Creating targeted medical nutrition solutions

Six areas for innovation

dsm-firmenich

Identifying new opportunities in the medical nutrition market

Disease-related malnutrition (DRM) is a common condition, characterized by inadequate intake of energy, protein and/or micronutrients, arising due to the specific nutritional needs that develop during a disease or the treatment of a disease. It can affect patients at any life stage, but is most prevalent in the elderly. To achieve the best possible nutritional care for older populations and patients, individuals should be encouraged to consume nutritious meals or fortified foods that optimize nutritional status. However, in many cases, medical nutrition solutions may be required to achieve the required amounts of essential nutrients.

The reported prevalence of 'anorexia of aging' is **62%** in hospital populations **85%** of adults in care homes are at risk of malnutrition[1]

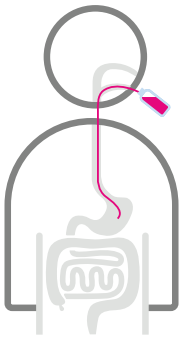
Immune health as an enabler of optimized nutritional care

Optimal immunity supports the health and recovery of patients and the elderly. However, immune function is often compromised in clinical settings. As immunity and nutrition are closely linked, it is possible to support the immune system via targeted medical nutrition solutions and improve patient outcomes.

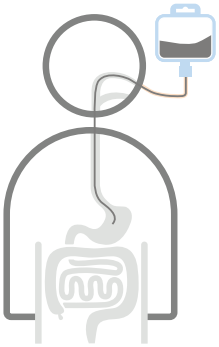
Getting the right nutritional care in a timely manner helps to support optimal immune function, reduce medical complications and promote the recovery and independence of patients and elderly individuals. Medical nutrition products – such as oral nutrition supplements, enteral nutrition (tube feeding) and parenteral nutrition (intravenous feeding) – benefit elderly people and patients by addressing DRM and complementing the normal diet. Taking a disease-specific approach enables manufacturers to develop targeted and appealing solutions that will address the special nutritional requirements presented in specific patient groups. In-depth knowledge of individual diseases and conditions, combined with patient insights, helps to identify gaps in the current market and inspire the creation of delivery formats that will both support compliance and improve the nutritional status of vulnerable individuals; giving them the best possible clinical outcomes.

Currently, there are six health conditions where dsm-firmenich has identified opportunities for insight-led medical nutrition innovation

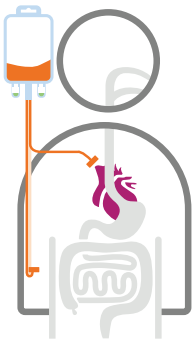
Medical nutrition



Oral nutritional supplements



Enteral nutrition



Parenteral nutrition

Benefits of targeted medical nutrition solutions:

Safe

Effective

Aids recovery

Helps patients reach nutritional targets

Improves quality of life

Reduces healthcare costs

Six therapeutic areas inspiring your next innovation:

Sarcopenia

The world's ever-growing elderly population is leading to a rise in prevalence of 'diseases of aging', like sarcopenia. Sarcopenia is described as a 'progressive and generalized skeletal muscle disorder that involves the accelerated loss of muscle mass and function' contributing to gradual frailty, reduced mobility and increased falls and fractures. The cause of the condition is multi-factorial – including poor nutritional intake and a sedentary lifestyle – and is associated with major clinical problems that can seriously impact an individual's independence and quality of life, including increased hospitalizations and mortality rates. It mostly occurs in older adults but can also impact people with mobility issues or individuals with specific medical conditions. Thought to already affect around 10% of individuals worldwide depending on the diagnostic tools and definition used for the disease, the prevalence of sarcopenia is expected to rise significantly in the coming years.[2,3]

Key ingredients for sarcopenia

Proteins and amino acids (including hydroxymethylbutyrate (HMB) – a metabolite of L-leucine) | Vitamin D | EPA and DHA omega-3 fatty acids

Science digest

- In combination with exercise, protein and essential amino acid supplementation benefits muscle mass and strength[4,5]
- Higher vitamin D status is linked to lower risk of sarcopenia[6]
- Vitamin D has positive effects on muscle function and strength, physical performance (e.g. better lowerextremity musculoskeletal function) and protein synthesis[7,8,9]
- Prolonged inflammation can lead to increased muscle breakdown and reduced muscle synthesis. The anti-inflammatory properties of EPA and DHA benefit individuals with sarcopenia as they support a balanced immune response and resolve the excessive inflammation associated with the disease.[10,11] EPA and DHA omega-3s may also modulate protein synthesis and muscle strength and functioning.[12,13,14,15] Evidence shows that lower levels of EPA are associated with reduced muscle function[16]
- Combining ingredients has shown to be more effective than single nutrient interventions. One study showed that vitamin D and L-leucine enriched whey protein preserved muscle mass and improved muscle strength in older adults.[17] In another study, the combination of whey protein, vitamin E and vitamin D also preserved muscle mass and strength in older adults with sarcopenia, contributing to better quality of life[18]
- Astaxanthin is a new promising ingredient that may also help to slow progression of sarcopenia. An astaxanthin formulation – also containing vitamin E and zinc – enhanced muscle strength and size in the elderly, compared to the placebo group. Supplementation in addition to endurance and mobility training was found more effective than exercise alone.[19]

Pre-/post-surgery

Malnutrition is a serious risk factor for surgical complications, leading to longer hospital stays, increased vulnerability towards infection and higher mortality rates. For example, patients are three times more likely to have complications if they are malnourished at the time of surgery, but only one in five individuals undergo nutrition screening or nutrition intervention pre-op.[20] To prevent surgical complications, the Enhanced Recovery After Surgery concept – known as ERAS – advocates the integration of perioperative nutritional therapy into the overall management of patients.[21]

ERAS involves:

- Nutrition screening during pre-operative evaluations
- Avoiding long periods of pre-operative fasting
- Optimized nutrition pre- and post-surgery by starting nutritional therapy early and maintaining metabolic control, e.g. of blood glucose
- Promoting movement to facilitate protein synthesis and muscle function

Perioperative immune modulating nutrition (IMN) can also be utilized to prepare patients better for surgery and speed up the recovery time post-operation. Evidence shows that the pre-operative administration of IMN for a minimum of five days, either orally or enterally, leads to a significant reduction in post-operative infectious complications and length of hospital stay.[22]

Science digest

• Immune-modulating formulas containing a combination of antioxidants, omega-3 fatty acids and arginine improve surgical outcomes by moderating the immune-inflammatory response after surgery[23]

• The anti-inflammatory properties of EPA and DHA help to reduce chronic inflammation without increasing risk of infection and also reduce length of hospital stay. As part of the immune response, EPA and DHA are converted into specialized proresolving mediators, which together with other molecules, coordinate the resolution of inflammation and support healing[24]

• Arginine is important for wound healing, but its stores are depleted rapidly during surgery. Perioperative arginine helps to lower the risk of infection post-surgery and length of stay in hospital[25,26]

• Specific vitamins and minerals (vitamins A, C, E, zinc and selenium) and amino acids (glutamine and cysteine) act as antioxidants in the body. Studies show that they may improve surgical outcomes by moderating the immuneinflammatory response after surgery induced by major surgery or critical illness[27]

• Oral nutrition supplementation post-surgery improves energy, protein and micronutrient intake and is linked to reduced risk of infection and fewer antibiotic prescriptions.[28,29]

Key ingredients for surgical patients

Antioxidants | EPA and DHA omega-3 fatty acids | Arginine

Cancer cachexia

Cancer cachexia is a prevalent wasting condition in patients with cancer, marked by significant muscle and weight loss, anorexia, weakness and anemia. The condition is a complex syndrome, thought to arise due to the interaction between the tumor and factors such as decreased food intake, modified immune function and increased inflammation. Not only does cancer cachexia negatively affect a patient's quality of life as well as their prognosis and therapy outcomes, but it is the direct cause of more than 20% of cancerrelated deaths.[30]

Combination therapy is recommended for cancer-associated malnutrition

Nutrition counselling | Medical nutrition | Physical therapy | Drug therapy

The European Society for Clinical Nutrition and Metabolism – **ESPEN** – recommends nutritional intervention and exercise to help manage the condition. Here, optimized nutrition supports positive patient outcomes by improving appetite and food intake, mitigating metabolic imbalances and boosting immune function, while reducing the inflammation associated with the condition, maintaining skeletal muscle mass and physical performance and reducing risk of interruption to anticancer treatments.

Key ingredients for cancer cachexia

Protein | EPA and DHA omega-3 fatty acids | Vitamins and minerals

Science digest

- Increased protein intake may promote muscle protein anabolism, whereas branched chain amino acid supplementation may improve fat free mass[31,32]
- EPA and DHA omega-3 fatty acids downregulate the inflammatory process, help to maintain muscle mass, and possibly even decrease tumor proliferation and angiogenesis, i.e. the formation of new blood vessels that help the cancer to grow and spread[33]
- EPA and DHA may also act as an adjunct to cancer therapy and promote better treatment outcomes.[34] In one study in non-small cell lung cancer patients, a two-fold increase in therapy response rate and clinical benefit was observed in patients receiving EPA and DHA compared to patients undergoing the same treatment without supplementation.35 Known as a drug-nutrient interaction, it is thought that DHA supports the programmed cell death of cancerous cells by increasing the sensitivity of tumor cells to conventional therapies, while simultaneously protecting healthy cells[36]
- The low status of micronutrients in cancer patients negatively impacts immune function, wound healing and recovery, and increases the risk of depression. It is therefore recommended to supply vitamins and minerals in amounts equal to the recommended daily intake in all cancer patients.[37,38]

Cognitive health

With the aging population, cognitive performance and mental wellbeing are among the modern world's greatest challenges. Aging increases a person's vulnerability towards conditions that affect normal brain function, like dementia – a major cause of disability and dependency among older adults. It is thought that 50 million people worldwide are currently living with dementia, however, as this number is set to triple by 2050 and with no treatment currently available, bringing solutions to the market that offer preventative measures and support brain health is therefore critical.[39]

Key ingredients for cognitive health

EPA and DHA omega-3 fatty acids | Vitamins B, E and D | Lutein

Science digest

- DHA is the most important and abundant omega-3 fatty acid in the brain and exhibits neuroprotective properties[40]
- There is evidence that indicates a positive link between omega-3 intake or status and cognitive function and reduced risk of dementia[41]
- EPA and DHA omega-3s decrease brain inflammation and preserve the function of neuron membranes[42]
- B-vitamins are actively involved in the uptake of DHA into the brain. Interactions between vitamin B6 and B12 and folic acid are linked to lower concentrations of homocysteine in the plasma – a risk factor for Alzheimer's Disease – decreased brain atrophy and lower risk of cognitive decline[43,44,45,46]
- A mutual interaction between omega-3s and the B vitamins has been observed; if the status of one of these nutrients is low, the effect of the other is also diminished, but when omega-3 levels are in the upper normal range, B vitamins interact to slow cognitive and clinical decline[47] The antioxidant properties of vitamin E may help to protect cells from the damage associated with oxidative stress which can cause neurodegeneration and lower cognitive performance[48]
- Vitamin D may support cognition function by regulating vascular processes and oxidative stress, calcium homeostasis, neurotransmission, modulating immune and inflammatory processes and directly impacting amyloidosis, i.e. the abnormal protein build up associated with increased risk of stroke and dementia[49]
- In combination with DHA, lutein-supplemented elderly women scored better in a verbal fluency memory test, had better memory scores and their rate of learning also improved significantly.[50]

Chronic kidney disease

Chronic kidney disease (CKD) is a long-term condition where kidney function gradually declines. It is a common disease estimated to affect almost 10% of the global population, and often associated with aging.51,52 CKD is usually caused by other conditions that impact kidney function, including high blood pressure and diabetes, or can develop as a side effect from the long-term use of specific medications, like non-steroidal anti-inflammatory drugs – widely used to relieve pain and reduce inflammation. There are typically no symptoms of kidney disease in the early stages, making it difficult to diagnose. In the advanced stages though, patients may need life-long dialysis or other types of renal replacement therapies, including kidney transplants. Such therapies need to be managed carefully to decrease side effects, complications, and impact on quality of life.

Key ingredients for CKD

Protein | EPA and DHA omega-3 fatty acids | Vitamins and minerals

Science digest

- Most patients with CKD are advised to limit their sodium, potassium and phosphorus intake
- Some patients – mainly those not on renal replacement therapy – are recommended to lower their protein intake. If this is required, the proteins that are consumed should have a high content of essential amino acids
- The Alpha Omega trial showed that long-term supplementation with 400 mg/day EPA and DHA benefited kidney function in older patients [53]
- A meta-analysis of nine studies concluded that omega-3 supplementation is associated with reduced risk of end-stage renal disease in CKD patients, and generally delays the progression of the condition [54]
- Increasing evidence shows that individuals with CKD are at higher risk of poor vitamin K status, therefore vitamin K supplementation may be advised [55]
- Bone disorders are common in patients with CKD as damaged kidneys and abnormal hormone levels cause calcium, potassium and phosphorus levels in a person's blood to become unbalanced. Vitamin D may therefore play an important role in the survival of patients undergoing dialysis, as it is linked to mineral levels [56,57]
- An antioxidant supplement containing nutrients, like vitamin B, C, D and E, as well as EPA and DHA omega-3 fatty acids, may help to reduce the increased oxidative stress patients experience during analysis. [58]

Chronic obstructive pulmonary disease

Chronic obstructive pulmonary disease (COPD) comprises a group of life-threatening lung conditions, including emphysema and chronic bronchitis, that cause breathing difficulties. The exact prevalence of COPD is unknown, but it is estimated to affect between 7–19% of the global population, with smokers at higher risk of developing it. 59 COPD is often associated with an imbalance in energy (weight loss), a progressive loss of muscle mass and function (sarcopenia) and increased inflammation, which can increase nutritional losses. Although incurable, progression can be slowed through medication and nutritional intervention, helping to improve the quality of life of patients and reduce the risk of complications.

Science digest

• Early nutritional intervention may help to improve lung function and slow the progression of COPD and the accompanying loss of muscle mass [60,61]

• A daily intake of 1–1.2 g protein/kg bodyweight/day is recommended for patients with COPD. 1.2–1.5 g protein/kg bodyweight/day is advised in older individuals who are malnourished or those with a chronic disease [62]

• Observational data supports the hypothesis that omega-3 fatty acids are important for the management of COPD – a chronic inflammatory disease – due to their anti-inflammatory benefits [63]

• Because oxidative stress plays an important role in the pathology of COPD, several nutrients associated with anti-inflammatory and antioxidant properties may help to reduce risk and/or progression of the diseases [64,65]

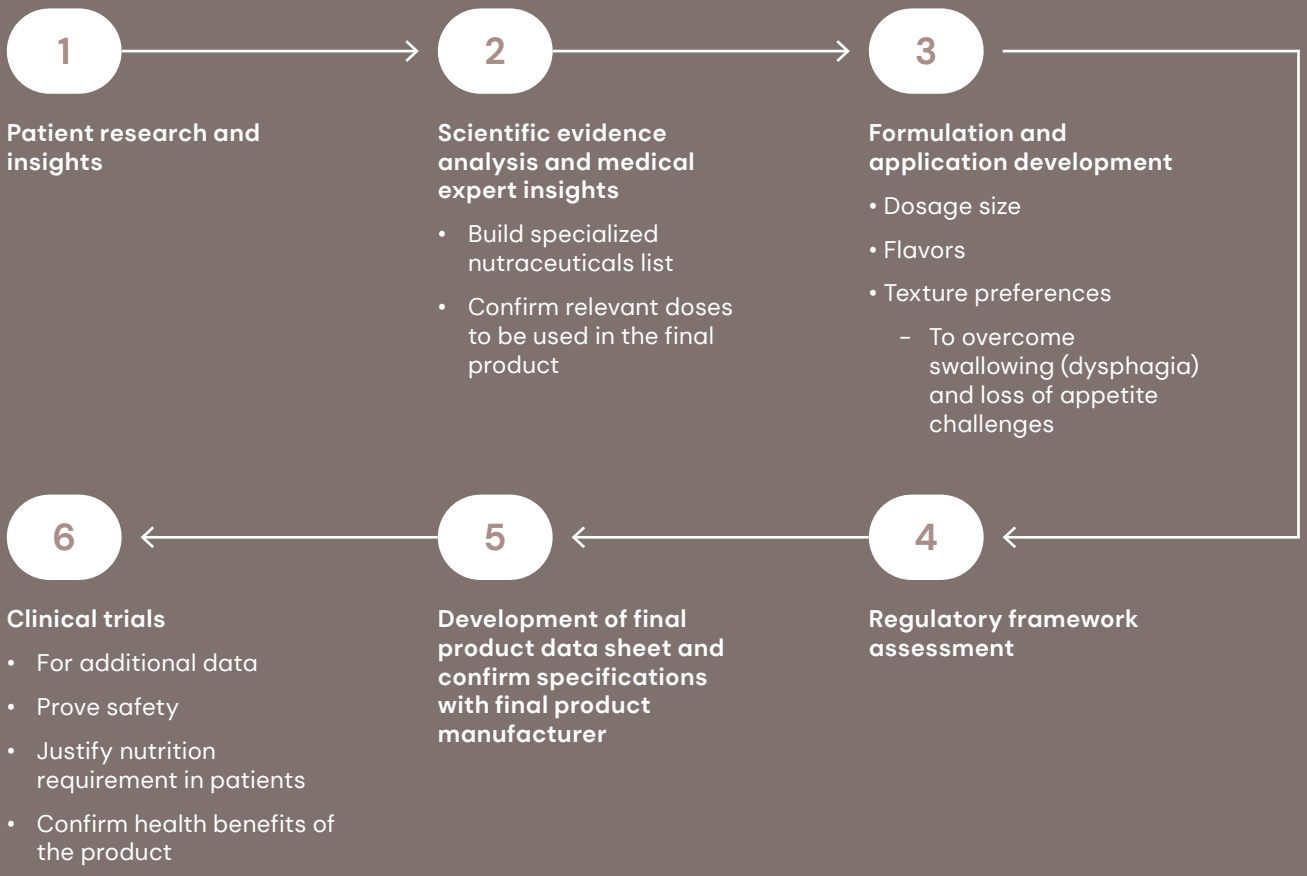
Key ingredients for COPD

Protein and amino acids | EPA and DHA omega-3 fatty acids | Dietary fibers | Dietary antioxidants

• Vitamin D deficiency is shown to be highly prevalent in COPD, with levels shown to be lower in the more advanced stages of the condition, suggesting a link between COPD severity and vitamin D deficiency [66,67,68,69] Although a role for vitamin D in the long-term prognosis of COPD patients remains to be determined, supplementation of the nutrient is hypothesized to be beneficial.

Developing medical nutrition solutions

From concept to consumption



Your preferred partner for medical nutrition innovation

Creating insight-led medical nutrition solutions takes more than ingredients. It takes a partner that is inspired by patients to continuously innovate to meet their needs. As a purpose-led company, dsm-firmenich is passionate about supporting the health, recovery and independence of patients and the elderly, as well as reducing the burden on global healthcare systems. For dsm-firmenich, quality care and optimal diet are integral to the welfare of individuals in clinical settings, as both factors have a real impact on patient dignity and overall wellbeing. dsm-firmenich takes an insight-led and human-centric approach to innovation; to ensure the patient's needs and preferences are addressed in a way that will ultimately enhance their quality of life.

When you partner with dsm-firmenich, you get access to the broadest offering in the industry, customized solutions and expert services at every stage of your product's development so that you can meet the ever-evolving and complex nutritional needs of patients and the elderly.

dsm-firmenich offers medical nutrition solutions designed with the benefit of:

- In-depth patient and elderly insights
- Extensive industry expertise
- Unrivalled formulation and application knowledge
- Science-led innovation capabilities
- A global network and local support

Complete ingredients portfolio

- dsm-firmenich provides a complete portfolio of science-based and high-quality nutritional ingredients
- From vitamin straights as individual ingredients, including vitamins as active pharmaceutical ingredients for parenteral nutrition, to nutrients such as EPA and DHA omega-3 fatty acids from marine and algae sources, dsm-firmenich's ingredients can be used in a range of medical nutrition formulations.

Customizable solutions

- dsm-firmenich's global blending capabilities allow for the creation of fully customizable premixes, including nutrient blends of desired functional ingredients – vitamins, minerals, amino acids, nutraceuticals and more – in one single, efficient and homogenous premix
- dsm-firmenich makes specialized medical nutrition solutions available to customers globally with its 15 state-ofthe- art facilities strategically placed around the world.

Expert services

- dsm-firmenich is committed to adding value at every stage of development – from concept to consumption – through its broad range of expert services available across its global network. These services support the development of medical nutrition solutions that successfully address the needs and format preferences of the elderly and patients under medical supervision.

For further insights or information about how dsm-firmenich can support you in developing innovative, appealing medical nutrition solutions that will meet the needs of patients and the elderly, please visit www.dsm-medicalnutrition.com or contact us.

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