



Review

Management of cancer cachexia towards optimizing care delivery and patient outcomes



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ABSTRACT

Cancer cachexia is a complex syndrome characterized by progressive weight loss, muscle mass depletion, and systemic inflammation, profoundly affecting the well-being and treatment outcomes of cancer patients. Effective management of cancer cachexia demands a coordinated, multifaceted approach involving various healthcare disciplines and operational strategies. Streamlining care processes is crucial to ensure timely interventions and support, reducing delays in diagnosis and treatment initiation. Multidisciplinary collaboration is pivotal in creating integrated care plans that address the multifactorial nature of cancer cachexia comprehensively. Data-driven decision-making empowers healthcare teams to identify trends, monitor treatment responses, and tailor care plans to individual needs, ultimately leading to improved patient outcomes. Standardized assessment and monitoring play a vital role in maintaining consistent, high-quality care, facilitating early interventions and treatment adjustments. Implementing patient-centered care fosters trust, enhances treatment adherence, and encourages patients to actively engage in their care journey, thereby improving their overall quality of life. This paper underscores the significance of applying operations management principles to optimize care delivery and enhance patient outcomes in the management of cancer cachexia. It provides valuable insights for healthcare institutions and professionals striving to provide comprehensive and effective care for individuals affected by this challenging condition.

Introduction

Cancer cachexia is a multifactorial condition in cancer patients and is associated with increasing weight loss, loss of muscle mass, and systemic inflammation.¹ Cachexia is observed in almost half of cancer patients^{2,3} and also affects 86% of cancer patients in the last few weeks of life.^{4,5} It is seen that 45% of patients lose more than 10% of their actual body weight as the disease progresses.⁵ Cachexia negatively impacts the patient's quality of life, prognosis, and capacity to tolerate therapy, leading to severe morbidity and mortality. Cachexia is often a neglected condition and many times it is underdiagnosed.^{6,7} It is reported in various studies that 30% of weight loss frequently results in death.⁸

As we know that it cannot be cured, current therapies are focused on relieving symptoms and lessening the suffering of patients and their caregivers.⁹ Treatment of cancer cachexia involves a multimodal approach that includes nutritional support, exercise, offering psychological and social support, minimizing catabolic alterations, and management of underlying symptoms such as pain, nausea, and weakness.¹⁰ Nutritional interventions may include oral (regular diet, therapeutic diet,

e.g., fortified food, oral nutritional supplements) or enteral supplements, as well as intravenous nutrition in severe cases to prevent or treat malnutrition.¹¹ Weimann et al. reported that exercise is a safe, non-pharmacological, and cost-effective therapy that can help to maintain muscle mass and functional status, while medications such as appetite stimulants and anti-inflammatory drugs can be used for symptom management.¹²

Shankar et al. reported that cancer cachexia is well managed with a multidisciplinary and multitherapy approach given the complex interplay between systemic inflammation and metabolic changes.¹³ Complementary and alternative medicines (CAMs) have also been tried and well-accepted for the treatment of cancer cachexia given lesser side effects and ease of use, as reported in a review by Shankar et al.¹⁴

Prevention of cancer cachexia is a significant goal in cancer care and may involve early identification of patients at risk, aggressive treatment of cancer-related symptoms, and proactive nutritional support. The cornerstone of cancer cachexia management is treating the underlying malignancy because it will only entirely reverse the cachexia syndrome.

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On the different side, operations management (OM) approaches can be employed for patients' quality of life and outcomes by using the available resources in the best way. OM is a function that is often overlooked for improving various aspects of cancer care even though their deployment might result in OM surplus, where the capital can be accessed to improve the quality of treatment for cancer patients, as discussed by Gautam and Shankar.¹⁵

Addressing the OM concerns in cancer cachexia can help us to provide efficient, effective, and patient-centered care by optimizing workflows, fostering collaboration, and implementing evidence-based practices. This narrative review will discuss various OM applications in the management of cancer cachexia to make overall care effective and impactful.

Interdisciplinary coordination of care

Effective management of cancer cachexia requires the coordination of care across multiple health-care providers, including oncologists, dietitians, physical therapists, and palliative care specialists.¹⁶ Coordination of care can be challenging because of the complicated nature of cachexia and the need to address multiple symptoms simultaneously.

Clinical assessment and multidisciplinary care by interdisciplinary team is the basic essence of the management of cancer cachexia. There is a consensus about addressing domains like decreased food intake, muscle mass and strength, functional losses, psychological issues, and catabolic drivers but there is a lack of uniformity in practice and implementation.¹⁷ Del Fabbro proposed a multimodality treatment model that includes pharmacologic and nonpharmacologic interventions and nutrition support.¹⁸

Pharmacologic interventions target the various metabolic mechanisms contributing to cancer cachexia, manage pro-inflammatory cytokines, control poor appetite, address endocrine dysfunction, and manage elevated resting energy expenditure and weight. The nonpharmacologic interventions include exercise, nutrition counseling, and control of nutritional impact symptoms (NIS).¹⁹

There are several discussions on the relevance of interdisciplinary coordination of care to treat cancer cachexia. Nursing is an important component in the multidisciplinary care team model for the management of cancer cachexia, as nurses are well-trained to perform primary screening, symptom control management, nutritional care, psychological care, coordination of service, referral, and hospice care.¹⁶

Speech-language pathologist in the team addresses swallowing difficulties as it is very common in cancer patients leading to cachexia, and social workers provide social support to patients and ensure social mobilization to approach the care team.¹⁷ The physician prescribes the pharmaceutical treatment of cachexia and/or treatment of symptoms whereas the nutritionist takes care of nonpharmacological treatment of NIS along with dietary advice and counseling. Psychologist gives psychosocial support to the patient and/or family.²⁰

There is a need for continuous support from operational and logistical personnel for optimal management of cancer cachexia. Their role is to ensure the delivery of supplies without breaks, training of health personnel, smooth patient stay, and staff adequacy with the use of technology. Cancer cachexia care can be more coordinated by sharing patient information, treatment plans, and progress reports in a timely and accurate manner.^{21,22}

There are many recommended interdisciplinary communication tools like Interdisciplinary Toolbox (research assumptions are made understood with structured dialogue), Integrated Timeline (historic events which led to the current situation are brainstormed with all participants and disciplines), Mind Mapping & Mini-Mind Mapping (brainstorm factors and drivers that influence the outcomes), cross-impact analysis (relationships between each major factors are identified), Imagining the Ideal (visions about the ideal outcome or solution to the problem is created and shared), and Backcasting (scenario-building exercise that works backward from imagining the problem is solved and find the path to reach there) can be used in ensuring effective communication in the

management of cancer cachexia.²³

Patient and caregiver education and engagement are also important for the coordination of care including nutrition, exercise, symptom management, and palliative care.²⁴ Patients must also be involved in the development of their care plan and have a voice in shared decision-making. Effective coordination of care can help to significantly improve patient's experience by reducing redundancies and eliminating inefficiencies in care delivery to provide the highest quality of care possible.²⁵

Shared decision-making for treatment plans between patients and clinicians may play a key role in facilitating adherence to their individualized treatment and will ensure the treatment delivery. This process supports and motivates patients to make their own choice about their care, respecting the appropriate levels of intervention which are appropriate to individual goal.

Most of the time, caregivers or family members accompany the patients of cancer cachexia to the hospital, and this is highly valued as sharing experience helps to reduce feelings of helplessness that carers generally encounter at different phases of care. As caregivers are big support to the patients, it provides an opportunity to discuss around common issues encountered during the progression of cachexia.²⁶ Each hospital has a different set of organizational infrastructure in the form of committees, panels, or individuals for decision-making, and based on the urgency decision-making is prioritized.

Individuals cease or restrict practices when they become aware of new evidence or to address local needs and priorities. Decision-making about treatment protocols, specialized care for cancer cachexia, training and development of staff, nursing, supportive care, nutrition care, and exercises are important in patients with cancer cachexia and need to be prioritized in cancer care settings.

Effective coordination of care will ensure the necessary care and support from multiple health-care providers, and can aid in improving patient outcomes and satisfaction, and cut down on health care costs. This further requires communication and collaboration among health-care providers.²⁷

Resource allocation

Barcos et al. reported that resource allocation is imperative in the OM challenges of managing cancer cachexia.²⁸ Management of cancer cachexia is a resource-intensive process, requiring specialized equipment, staff, and supplies, and sufficient resources should be allocated by hospitals to ensure necessary care and support to cachexia patients.¹⁷ Cancer cachexia management requires feeding tubes or intravenous nutrition, nutritional supplements, and anti-inflammatory medications.²⁹ Cancer-care providers must identify and classify the resources that are most critical to patient care and should be allocated accordingly. Patients' stages, the severity of the symptoms, and general conditions should be taken into account to prioritize the patients.³⁰

Controlling the consumption of clinical resources is a key to managing demand and minimizing the supplies that navigate through the process chain. A study by Laquanda reported the importance of effective supply chain management, including inventory management, procurement, and distribution is an important consideration to monitor resource utilization and adjust allocations to ensure the best care to patients.³¹

Resource allocation helps in the containment, control, and mitigation phases when it comes to health-care resource planning. Cancer hospitals should ensure adequate human resources and beds to take care of the needs of cancer patients with cachexia. Resource allocation should be optimized in terms of drugs used in cancer cachexia, nutrition supplements, and other supportive care medicines.³²

It can be better done by dividing the work equally among staff to prevent burnout and better efficiency. It can be further strengthened by providing training to impart skills, and knowledge necessary to complete allocated work. This can be done by allocating the right task to the well-suited person. In the management of cancer cachexia, if a psychologist

takes charge of psychological issues, and a nutritionist addresses nutritional concerns then it will be best for improving outcomes. Even a stationed nursing staff in the ward can do this but she is not the right resource for these jobs.

Supply chain management

According to Gullet et al., an effective supply chain management is necessary for controlling inventory levels, guaranteeing on-time delivery, and upholding quality control. Patients must acquire the necessary nutrition to stop future weight loss and muscle wasting by receiving the special supplies they need in a timely manner.³³

Effective supply chain management involves several elements, including inventory management, procurement, and distribution. Health-care providers must maintain adequate inventory levels of nutritional supplements and other supplies to meet patient's needs.³⁴ This requires effective demand forecasting and inventory tracking to ensure that supplies are available when needed.

Tarn et al. discussed the role of health-care providers in identifying reliable suppliers of high-quality nutritional supplements and other supplies and negotiating favorable terms and pricing.³⁵ This requires careful supplier selection and contract management to ensure that supplies are delivered on time and at an affordable cost.

Health-care providers must have an efficient distribution system in place to deliver nutritional supplements and other supplies to patients in a timely and efficient manner. This may involve the use of technology, such as barcode scanning and electronic order tracking, to ensure that supplies are delivered to the correct patient, and that the supply chain operates efficiently.³⁶

Effective supply chain management can help to ensure that patients receive the necessary nutritional supplements and other supplies to manage their symptoms and improve their quality of life.³⁷ At the same time, it can help to reduce waste and minimize costs, which can improve operational efficiency and reduce health care costs.

There is a need to understand end-to-end logistic management. While executing the supply chain, it will be important to focus on infrastructure, human resources, and technology. We should work on improving collaboration with suppliers for demand, data-driven forecasting, and inventory management. There should be proper maintenance of inventory to track the supply required in the management of cancer cachexia.

Supply chain management will improve operation efficiency and outcomes in cancer cachexia by reducing inventory, improving fulfillment rates, and ensuring product availability at the point of care. We can collect the data to identify trends and demand to prime the supply chain to respond faster to the changing demands. Multichannel programs will change expectations from supply chain forecasting/planning paradigms to building responsive supply chains.

Workflow optimization

OM can reduce wait times, eliminate bottlenecks, and improve overall care delivery efficiency by analyzing and optimizing the workflow of several health care departments engaged in the treatment of cancer cachexia patients.

There is a need for a systematic approach to identifying patients who are at a greater risk of developing cancer cachexia in the early phase of cancer care. This can be achieved with regular screening of important parameters like weight loss, muscle wasting, and other symptoms indicative of cachexia. A study by Cong et al. discussed standardized assessment tools Edmonton Symptom Assessment System (ESAS) or the Patient-Generated Subjective Global Assessment (PG-SGA), which can aid in early detection.³⁸

A multidisciplinary team (MDT) of oncologists, dietitians, physical therapists, palliative-care specialists, and other health-care professionals can work together to provide personalized tailored therapy to the patients of cancer cachexia. Taberna et al. published the MDT approach and

quality of care, which is very relevant for the management of cancer cachexia. Along with taking care of nutrition and physical activity, the team can also help with symptom management with or without pharmacological interventions.²⁴

Workflow optimization should follow a healthcare-specific methodology that leverages the best elements from Continuous Quality Improvement (CQI) Lean, Six Sigma, and Robust Process Improvement (RPI). This further requires assessment for improvement and the process that is most suited to counter the challenges in optimizing the workflow adopted. We should add the latest developments in the management of cancer cachexia to provide a standard of care along with innovating the process of delivery with the latest advancements to improve patient satisfaction. By continuously improving the care for patients with cancer cachexia, we can achieve the strategic goal of overall care delivery.

Process optimization can be better understood by dividing cancer cachexia into 4 phases i.e., pre-cachexia, cachexia, refractory cachexia, and outcome phase. The interdisciplinary team is required in all phases for better outcomes and quality of life. In pre-cachexic phase, risk assessment is done by taking cancer type, cancer treatment, performance status, and sarcopenia into consideration. Cancer patients diagnosed with gastrointestinal cancers (pancreatic cancer, gastric cancer, and esophageal cancer) and lung cancer are at the highest risk of developing cachexia.^{39,40}

Patients with cancer of the head and neck, receiving concurrent chemotherapy and radiation therapy may develop severe stomatitis and dysgeusia that may lead to secondary cachexia.^{41,42} Poor performance status can be identified in pre-treatment stages; it is mostly associated with early weight loss and inferior cancer cachexia outcomes.⁴³ While the majority of sarcopenic patients do not develop cachexia, the majority of cancer cachexia patients develop sarcopenia.⁴⁴

Early detection of cachexia or pre-cachexia is undertaken by either one clinician or a MDT of clinicians, nutritionist, and a nurse practitioner. High-risk cancer patients are assessed for early detection by measuring weight loss, body mass index (BMI) or muscle mass, and NIS.

Specialized cancer cachexia clinic can optimize the management of cachexia phase, where comprehensive assessment will be conducted on cancer patients who were previously screened and diagnosed with either pre-cachexia or cachexia. All symptoms are assessed, in particular, those impacting nutrition such as anorexia, nausea, vomiting, depression, gastroparesis, dysgeusia, pain, diarrhea, and constipation.¹⁸

The therapeutic intervention with follow-up care for cancer cachexia is accomplished by the entire interdisciplinary team at the cachexia clinic. End-of-life care and hospice care should be planned well in advance in refractory phases. While considering end-of-life care in cancer patients, artificial nutrition and hydration are not encouraged, and patients and families should be offered palliative care providing aggressive symptom management and emotional support.⁴⁵

Outcomes can be measured in terms of clinical status, function, and patient and family satisfaction. Cachexia status and mortality are medical outcomes, whereas symptom management, patient function, patient's quality of life, and patient satisfaction are patient-centered outcomes. Efficacy of cancer cachexia interventions by can be measured by these outcomes and it will help the interdisciplinary team to evaluate the possibility for improvement.

Protocol standardization

OM can help to establish and implement standardized treatment protocols for cancer cachexia patients. Standardization guarantees that all patients receive evidence-based care and helps to avoid treatment result discrepancies by ensuring consistency, comparability, and reproducibility of research and clinical practices.

Standardized criteria and assessment tools should be used for diagnosing cancer cachexia and monitoring its progression and nutritional assessment. Gullet et al. advocated for treatment algorithms on nutritional support, exercise interventions, pharmacological treatments, and palliative care should be designed.³³

Quality assurance

Quality assurance is a critical element in the OM challenges of managing cancer cachexia. Effective quality assurance ensures that health-care providers deliver high-quality care, and that patients receive the best possible outcomes.⁴⁶

Quality assurance helps to mitigate these risks by ensuring that health-care providers follow established protocols and guidelines, adhere to best practices, and deliver care that meets or exceeds industry standards, as reported in a study by Baracos et al.²⁸

Health-care providers must monitor their own and peers' performance to see the scope of improvement with the use of performance metrics and quality indicators to track progress and identify areas of weakness.⁴⁷

Al-Abri and Al-Balushi emphasized the effectiveness of their care, and the impact on patient outcomes should be evaluated by health care providers with the use of patient satisfaction surveys, outcomes data, and other metrics to assess the effectiveness of care and identify opportunities for improvement.⁴⁸

Health-care providers must provide feedback to each other to improve performance and ensure that care is delivered consistently and effectively.⁴⁹ This requires a culture of continuous improvement and a commitment to learning and development.

Effective quality assurance can help to reduce health-care costs by minimizing errors and reducing waste. CQI initiatives can improve the efficacy of cancer cachexia treatment.

Cancer cachexia management has an important objective of improving patients' quality of life through interventions related to nutrition, speech, mental issues, and supportive care. Goals of cachexia management in cancer patients can be well achieved by setting an objective for the health-care workers, defining individual responsibility, outcome expected, and operative guidance to cachexia care, action plans, and implementation of the plan.

Six Sigma and Lean principles can be used to detect and remove inefficiencies and errors in health-care systems. Lean management can help us make cachexia management more efficient, and adding more value to cancer patients by focusing on small but important processes and achieving perfection. Six Sigma is a statistical concept used as the quality theory that can be useful in eliminating mistakes in the care of cancer patients with cachexia by understanding, measuring, and improving the process by using the latest guidance and techniques.

Total Quality Management (TQM) is an important health quality theory aimed at patient's satisfaction. It is about learning from your process and continuously improving it to better. Management of cancer cachexia can be made better using this principle by incorporating the cost of quality care, meeting cancer patients' needs and expectations, high-quality training and education, and effective communication between patients and health-care providers.

Staff training and development and capacity planning

Management of cancer cachexia requires specialized training and development for all the health-care workers involved in cancer care delivery and can include training in nutrition, exercise, symptom management, and palliative care.

Staff training and development are essential to ensure that health-care providers have the necessary skills and knowledge to work effectively as a team and deliver high-quality care. This may involve training on nutrition and exercise interventions, symptom management, communication skills, and collaboration techniques. It may also involve ongoing professional development to stay up-to-date with the latest research and best practices, which have been discussed in detail in an article by Gesme et al.⁵⁰

Planning for changes in patient load and treatment requirements is critical for effective cancer cachexia management. Capacity planning can be aided by OM strategies, allowing health care facilities to adequately accommodate patient's needs.

Data management and analytics

Effective data management ensures that health care providers have access to accurate and timely information to make informed decisions about patient care. This data includes patient history, medical records, test results, nutritional status, and other important information that health-care providers use to manage symptoms and develop treatment plans.⁵¹

Data management is essential to ensure that health-care providers can access this information quickly and efficiently. This may involve the use of electronic health records (EHRs) and other digital tools to store and manage patient's data. It may also involve the use of data analytics tools to identify patterns and trends in patient's data, which can help health-care providers make informed decisions about patient's care.

The data is utilized to assess the treatment outcome, quality of life, follow-up data, survival rates, resource allocation, referral patterns analysis, cancer incidence reporting, and treatment efficacy evaluation.

To create cutting-edge decision support systems for cancer, it is necessary to follow best practices, such as the use of formal behavior change theories, validated electronic questionnaires for quality-of-life assessment, adoption of appropriate information modeling standards supplemented by terminologies/ontologies, adherence to fair data principles, and stratification of patients into subgroups for improved predictive modeling. Supporting emotional and social well-being, including patient-reported outcomes (PROs) into predictive modeling, and better customizing behavioral therapies for the specific population of cancer patients are all open research issues.⁵²

Patients and caregivers should be offered guidance on how to manage cachexia with dietary counseling by nutritionist. Parenteral nutrition and enteral feeding tubes should not be the preferred methods for dietary supplements. As there is no strong data supporting the use of any pharmacological strategy as a gold standard in the treatment of cancer cachexia, many clinicians may decide not to prescribe medicines. Progesterone analogues and short-term (weeks) corticosteroids are now accessible pharmacologic therapies to enhance appetite and/or improve weight gain.⁵³

Patient-centric care

OM can support patient-centric care by concentrating on personalized treatment plans that take into account cancer cachexia patients' particular requirements and preferences. Strasser emphasized the need for patient-centered cancer cachexia management, and whatever lessons learned from oncology, need to be taught to oncology.⁵⁴

While health care is becoming more patient-centered, patient-directed management of cancer cachexia is important to achieve the desired goal. As there are fewer efforts on interventions to ensure a better quality of life and functional and emotional well-being among patients, clinicians, and policymakers, so a holistic approach to manage cancer cachexia will help to implement integrated patient-centric care. Erickson et al. discussed nutritional care as an important component of the patient-centric care model in order to improve the overall well-being and quality of life of the patient.⁵⁵

Cancer cachexia management necessitates a multidisciplinary strategy with a focus on enhancing results and quality by concentrating on specific problems. A personalized care plan is created depending on the needs of the intervention after a cancer cachexia assessment is completed. By establishing a standard of care independent of a physician's preferences, evidence-based management ensures uniformity. Collaboration across specialties and disciplines aids in the patient's improved recovery and cancer cachexia management. Since addressing cancer cachexia requires extensive resource allocation, managing the supply chain for health-care professionals, medications, and supplements is crucial for providing high-quality patient-centered treatment. Since cancer cachexia is a significant predictor of both the clinical results and the quality of life of cancer patients, quality assurance is crucial at every stage of the process to ensure overall quality treatment of the condition.

Individualized evaluation, group decision-making, empowerment through education, formulation of common goals, regular follow-up, continuity of treatment, and respect for patient's autonomy, all can help in this.

Conclusions

The application of OM principles in the management of cancer cachexia holds immense potential for optimizing care delivery and improving patient outcomes. Through streamlining care processes, promoting multidisciplinary collaboration, data-driven decision-making, standardized assessment and monitoring, patient-centered care, and efficient resource allocation, health-care providers can effectively address the complexities of cancer cachexia and enhance the quality of life for affected individuals.

We all know that the management of cancer cachexia remains a complex and challenging task, so we need to make our system more adaptive and open to integrating the latest evidence-based practices into care models. In the current scenario, OM applications offer a promising pathway to optimize care delivery and enhance patient outcomes in the management of cancer cachexia.

Some of the future research guidelines will include exploring methods to detect cachexia at an early stage to alter patient's outcomes positively. Tailoring the treatment based on individual's needs could augment the effectiveness of interventions and minimize resource wastage. Combination therapies would be worthwhile future research direction that suggest combining not only pharmaceutical interventions but also effective management interventions to yield synergistic effects in dealing with cachexia. In the context of managing cancer cachexia, "responsible operations" refers to moral, long-term, and patient-focused methods of providing care and interventions to cancer cachexia patients, which can also be one interesting research direction.

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Perna Gautam: Conceptualization, Review of literature, Writing – Original and revised draft preparation, Submission. **Abhishek Shankar:** Conceptualization, Review of literature, Writing – Original and revised draft preparation, Submission. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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The authors declare no conflict of interest.

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