professionals serve as "interpreters of daily life."

Models and Barriers to Integration

Models include parallel, sequential, and integrated approaches, with the integrated model showing the most significant promise by embedding rehabilitation within palliative teams [10]. Barriers persist, including inadequate reimbursement, misconceptions that rehabilitation is inappropriate near the end of life, and workforce shortages [2]. Education, policy reform, and evidence of cost-effectiveness are needed to overcome these challenges.

Ethical and Future Considerations

Balancing function with the inevitability of decline requires individualized, values-based care. Rehabilitation should not be routine but aligned with patient goals, avoiding undue burden. Future directions include home-based and tele-rehabilitation, as well as systematic inclusion of functional assessments in palliative consultations.

Rehabilitation in palliative care is about enriching, not simply extending, life. By safeguarding autonomy, supporting meaningful activity, and reinforcing dignity, rehabilitation fulfills the deepest aims of palliative medicine, empowering patients to live fully until the end.

III. Disease-Specific Rehabilitation Practice

While the principles of cancer rehabilitation are broadly applicable, disease-specific considerations are crucial for optimizing outcomes and minimizing risks. Cancer types differ substantially in their functional sequelae, prognoses, and treatment complications. This section highlights rehabilitation approaches for bone metastases, brain metastases, and lung cancer, which represent common and clinically challenging populations in palliative care (**Table 1**).

Table 1. Disease-Specific Rehabilitation Approaches in Palliative Care.

Cancer Type	Key Risks / Symptoms	Assessment Tools	Core Rehabilitation Strategies	References
Bone metastases	Pain, pathological fracture, spinal instability	Mirels' score; SINS	Pain-adapted mobilization, assistive devices, fall prevention, and caregiver training	Mirels 1989[12] Itokazu, et al. 2022[14]
Brain metastases	Hemiparesis, aphasia, cognitive impairment, ataxia	Functional Independence Measure (FIM), neurocognitive tests	Task-specific motor training, cognitive rehab, speech therapy, and multidisciplinary support	Vargo 2017[15] Thakkar, et al. 2020[16]
Lung cancer	Dyspnea, fatigue, cachexia	6-minute walk test, Borg Dyspnea Scale	Pulmonary rehab, breathing retraining, exercise, fatigue management, nutritional support	Cruz Mosquera, et al. 2024[17] Vargo, et al. 2025[18]

A. Bone Metastases

Bone metastases occur in approximately totally65–75% of patients with advanced breast, prostate, and lung cancers. They are associated with pain, pathological fractures, spinal cord compression, and hypercalcemia. Functional impairment arises not only from pain but also from mechanical instability, necessitating careful risk stratification before prescribing rehabilitation interventions.

Risk Assessment and Clinical Scales

Two widely used assessment tools guide rehabilitation safety in bone metastases:

- Mirels' scoring system evaluates fracture risk based on lesion site, pain, lesion type, and size. A score of ≥8 indicates a

high fracture risk and often prompts surgical fixation or radiotherapy before active mobilization [12].

- Spinal Instability Neoplastic Score (SINS) assesses spinal instability across six domains (location, pain, alignment, vertebral body collapse, posterior involvement, and lesion type). Scores of 13 or higher indicate significant instability, warranting surgical consultation [13].

Itokazu et al. [14] demonstrated that rehabilitation in patients with stable spinal metastases improved mobility and reduced caregiver burden without increasing fracture risk, provided risk assessment tools were systematically applied.

Rehabilitation Strategies

- Pain-adapted mobilization: Gentle range-of-motion and positioning strategies to maintain mobility while protecting fragile bones.
- Assistive devices: Early introduction of walkers, orthoses, or braces to enhance safety.
- Strengthening and conditioning: Focus on non-involved regions to preserve overall function.
- Patient and caregiver education: Training in safe transfers and fall prevention.

The goal of rehabilitation in bone metastases is not to achieve maximal exertion, but rather to ensure safe mobility, prevent deconditioning, and maintain independence.

B. Brain Metastases

Brain metastases affect 20–40% of advanced cancer patients and are associated with profound functional and cognitive deficits, including hemiparesis, ataxia, aphasia, neglect, and executive dysfunction. These impairments often cause greater disability than systemic disease itself, highlighting the importance of neurorehabilitation.

Functional and Cognitive Deficits

Vargo reported that brain metastasis survivors who received targeted neurorehabilitation demonstrated significant improvements in motor function, ADLs, and cognitive outcomes [15]. Cognitive deficits, particularly in attention and executive function, can hinder rehabilitation engagement. Thakkar et al. emphasized that early, tailored cognitive rehabilitation is essential for improving functional outcomes and patient participation [16].

Rehabilitation Strategies

- Task-specific motor training: Focused on ambulation, transfers, and upper-limb function.
- Cognitive rehabilitation: Memory aids, structured problem-solving, and compensatory strategies for executive dysfunction.
- Speech and language therapy: Critical for aphasia and dysarthria management.
- Multidisciplinary approach: Integration of neuro-oncology, rehabilitation, and palliative care to optimize function while addressing prognosis.

Importantly, rehabilitation goals in brain metastases must be realistic and time-sensitive, given the often-limited prognosis. Small functional gains, such as the ability to transfer safely, may significantly reduce caregiver burden and preserve dignity.

C. Lung Cancer

Lung cancer is the leading cause of cancer mortality worldwide and is frequently associated with debilitating symptoms such as dyspnea, fatigue, and cachexia. These symptoms often precede functional decline, making rehabilitation an essential component of supportive and palliative care.

Dyspnea and Fatigue

Pulmonary rehabilitation, traditionally used in chronic obstructive pulmonary disease (COPD), has been adapted for lung cancer populations. Cruz Mosquera et al. [17] demonstrated that exercise-based pulmonary rehabilitation significantly reduced dyspnea and improved exercise tolerance in patients with advanced lung cancer. Similarly, Vargo reported that a multimodal rehabilitation program—including breathing retraining, endurance exercise, and psychological support—improved fatigue scores and QOL in stage IV lung cancer patients [18]. Matched case analyses also suggest that preoperative pulmonary rehabilitation improves surgical outcomes and reduces postoperative complications in patients with lung cancer [19].

Rehabilitation Strategies

- Breathing retraining: Pursed-lip breathing, diaphragmatic breathing, and pacing strategies.
- Exercise interventions: Low- to moderate-intensity aerobic and resistance training adapted to tolerance.
- Fatigue management: Energy conservation, activity pacing, and structured rest.
- Nutritional support: Integration with dietitians to address cancer cachexia.

Lung cancer rehabilitation exemplifies the synergy of physical and psychosocial interventions, as improved breathing control often enhances self-efficacy and reduces anxiety.

Disease-specific rehabilitation in palliative care emphasizes the importance of tailoring interventions to individual clinical risks and functional goals. For bone metastases, the priority is safe mobility within the context of fracture prevention. For brain metastases, targeted neurorehabilitation addresses both motor and cognitive deficits, enhancing independence. For patients with lung cancer, pulmonary rehabilitation helps mitigate dyspnea and fatigue, empowering them to remain engaged in daily life. Across these conditions, rehabilitation embodies the principle of “function as dignity,” ensuring that patients live as actively and meaningfully as possible despite progressive disease.

IV. Multidisciplinary Collaboration and Advance Care Planning

High-quality palliative care relies on multidisciplinary collaboration, as no single discipline can fully address the physical, psychological, social, and spiritual needs of patients and families. Physical, occupational, and speech-language therapists contribute a unique perspective by focusing on how illness affects daily life. Their role as "life experts" is particularly valuable in advance care planning (ACP), where functional goals often clarify broader values (**Table 2**).

Table 2. Roles of Multidisciplinary Team Members in ACP and Rehabilitation

Discipline	Primary Role in ACP	Rehabilitation-Related Contribution
Physician	Provide prognosis, treatment options, and clarify medical risks/benefits	Integrate rehab findings into the overall treatment trajectory
Nurse	Support ongoing dialogue, symptom monitoring	Reinforce daily function goals during bedside care
Rehabilitation professional (PT/OT/ST)	Identify functional priorities, translate daily life goals into ACP	Provide interventions to maintain mobility, communication, and ADLs
Psychologist / Psychiatrist	Address emotional readiness for ACP	Link psychological coping strategies with functional adaptation
Social worker	Facilitate family meetings, address social determinants	Support environmental modifications for continued independence
Dietitian	Nutritional guidance within the ACP goals	Coordinate with the rehab team for energy conservation, cachexia support

Rehabilitation as "Life Experts" in ACP Dialogue

ACP is often framed as a discussion of treatments such as chemotherapy, nutrition, or resuscitation. Yet, it is most meaningful when rooted in values and daily priorities. Rehabilitation assessments often reveal such milestones as walking independently, eating without assistance, or participating in family rituals. Sudore et al. [20] urged ACP to shift from treatment-based to value-based frameworks. Rehabilitation naturally uncovers these perspectives. For instance, a patient who wishes to climb stairs to a bedroom signals autonomy and home-centered living—anchors for subsequent medical decisions.

Multidisciplinary Models of ACP Support

Song et al. [2] demonstrated that implementing ACP within rehabilitation settings facilitated the translation of patients' functional goals into informed care decisions. Habib et al. [11] further highlighted the importance of rehabilitation professionals as essential partners in palliative care teams, ensuring that ACP discussions reflect daily life priorities.

Conceptual flow (**Figure 1**):

Functional assessment → 2. Identification of life goals → 3. Translation into ACP decisions → 4. Multidisciplinary dialogue → 5. Ongoing reassessment.

This ensures ACP remains dynamic and grounded in lived experience.

Figure 1. Conceptual Flow of Rehabilitation Contribution to ACP



Barriers and Challenges

Integration faces several obstacles:

- Role recognition: Therapists are often excluded from discussions regarding ACP.
- Communication gaps: Functional findings may not reach physicians.
- Time limits: Acute care settings often lack the opportunity for longitudinal dialogue.
- Cultural hesitancy: Discussing decline may be taboo in some contexts.

Ethical Considerations

Patients may interpret functional decline differently: some value rehabilitation despite a limited prognosis; others see it as burdensome. Respecting autonomy requires aligning interventions with stated values. Sudore's "Patient Priorities Care" model emphasizes the documentation of functional goals to prevent both overtreatment and undertreatment [20].

Future Perspectives

- Develop standardized tools linking function and ACP.
- Train rehabilitation staff in communication for sensitive conversations.
- Integrate functional assessments into electronic health records.
- Expand research on outcomes such as concordance between goals and care.

Rehabilitation reframes ACP as a life-centered rather than treatment-centered process. By grounding decisions in everyday function, rehabilitation professionals enrich team discussions and ensure ACP truly reflects what matters most.

V. Emerging Topics and Research Trends

Cancer rehabilitation in palliative care is a rapidly evolving field, shaped by advances in technology, new models of care delivery, and the growing recognition of the role of rehabilitation in improving quality of life (QOL). While traditional rehabilitation emphasized hospital- or clinic-based physical interventions, recent research has expanded its scope to include prehabilitation, tele-rehabilitation, and technology-assisted monitoring, including artificial intelligence (AI) and wearable devices (**Table 3**). These innovations not only broaden access but also personalize rehabilitation, making it responsive to the needs of patients with advanced cancer.

Table 3. Emerging Trends in Cancer Rehabilitation in Palliative Care

Trend	Key Features	Evidence/Benefits	Challenges	References
Prehabilitation	Pre-treatment exercise, nutrition, and psychological support	Improves treatment tolerance, reduces complications, and enhances resilience	Limited applicability in rapidly progressive cancers; requires early referral	Sadlonova, et al.2023[22]
Tele-rehabilitation	Remote exercise, education, and counseling via digital platforms	Maintains functional outcomes, reduces travel burden, and expands access	Digital divide, patient safety during unsupervised activity	Brick, et al. 2022[26] Dennett, et al. 2024[27]
AI and Wearables	Real-time monitoring, predictive analytics, personalized programs	Early detection of decline, proactive interventions, and individualized rehab	Data privacy, algorithm transparency, and the cost of technology	Rasa, et al. 2024[31] Nairn, et al. 2025[32]

Prehabilitation: Enhancing Resilience Before Treatment

Prehabilitation refers to structured interventions delivered between the diagnosis of cancer and the initiation of acute treatments (e.g., surgery, chemotherapy, or radiation). It aims to enhance physical and psychological resilience, enabling patients to tolerate treatment more effectively and recover more quickly [21]. Sadlonova et al. [22] conducted a meta-analysis demonstrating that multimodal prehabilitation, including exercise training, nutritional optimization, and psychological support, significantly improved postoperative outcomes in cancer patients. In the context of palliative care, prehabilitation holds promise for patients facing high-risk or symptom-burdening treatments. For example, strengthening respiratory function before lung cancer surgery or enhancing mobility before spine stabilization can reduce complications and improve postoperative function [19,23]. Moreover, prehabilitation supports patient empowerment. Engaging in structured activity before treatment reinforces a sense of agency, often mitigating anxiety and fostering hope during a period when patients may otherwise feel powerless [24].

Tele-Rehabilitation: Expanding Access and Continuity of Care (Figure 2)

The COVID-19 pandemic accelerated the adoption of telehealth, and cancer rehabilitation has been no exception. Tele-rehabilitation leverages digital platforms to deliver guided exercise, education, and counseling remotely, ensuring continuity of care even when patients are unable to attend in-person sessions [25]. Brick et al. [26] reported that tele-rehabilitation improved functional capacity and adherence compared to usual care among advanced cancer patients who were isolated due to the pandemic. Dennett et al. [27] further confirmed that hybrid models, which combine in-person and virtual sessions, resulted in high patient satisfaction, reduced travel burden, and maintained functional outcomes. Meta-analytic studies confirm that exercise-based cancer rehabilitation via telehealth can significantly improve cardiopulmonary fitness and physical activity levels, providing robust support for technology-based approaches [28]. Tele-rehabilitation also enhances equity by reaching rural and underserved populations, where access to specialized oncology rehabilitation services is limited [25]. However, challenges remain, including digital literacy, access

to reliable internet, and ensuring safety during unsupervised exercise. A recent systematic review highlighted the growing use of technology-assisted approaches in cancer prehabilitation, such as digital monitoring and mobile applications, which further enhance feasibility and patient engagement [29]. Likewise, scoping reviews have mapped a broad range of technological resources available to support cancer rehabilitation during chemotherapy, emphasizing the role of digital tools in real-world practice [30].

Figure 2. Tele-Rehabilitation Model Linking Hospital, Home, and Digital Platforms



AI and Wearables: Toward Personalized Rehabilitation

Technological innovations such as AI-driven analytics and wearable devices are reshaping cancer rehabilitation by enabling real-time, individualized monitoring. Rasa et al. [31] highlighted how wearable devices that track mobility, heart rate, and activity levels can provide continuous, objective data on patient function. This data supports early identification of functional decline, allowing rehabilitation teams to intervene proactively. For instance, detecting reduced step counts over several days may prompt a health check-in or an adjustment in exercise prescription. Nairn et al. [32] further demonstrated that AI algorithms analyzing wearable-derived data accurately predicted hospitalization risk and functional decline. By integrating predictive analytics into routine care, rehabilitation can shift from a reactive to a preventive approach, aligning with the palliative care goal of maintaining stability and preventing crises. Beyond monitoring, AI-driven platforms are being developed to deliver personalized exercise prescriptions and real-time feedback during home-based sessions [33]. Such technologies may reduce disparities in access by enabling effective self-management under virtual supervision.

Integration with Palliative Care Principles

- Prehabilitation supports patient preparedness and resilience, reinforcing autonomy.
- Tele-rehabilitation enhances accessibility and continuity, ensuring patients remain supported despite logistical or health-related barriers.
- AI and wearables personalize care, enabling anticipatory interventions that prevent crises and promote stability.

Thus, innovation in cancer rehabilitation serves as a natural extension of palliative care's holistic, patient-centered approach.

Future Research Directions

While evidence for these approaches is promising, several gaps remain:

1. Clinical outcomes: More robust trials are needed to determine the long-term impact of prehabilitation and tele-rehabilitation in advanced cancer populations.
2. Cost-effectiveness: Demonstrating economic sustainability will be crucial for the widespread adoption of this approach.
3. Ethical concerns: As AI becomes more integrated, transparency and patient consent will be critical to maintaining trust.

Addressing these concerns involves implementing robust ethical safeguards, such as ensuring clear communication about data privacy practices and acquiring informed consent before using patient data in AI-driven interventions. Additionally, establishing guidelines for data retention and storage, along with regular audits to ensure compliance with privacy regulations, will be essential to preserve trust and integrity in these innovations. By focusing on these practical measures, ethical issues can be mitigated effectively, fostering responsible innovation.

Emerging trends in cancer rehabilitation, including prehabilitation, tele-rehabilitation, and AI-driven monitoring, offer transformative opportunities to integrate rehabilitation more deeply into palliative care. These innovations extend the reach of rehabilitation, enhance personalization, and ensure that care remains proactive rather than reactive. By embracing these approaches, the field can move closer to achieving the shared goal of palliative care, enabling patients to live as fully and meaningfully as possible, regardless of the stage of their disease.

VI. Current Situation and Challenges in Japan

Japan, one of the most rapidly aging societies in the world, faces unique challenges and opportunities in integrating cancer rehabilitation into palliative care. While the concept of rehabilitation has gained increasing recognition in oncology, systemic, workforce, and educational barriers limit its widespread implementation. At the same time, pioneering initiatives in academic centers and regional hospitals demonstrate innovative approaches that may inform broader practice (**Table 4**).

Table 4. Current Situation and Challenges in Cancer Rehabilitation in Japan.

Domain	Current Status	Challenges	Potential Solutions	References
Healthcare system	Universal coverage; limited rehab reimbursement in advanced cancer	Lack of financial incentives for oncology/palliative rehab	Policy reform to expand reimbursement criteria	Hasegawa, et al. 2021[4]
Workforce	Growing therapist workforce; few trained in oncology rehab	Shortage of specialized staff, esp. speech therapists	National training programs, dedicated oncology rehab tracks	Fukushima, et al. 2025[36]
Education	Limited oncology content in core curricula	No standardized certification; practice variability	Establish competency guidelines, integrate oncology modules	Fukushima, et al. 2025[36]
Clinical practice	Emerging hospital- and community-based models	Uneven access across regions	Scale up best practices, promote tele-rehabilitation	Fukushima, et al. 2025[36]
Cultural context	Emphasis on family harmony and "not burdening others"	Hesitancy to pursue rehabilitation aggressively	Frame rehab goals as family-centered participation	

System-Level Context

The Japanese healthcare system operates under a universal insurance model, ensuring broad access to cancer treatment and palliative care services. However, reimbursement for rehabilitation services in advanced cancer remains restricted, often tied to acute hospital settings or specific procedural indications. Hasegawa et al. [4] reported that policy frameworks prioritize rehabilitation for conditions such as stroke or orthopedic surgery, while oncological rehabilitation, especially in the palliative phase, receives limited institutional support. This systemic under-recognition contributes to fragmented care: patients often transition from acute oncology wards to home or hospice care without sustained access to rehabilitation.

Workforce Limitations

Japan faces a shortage of specialized oncology rehabilitation professionals. While the number of physical and occupational therapists has increased overall, relatively few receive structured training in cancer-specific rehabilitation. Fukushima et al. [34] highlighted that even in major cancer centers, less than 40% of rehabilitation staff had formal education in oncology or palliative care. The scarcity of interdisciplinary rehabilitation staffing constrains the ability to deliver comprehensive services.

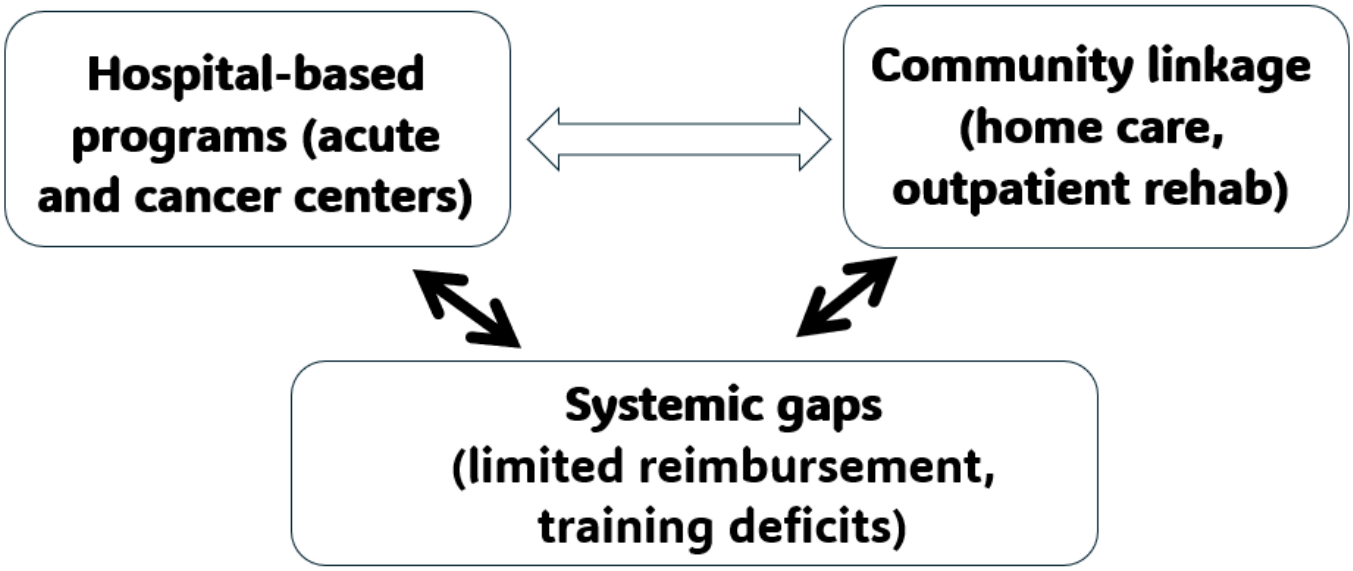
Educational Gaps

Education in cancer rehabilitation in Japan is still in its developmental stage. Undergraduate curricula in physical and occupational therapy programs emphasize musculoskeletal and neurological rehabilitation, with only limited exposure to oncology or palliative care. Continuing education programs exist, but uptake is variable and often dependent on institutional commitment. The absence of standardized national certification or competency guidelines for oncology rehabilitation further contributes to variability in practice quality. As a result, rehabilitation in cancer care often depends on individual clinician expertise rather than systematic training.

Emerging Initiatives and Best Practices (**Figure 3**)

Despite these challenges, several promising models have emerged. Some tertiary hospitals in Tokyo, Osaka, and Nagoya have established hospital-based palliative rehabilitation teams that integrate rehabilitation professionals into palliative care units. These teams provide proactive functional assessments and tailor rehabilitation plans to support ACP discussions. Community-based rehabilitation networks and regional initiatives, supported by municipal governments, link hospital-based rehabilitation to community facilities, ensuring continuity of functional support after discharge. Furthermore, tele-rehabilitation pilots, inspired by the COVID-19 pandemic, have explored virtual rehabilitation sessions for advanced cancer patients at home, reducing caregiver burden and improving continuity of care. Fukushima et al. [34] described a multicenter Japanese study where structured community-based rehabilitation improved QOL and decreased hospitalization rates among older adults with advanced cancer. These findings suggest that scalable models may be achievable with system-level investment.

Figure 3. Japanese Oncology Rehabilitation Map.



Cultural Dimensions

Cultural attitudes toward rehabilitation in Japan also shape practice. Patients and families often prioritize "not being a burden" over functional independence, which can lead to reluctance in pursuing active rehabilitation. At the same time, the Japanese emphasis on harmony and family-centered care creates opportunities for rehabilitation professionals to frame functional goals in relational rather than individual terms.

Future Directions

To advance cancer rehabilitation in Japan, several steps are recommended:

1. Policy reform: Expand reimbursement frameworks to recognize rehabilitation as an essential component of palliative care.
2. Workforce development: Establish national training curricula and certifications in oncology rehabilitation, including mandatory continuing education.
3. Integration across settings: Strengthen hospital–community linkages to ensure continuity of rehabilitation support after discharge.
4. Research infrastructure: Encourage multicenter studies to build a stronger evidence base for cancer rehabilitation in Japanese populations.
5. Cultural adaptation: Frame rehabilitation goals in ways that resonate with Japanese values, emphasizing family participation and dignity.

Japan's current situation in cancer rehabilitation reflects both significant challenges—systemic under-recognition, workforce shortages, educational gaps—and emerging opportunities through innovative hospital- and community-based models. Addressing these barriers will require coordinated efforts among policymakers, educators, and clinical leaders. Importantly, integrating rehabilitation into the ethos of Japanese palliative care—supporting both individual independence and family harmony—can ensure that patients live with dignity and functional well-being even in advanced stages of cancer. Globally, meta-analyses have consistently confirmed that integrated palliative care improves quality of life compared with standard models, suggesting that Japan's challenges reflect a broader international agenda [35]. In addition, evidence from large-scale meta-analyses of exercise interventions in adults with cancer further consolidates the role of structured physical activity as a foundation of rehabilitation and survivorship care [36].

DISCUSSION

Main findings

This hybrid review adopted a systematic-narrative approach to clarify the role of cancer rehabilitation within palliative care. By integrating clinical observations, cultural context, and evolving professional roles, the synthesis demonstrates that cancer rehabilitation is not merely an adjunct but a central component of palliative medicine. [7] Rehabilitation professionals emerge as "life experts", translating patients' functional abilities and goals, such as walking independently or engaging in family rituals, into care decisions within the framework of Advanced Care Planning (ACP). [2,11]

Furthermore, disease-specific insights show how rehabilitation directly contributes to dignity and safety. In bone metastases [12-14], validated tools such as SINS and Mirels guide safe mobilization. In brain metastases [15,16], neurorehabilitation addresses both physical and cognitive adaptation. In lung cancer, pulmonary rehabilitation helps mitigate dyspnea and fatigue, allowing for continued daily engagement [17,18]. Emerging innovations, including prehabilitation [21,22,24], telerehabilitation [25-27], and AI-driven wearables

[32,33], expand access to care and personalized treatment, aligning with the holistic goals of palliative medicine. Recent international reviews have reinforced these perspectives, confirming both functional benefits and an improved quality of life through structured rehabilitation [7, 9, 28-30, 34, 35]. Future methodological advancements, such as statistical bias control strategies (e.g., prior event rate ratio methods) and novel analytical frameworks like reverse time-to-death modeling, may enhance the rigor of future research in this domain [37,38].

Strengths and Limitations

A notable strength of this review is its hybrid design, combining systematic evidence retrieval with narrative integration. This allowed comprehensive coverage of diverse study designs, including randomized trials on prehabilitation [21,24], feasibility studies of tele-rehabilitation [25], and observational cohorts linking rehabilitation to ACP [2], while also capturing cultural and policy dimensions specific to Japan [4,36]. The approach underscores both the promise and complexity of this evolving field. Additionally, the review's adaptability in synthesizing heterogeneous data from various methodological frameworks enhances its ability to provide insightful cross-contextual analyses.

However, the study faces several limitations that must be critically reflected upon. Heterogeneity in study methodologies presented challenges in achieving uniformity in interpretation, as varying protocols, outcome measures, and intervention durations can influence results. To address this heterogeneity, stratified analyses were employed where applicable, categorizing studies by design and patient population to draw more precise conclusions. Small sample sizes in the included studies limit the generalizability of findings, accentuating the need for larger-scale research. Most of the literature originates from high-income countries, raising questions about its applicability in resource-limited contexts. This disparity necessitates a cautious approach to extrapolating findings globally and highlights an opportunity for future research in more diverse locales. Moreover, while rapid technological advances, such as AI and telehealth, show promise, they still require further validation to ensure consistent safety, equitable access, and thorough ethical consideration, which presents an ongoing challenge in their integration into standard practice.

Contributions to International Literature

This review suggests several practical directions. Clinically structured functional assessments and rehabilitation-informed ACP should be integrated into palliative consultations. This can be achieved by establishing standardized protocols for assessments and ensuring they are a routine part of the palliative process. Multidisciplinary collaboration, involving physicians, nurses, therapists, and pharmacists, ensures that care aligns with the patient's life priorities and goals. Teams can implement regular interdisciplinary meetings to discuss patient care plans and integrate rehabilitation goals with medical treatments.

Policymakers should expand reimbursement frameworks, support workforce training in oncology rehabilitation, and develop standardized curricula to enhance patient care and treatment outcomes. This may include lobbying for policy change by presenting data on improved patient outcomes and cost efficiencies associated with comprehensive rehabilitation services. Internationally, prehabilitation and tele-rehabilitation represent scalable models that can overcome geographic and logistical barriers. Developing low-cost tele-rehabilitation modules and training local healthcare workers in resource-limited settings can enhance access. AI-enabled monitoring may shift care from a reactive to a preventive approach, potentially involving the integration of wearable technology to track patient progress and issues.

Future research must prioritize robust multicenter trials, cost-effectiveness analyses, and equity-focused evaluations, particularly in underrepresented populations such as the frail elderly and those in low- and middle-income countries. Considering the current situation in Japan [4,36], these strategies will not only advance Japanese practice but also provide a transferable model for other countries navigating similar demographic and cultural landscapes. By embracing innovation responsibly and grounding interventions in patient values, rehabilitation can fulfill its potential as the functional arm of palliative care, empowering patients to live with dignity, autonomy, and meaning throughout their cancer journey.

CONCLUSION

This hybrid review demonstrates that cancer rehabilitation is not only an adjunct to palliative care but a central component that operationalizes the values of dignity, autonomy, and quality of life. While systematic evidence highlights promising interventions, narrative synthesis emphasizes the lived experiences of patients and the indispensable role of rehabilitation professionals in facilitating meaningful living. Future efforts must bridge persistent evidence gaps, advocate systemic recognition, and embrace innovation responsibly. Thus, rehabilitation can realize its full potential as the functional arm of palliative care, enabling patients to live actively and authentically, even in the most advanced stages of disease.

AI disclosure statement

Generative AI tools (ChatGPT, OpenAI) were employed to support the organization of literature and refine the

manuscript structure. The tool was not used to generate any original data or scientific conclusions. All content was critically reviewed and finalized by the author, who is fully responsible for the integrity and accuracy of the manuscript.

Abbreviations

ACP: advance care planning,
QOL: quality of life,
ICF: International Classification of Functioning, Disability, and Health,
COPD: chronic obstructive pulmonary disease,
ADL: activity of daily living,
SINS: Spinal Instability Neoplastic Score

Acknowledgements

The authors thank the multidisciplinary staff of Sapporo Kojinkai Memorial Hospital for their collaboration and support in integrating rehabilitation and palliative care practice.

Authors' Contributions

S.O. and S.S. conceived the study and drafted the manuscript. S.O. and S.S. conducted the literature review and contributed to drafting. N.S., A.T., A.K., and J.I. provided clinical insights. A.T. and M.O. contributed to data interpretation. R.S. and Y.O. revised the manuscript critically for important intellectual content. All authors reviewed and approved the final version.

Disclaimer

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of their affiliated institutions.

Funding Information

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Disclosure Statement

No competing financial interests exist.

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