Review Article

Oral Nutrition Supplementation in the Health Dynamics of Dialysis Patients

Abstract

Inadequate nutritional management poses health challenges to patients on dialysis. Its iatrogenic effects include intradialytic hypotension, gastrointestinal intolerance, muscle cramps, inflammations, renal osteodystrophy, poor quality of life, and protein energy wasting (PEW). Nutrition care helps manage these effects. Nutritional intervention for these patients includes dietary counseling with food modifications. Oral nutritional supplements (ONS) are recommended when kitchen-based food does not meet nutritional needs. ONS improve the nutrition status, blood parameters (serum albumin, pre-albumin), sleep quality index, hand grip strength, body mass index, nutritional intake, muscle mass, and physical and mental quality of patients on dialysis. ONS types that have shown improvement are soya protein, whey protein, collagen peptide, egg albumin, branched-chain amino acid, a blend of casein, and whey. Enhancing protein digestion by using proteolytic enzymes with a high-protein diet would also help in PEW treatment. Ghrelins also improve the appetite and food intake. The nutrition supplements recommended to dialysis patients need to be used appropriately to suit patient-specific requirements and challenges. A multidisciplinary team and holistic approach are important for better patient outcomes.

Keywords: *Dialysis, Nutrition status, Oral Nutrition Supplements, Protein Energy Wasting, Proteolytic enzyme*

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Introduction

Malnutrition, commonly seen among dialysis patients, is associated with increased mortality and morbidity. Medical nutritional therapy (MNT) is integral in controlling and managing dialysis-associated complications. These complications, namely, intradialytic hypotension, muscle cramps, protein-energy wasting (PEW), gastrointestinal intolerance, inflammation, cardiac diseases, and bone disease [Figure 1], could be controlled through proper diet and lifestyle.[1] When the former cannot be maintained by regular kitchen-based food, oral nutrition supplements (ONS) become essential.[2] There are many ONS types for dialysis patients. Complete nutritional assessment is necessary to decide the supplement type and amount. Adequate nutritional intake and holistic lifestyle modification can protect patients on hemodialysis (HD) from malnutrition and complications.

Significance of Medical Nutrition Therapy in Dialysis Associated Complication

Intra-dialytic hypotension

The National Kidney Foundation recommends an ideal intradialytic weight gain of 1.5-2 kg. An improper diet with excess salt and fluid could primarily lead to excess intradialytic weight gain. A higher ultrafiltration rate to remove this excess fluid may not be tolerated by some patients, as the rapid fluid removal may cause low blood pressure (hypotension) and cramping. This could lead to inappropriate fluid removal.[3] Dietary adherence to fluid and salt restriction needs to be followed to avoid complications. Sugary and salty food causes more thirst. Sodium in the diet should be <2 g per day. The patient's water requirement varies by urine output.

The dietary energy and protein intake are less on dialysis days.[4] Providing a meal or

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Figure 1: Significance of medical nutrition therapy in dialysis-associated complication.

ONS during an HD session can reduce PEW. However, these meals should be individualized according to the patient's nutritional requirements and risk profile for developing hypotension.[5] High-protein snacks or ONS, rather than a full meal with high-carbohydrates, prevent intradialytic hypotension.

Muscle cramps

Muscle cramps among HD patients are multifactorial. Excess fluid removal during dialysis (as stated above), alternation of blood pH (metabolic acidosis/alkalosis), electrolyte imbalance, and carnitine deficiency are common causes.

Metabolic acidosis: Dialysis patients are prone to metabolic acidosis. It is characterized by low serum bicarbonate levels (<22 mmols/L). Dietary management plays a vital role in metabolic acidosis prevention and correction. Including plant-based food rich in alkalis can mitigate metabolic acidosis.[6] It is important to include adequate low-potassium vegetables and fruits to mitigate the acidic effects of animal protein consumed to meet high-protein requirements.

Metabolic alkalosis: Metabolic alkalosis due to low protein intake and greater dialysis doses also causes muscle cramps (bicarbonate levels ≥ 26 meq/L) in dialysis patients.[7] It is essential to monitor the protein intake of patients on dialysis.

Carnitine deficiency: Carnitine is lost, less produced by the kidneys, or consumed below the requirements, during dialysis, commonly causing deficiency. However, L-carnitine supplementation is warranted only for symptomatic patients when usual measures are unresponsive. Its therapeutic usage has been beneficial for intradialytic muscle cramps, hypotension, asthenia, cardiomyopathy, lowered ejection fraction, muscle weakness or myopathy, reduced oxygen consumption, and anemia requiring large erythropoietin dosage.[8] ONS suggested for patients on dialysis are enriched with L-carnitine to meet these specific requirements.

Electrolyte imbalance: Hyperkalemia (Serum potassium > 5 mmol/L) is commonly seen among dialysis patients. Electrolyte imbalance could trigger heart muscle weakening, leading to cardiac arrhythmias. These patients should have a limited dietary potassium intake (40-70 mEq/day).[9]

Cardiovascular complications

Dietary modifications significantly help curtail cardiovascular complications in patients on dialysis. A meta-analysis confirms improved diastolic pressure (p value = 0.0001), triglycerides (p value = 0.01), and myeloperoxidase (p value = 0.0001) with consumption of plant-based diets rich in polyphenols.[10] Supplementation of fermentable soluble fiber improved the lipid profile, oxidative, and inflammatory status in patients on HD.[11]

Protein-energy wasting

Protein and fat wasting causes weakness and poor quality of life. A 11.95 ± 0.69 g amino acid (AAs) loss was observed per HD session.[12] This AA-loss coupled with inadequate food intake, can worsen muscle and fat wasting. Therefore, it becomes essential to ensure adequate protein (1.0 g-1.2 g/kg/day) and energy intake (30-35 kcal/kg ideal body weight) in dialysis patients.[13] Protein powders and medium chain triglycerides can be added to food to enhance its protein and energy content.

Renal osteodystrophy

As kidney functions decline, hyperphosphatemia (Serum phosphorus > 4.5 mg/dL) occurs. Most high protein food sources are high in phosphorus. The phosphorus in diet should be < 800-1000 mg per day.[14] The desirable phosphorus-to-protein ratio is <12 mg/g of protein.[15] ONS are formulated with low phosphorus and high protein.

Gastrointestinal symptoms

Inadequate food intake may be caused due to gastroesophageal reflux disease, gastric intolerance, gastrointestinal inflammation, bloating, constipation, and dyspepsia. Studies have suggested a higher dyspeptic symptom prevalence in patient on HD when compared to the general population. It is defined as an upper abdominal pain or discomfort, bloating, early satiety, post prandial fullness, nausea with or without vomiting, anorexia, regurgitation, and belching.[16]

Constipation: Constipation is prevalent in 63% HD and 29% of peritoneal dialysis (PD) patients. Medications such as phosphate binders, antibiotics, water restrictions, and dietary restrictions on potassium (restrictions of fruits and vegetables) may exacerbate constipation.[17] Sufficient whole grains, fiber-rich low-potassium fruits, and vegetables would aid in better bowel movement and help constipation treatment.

A structured resistance exercise program during HD sessions is a safe and effective intervention that helps improve physical performance, nutritional status, quality of life, anabolic response, and muscle strength.[18]

Intestinal dysbiosis: Intestinal dysbiosis triggers inflammation and cardiac disease. Supplementing probiotics in the diet suppresses systemic inflammation.[19]

Food intolerances: Consuming easily digestible foods and improving chew count would aid in better tolerance and digestion. High-fat food remains in the stomach longer, increasing the chances of nausea and vomiting. Small frequent meals also aid in better food tolerance. Cultural and dietary habits vary in different regions of India and this should be factored while advising the diet.

Bloating and indigestion: There is protein dysregulation in dialysis patients. Protein digestion is compromised by dysregulation in its intake.[20] Supplementing protein-digesting enzymes aids digestion. Hence, a proteolytic enzyme with protein supplements or protein-rich food would improve its digestion, absorption, and assimilation.[21] Ghrelin administrations in dialysis patients have improved appetite and food intake, thereby improving nutritional status.[22]

Depression and financial limitations commonly seen among dialysis patients can curtail food intake.[23] Hence, a holistic approach to improve their nutritional status is needed.

Benefits of oral nutrition supplementation in dialysis patients

Oral nutrition supplementation and dietary counseling significantly improves the nutritional status of patients on dialysis [Figure 2]. This improvement is reflected by parameters like serum albumin, pre-albumin, subjective global assessment (SGA) scores,[24] body composition (muscle mass),[25] Pittsburgh Sleep Quality Index (PSQI) score,[26] physical activity, quality of life,[27] body mass index, hand grip strength,[28] and malnutrition inflammation score.[29]

Oral nutrition supplement in MNT of dialysis patients

Proteins are primarily used as ONS in healthcare settings and gymnasiums. Dietary protein sources, quality, and quantity among different Indian populations have been represented in Table 1.[30]

Types of oral nutrition supplements and its implications

The ONS types in dialysis patient management have been presented in Table 2.

Vegetable protein powder: Plant-based diets reduce the obesity, high blood pressure, and diabetes risk.[31] A study on patients supplemented with soy protein found an inverse relationship between inflammatory marker CRP levels and serum isoflavone levels ($P < 0.02$) and positive correlation between Δ-isoflavone and albumin variation ($R = 0.522$, $P = 0.05$) and insulin-like growth factor-1 ($R = 0.518$, $P < 0.05$).[32]

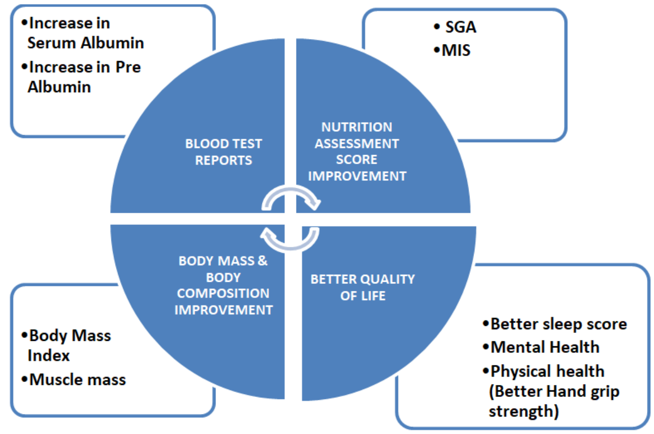

Figure 2: ONS in MNT of dialysis patients. ONS: Oral nutrition supplement, MNT: Medical nutrition therapy, SGA: Subjective global assessment, MIS: Malnutrition inflammation score.

Whey protein: Whey protein isolates used in patients on PD showed improved dietary protein intake and increased serum urea ($P = 0.002$) and normalized Protein catabolic rate (n PCR) ($P < 0.001$). The body weights, BMIs, skin-fold measures, and serum urea of positive responders increased.[33]

Balanced tube feeding ONS: The protein sources are a combination of whey and casein protein. ONS given to dialysis patients decreased MIS scores in 38% (p value 0.04) and improved serum albumin (p value = 0.02).[34]

High protein diet with proteolytic enzyme: Proteolytic enzymes are used to improve protein digestion. Using proteolytic enzymes with a protein-rich diet was beneficial in dialysis patients for better protein assimilation thereby reducing PEW. There was a significant improvement in dry weight and CRP reduction (p value < 0.05).[35]

Protein supplement with hydroxymethylbutyrate (HMB) helps in muscle protein synthesis by stimulating the mammalian target of rapamycin.[36] However, no significant HMB effects on dialysis patients with regard to body composition, bone density, strength, physical function, fall risk, quality of life, or blood parameters were seen.[37]

Egg albumin protein: Egg albumin-based supplement significantly improved serum albumin, n(PNA), triceps skinfold, mid-arm muscle circumference (MAMC), and calorie protein intake compared with the controls who received diet counseling only (p value < 0.05). The malnutrition percentage reduced by 28% in the study group compared with the control group (6%).[38]

Table 1: The sources of dietary protein and protein quality in different diets of India

Sex	Food source	Intake (g/day)	Protein content (g/day)	Lysine (mg/g protein)	Digestibility (%)	PDCAAS
			Rural-NNMB 2006			
Men	Cereals	363 ± 185	31.6	31	81	81
	Millets	55 ± 128	5.3	35		
	Pulses & legumes	31 ± 34	6.7	70		
	Nuts & oil seeds	16 ± 31	2.9	37		
	Fish & flesh foods	27 ± 39	5.9	81		
	Milk & milk products	94 ± 123	3.0	77		
Women	Cereals	328 ± 157	28.5	31	80	80
	Millets	37 ± 97	3.6	35		
	Pulses & legumes	27 ± 31	5.6	70		
	Nuts & oil seeds	14 ± 26	2.6	37		
	Fish & flesh foods	24 ± 42	5.2	81		
	Milk & milk products	80 ± 112	2.6	77		
			Urban-NNMB 1984			
Men and Women	Cereals & millets	381	35.1	33	81	81
	Pulses & legumes	47	10.2	70		
	Nuts & oil seeds	16	2.9	37		
	Fish & flesh foods	24	5.1	81		
	Milk & milk products	217	6.9	77		
			Slum-NNMB 1994			
Men and Women	Cereals & millets	381	35.0	33	80	80
	Pulses & legumes	27	5.8	70		
	Nuts & oil seeds	13	2.4	37		
	Fish & flesh foods	26	5.7	81		
	Milk & milk products	75	2.4	77		
			Tribal-NNMB 2000			
Men	Cereals	460 ± 239	40	31	79	72
	Millets	5 ± 14	0.5	35		
	Pulses & legumes	25 ± 31	5.4	70		
	Nuts & oil seeds	17 ± 33	3.1	37		
	Fish & flesh foods	20 ± 35	4.3	81		
	Milk & milk products	28 ± 59	0.9	77		
Women	Cereals	369 ± 169	32.1	31	80	76
	Millets	33 ± 113	3.2	35		
	Pulses & legumes	20 ± 27	4.3	70		
	Nuts & oil seeds	24 ± 30	4.4	37		
	Fish & flesh foods	26 ± 34	5.6	81		
	Milk & milk products	29 ± 58	0.9	77		

PDCAAS: Protein digestibility-corrected amino acid score, NNMB: National nutrition monitoring bureau

Collagen peptides: Administration of oral collagen peptide was beneficial in PD patients. It significantly increased protein intake (p value = 0.05) and serum urea levels (p value = 0.003). However, there was no significant serum albumin improvement.[39]

Branched chain amino acid (BCAA) level was low in malnourished HD patients. Supplementing BCAAs significantly improved the serum albumin, plasma BCAA, oral calorie and protein intake, and anthropometric indices (p value $<$ 0.05).[40]

Factors considered while recommending ONS

ONS are recommended for malnourished patients or those not meeting nutritional requirements. Malnutrition could be diagnosed using nutrition assessment tools like malnutrition inflammation score (MIS)[41] and SGA.[42]

Malnourished patients are recommended to take ONS twice or thrice a day based on their nutrition deficit. Consumption is recommended between the main meals to avoid interference with normal kitchen-based food quantity. Proteolytic enzymes are advised immediately after a high-protein meal. The ONS recommended for patients on dialysis should adhere to fluid, sodium, potassium, and phosphorus restrictions. ONS with the lowest phosphorus-to-protein ratio ($<$ 12) are preferred. ONS with additional benefits on fiber, probiotics, and

Table 2: Types of protein in the nutritional management of HD patients

Reference	Type of protein and its intervention
Paolo Fanti, Reto Asmis, Tammy J. Stephenson, B. Peter Sawaya, Adrian A. Franke, Nephrology Dialysis Transplantation, Volume 21, Issue 8, August 2006	End-stage renal disease patients on chronic HD with elevated CRP (>10.0 mg/L) were enrolled in this pilot study. The subjects were double-blinded and randomly distributed with a 2: 1 ratio to receive isoflavone-containing soy-based nutritional supplements (soy group) or isoflavone-free milk protein (control group) for 8 weeks. Serum isoflavone, inflammatory markers, and nutrition markers were assessed at baseline and the end of the treatment. Thirty-two subjects were enrolled. Fifteen subjects in the soy group and 10 in the control group completed the study; five dropped out due to acute illness and two due to food intolerance. After intervention, blood isoflavone levels were 5-10 fold higher in the soy group than in the control group P < 0.001. However, the isoflavone levels ranged widely in the soy group. Variation from baseline of the individual serum isoflavone levels (Δ-isoflavone) and CRP displayed a strong inverse correlation in the soy group (R = −0.599, P < 0.02). In addition, Δ-isoflavone correlated positively with the variation of albumin (R = 0.522, P = 0.05) and insulin-like growth factor-1 (R = 0.518, P < 0.05). Group levels of CRP were not statistically different after the intervention, although a trend towards lower levels was noted in the soy group [18.2 (12.7–29.1) mg/L at baseline vs. 9.7 (5.2–20.7) mg/L at week 8; NS] but not in the control group [20.6 (9.2–38.5) vs. 17.6 (9.1–40.7) mg/L].
Sahathevan, S., Se, C-H., Ng, SH., Khor, BH., Chinna, K., Goh, B. L., Gafor, H. A., Bavanandan, S., Ahmad, G., Karupaiah, T. Clinical Nutrition ESPEN 2018: Volume 25	126 malnourished CAPD patients (serum albumin <40 g/L, body mass index (BMI) <24 kg/m^2) randomized to the intervention group (IG, n = 65) received whey protein supplement powder (27.4 g) given for 6 months plus dietary counseling (DC) while the control group (CG, n = 61) received DC only. Achieved dietary protein intake (DPI) IG 59.5% (p < 0.001), CG 16.2%, dietary energy intake between groups was non-significant (p > 0.05). A higher DPI paralleled significant increases in serum urea (mean Δ: IG = +2.39 ± 4.36 mmol/L, p = 0.002, d = 0.57 vs. CG = -0.39 ± 4.59 mmol/L, p > 0.05, d = 0.07) and normalized protein catabolic rate, nPCR (mean Δ: IG = +0.11 ± 0.14 g/kg/day, p < 0.001, d = 0.63 vs. CG = +0.001 ± 0.17 g/kg/day, p > 0.05, d = 0.09) CG patients had a significant decline in QOL physical component (mean Δ = -6.62 ± 16.63, p = 0.020, d = 0.47). Using changes in nPCR level as a marker of within IG, 'positive responders' achieved significant improvement in weight, BMI, skinfold measures and serum urea (all p < 0.05), while such changes within 'negative responders' were non-significant (all p > 0.05).
Yuvaraj A, Vijayan M, Alex M, Abraham G, Nair S. Hemodialysis International 2016 Jan;20(1):56-62	Out of 55 chronic kidney disease patients on MHD (37 women, 18 men) aged between 21 and 67 years, 26 patients received high-protein commercial nutritional supplements (a combination of whey and casein protein), whereas 29 patients received high-protein kitchen feeding (HPKF). Every patient had their MIS, 24-hour dietary recall, hand grip, mid-arm circumference, and triceps skin-fold thickness at 0, 3, and 6 months. MIS, improvement in ONS group 38.1%, HPKF 8.7% (P = 0.04). Improvement in malnutrition in the ONS group, age group >65 years (P = 0.03) and Serum albumin <35 g/L (P = 0.02). Both high-protein kitchen feeding and high-protein commercial nutritional supplement cohorts were observed to have an improvement in overall nutritional status. Older patients >65 years old with lower serum albumin levels (<3.5 g/dL) were observed to have significant improvement in nutritional status with ONS.
Gharia SV, Ravichandran P, Periasamy S. International Journal of Nephrology and Therapeutics. 2020; 5(1): 018-024.	60 ESRD low-income patients on maintenance hemodialysis were included in the study. The candidates were categorized into three groups of 20 each. Baseline demographic, clinical, and data for laboratory assessment of nutritional parameters were collected and repeated at the end of the study (6 weeks). Group 1 received Enzotein-Whey protein 15 grams plus Proteolytic enzyme with 70000 HUT (Hemoglobin unit tyrosine); Group 2 -30 gms plain whey protein without proteolytic enzyme, and Group 3 control group with no supplements. The intervention Groups 1 and 2 showed improvement in their dry weight by 1.6 kg and 1.4 kg, respectively. The post-dialysis recovery time and serum C Reactive Protein (CRP) levels in groups 1 and 2 had declined, which was significant in Group 1 compared to Group 3 (p < 0.05). Clinical improvement in the mid-arm circumference, Triceps fold thickness, hand grip strength, and MIS were observed in Group 1 and Group 2 but were not statistically significant.
Fitschen, P. J., Biruete, A., Jeong, J., Wilund, K. R. Hemodialysis International 2017, 21(1):107-116	MHD patients were recruited and assigned to either daily supplementation with HMB (n = 16) or placebo (n = 17) for 6 months. Measurements of body composition, bone density, strength, physical function, fall risk, quality of life, and blood parameters were measured at baseline and 6 months. Blood was drawn at baseline, 3, and 6 months to measure compliance. No significant effects of HMB on body composition, bone density, strength, physical function, fall risk, quality of life, or blood parameters were observed. On analysis of plasma HMB concentrations, 5 of 16 patients (31%) in the HMB group were found to be noncompliant at 3 or 6 months. Therefore, we performed a per-protocol analysis with compliant participants only and observed no significant differences in our outcomes of interest.

Contd.,

Table 2: Continued

González-Espinoza, L., Gutiérrez-Chávez, J., del Campo, F. M., Martínez-Ramírez, H. R., Cortés-Sanabria, L., Rojas-Campos, E., Cueto-Manzano, A. M. Peritoneal Dialysis International. 2005: 25(2):173-80.	28 CAPD patients were allocated to a study (n = 13) or a control (n = 15) group. Both groups received conventional nutritional counseling; the study group received, additionally, an oral egg albumin-based supplement. During a 6-month follow-up, all patients had monthly clinical and biochemical evaluations and quarterly assessments of the adequacy of dialysis and nutrition. Serum albumin levels were not different between groups; however, a significant increase (baseline vs. final) was observed in the study group (2.64+/-0.35 vs. 3.05+/-0.72 g/dL) but not in the control group (2.66+/-0.56 vs. 2.80+/-0.54 mg/dL). Calorie and protein intake increased more in the study group (calories 1331+/-432 vs. 1872+/-698 kcal; proteins 1.0+/-0.3 vs. 1.7+/-0.7 g/kg) than in the control group (calories 1423+/-410 vs. 1567+/-381 kcal; proteins 1.0+/-0.4 vs. 1.0+/-0.3 g/kg). Similarly, the non-protein nitrogen appearance rate (nPNA) increased significantly more in the study (1.00+/-0.23 vs. 1.18+/-0.35 g/kg/day) than in the control group (0.91+/-0.11 vs. 0.97+/-0.14 g/kg/ day). Triceps skinfold thickness (TSF) and mid-arm muscle area (MAMA) displayed a non-significant trend to a greater increase in the study group (TSF 16.7+/-8.7 vs. 18.3+/-10.7 mm; MAMA 23.8+/-6.2 vs. 25.8+/-5.9 cm^2) than in controls (TSF 16.4+/-5.7 vs. 16.9+/-7.0 mm; MAMA 28.7+/-7.8 vs. 30.0+/-7.9 cm^2). At the end of the follow-up, the frequency of patients with moderate or severe malnutrition decreased by 6% in the control group and decreased by 28% in the study group.
Usamah, A., Mushahar, Govin, S. M., Lim, Y., and Leow, C. W. Kidney International Reports 2019: 4, S1–S437	38 individuals were randomized into 2 groups. Group 1 (n=19) received nutritional counseling and oral collagen peptides supplement, while Group 2(n=19) received nutritional counseling only. Nutritional assessments were performed at 0 and 8 weeks using diet records and biochemical and anthropometric measurements: mid-arm muscle circumference (MAMC) and triceps skinfold thickness (TST). There was no significant difference in demographic data, biochemical, or anthropometric measurements between the 2 groups at baseline. At the end of the study period, protein intake had increased from 0.8 to 1.0 g/kg/day (p=0.05) and 0.8 to 0.9 g/kg/day (p=0.02) in Groups 1 and 2, respectively. There was no significant difference in calorie intake between both groups. Serum urea significantly increased in Group 1 from baseline (12.9 to 15.7 mmol/L, p=0.003) vs. Group 2 (12.2 to 12.4 mmol/L, p=0.81). Serum creatinine increased in Group 1 but not Group 2 (p=NS). No significant difference was seen in kt/v in both groups. Serum phosphate had declined from baseline in Group 1 (1.44 to 1.28 mmol/L, p=0.16) but increased in Group 2 (1.49 to 1.56 mmol/l, p=0.06). In Group 2, the increased serum phosphate correlates with their higher phosphate intake (p=0.03). There was no significant improvement in serum albumin levels in both groups. In Group 1, there was an increase in MAMC (27 to 28cm, p=0.29) and TST (12.8 to 14.5mm, p=0.44). However, in Group 2, there was a decline in MAMC (27 to 26.4cm, p=0.25) and TST (16.0 to 14.0 mm, p=1.0)
Hiroshige K, Sonta T, Suda T, Kanegae K, Ohtani A. 2001. Nephrology Dialysis Transplant 2001: 16(9):1856-62	44 elderly (age >70 years) patients on chronic HD and 28 patients with low plasma albumin concentration (<3.5 g/dL) were classified as the malnourished group; they also suffered from anorexia. The other 16 patients did not complain of anorexia and were classified as the well-nourished group. Fourteen patients each received daily oral BCAA supplementation (12 g/day) or a placebo in random order in a crossover trial for 6 months. Body fat percentage, lean body mass, plasma albumin concentration, dietary protein and caloric intake, and plasma amino acid profiles were monitored. Lower plasma levels of BCAA and lower protein and caloric intakes were found in the malnourished group as compared to the well-nourished group. In BCAA-treated malnourished patients, anorexia and poor oral protein and caloric intake improved within a month concomitant with the improvement in plasma BCAA levels over the values in well-nourished patients. After 6 months of BCAA supplementation, anthropometric indices showed a statistically significant increase, and mean plasma albumin concentration increased from 3.31 g/dL to 3.93 g/dL. After exchanging BCAA for a placebo, spontaneous oral food intake decreased, but the favorable nutritional status persisted for the next 6 months. In 14 patients initially treated with a placebo, no significant changes in nutritional parameters were observed during the first 6 months. However, positive results were obtained by BCAA supplementation during the subsequent 6 months, and mean plasma albumin concentration increased from 3.27 g/dL to 3.81 g/dL.

carnitine are preferred. Protein from egg, whey, BCAA, and collagen can be considered.

A balanced oral nutrition formula is recommended for reduction in overall intake. The recommended guidelines for patients include: total fat ≤ 30% of energy intake, reducing saturated fat (<10% of total energy), monounsaturated fat (≤20% of total energy), polyunsaturated fat (≤10% of total energy), and cholesterol intake (<200 mg/d). Daily carbohydrate intake should reach 45% to 65% total energy and fiber intake ≥20 g/d.[43]

Proteins with neutral flavors are available. These types are used when patients resist commercial preparations with different flavors. Patients prefer routine food without flavor. It could be mixed into food. Micronutrient supplementation should be individualized based on nutrient levels indicated by blood test investigation. Formulas with high in Vitamin A & E should be avoided as they could be toxic.[44]

Vegetable-source protein supplements could be recommended for patients having high phosphorus values (>4.5 mg/dL), as the phosphorus in vegetable protein is less bioavailable. The taste and flavor preferences of the patient should also be considered while planning ONS.

ONS mixing & Administration: ONS should be mixed in lukewarm water for better miscibility. Medications should not be mixed in ONS as they can interfere with nutrient absorption.

Economic constraints of patients: The patients' financial constraints and consent should be considered before planning ONS. Kitchen-based protein-rich snacks could be included in the diet of patients having financial constraints.

Dialysis-associated complications should be efficiently managed by implementing the appropriate nutritional intervention. Dietary modification and suggesting suitable ONS as per guidelines would safeguard patients from malnutrition and provide a better quality of life.

Conflicts of interest: There are no conflicts of interest.

References

1. Bhalla AK, Bhargava V, Meena P. Assessment and management of nutrition in hemodialysis patients. J Renal Nutr Meta 2020;5:83-7.
2. Liu PJ, Guo J, Zhang Y, Wang F, Yu K. Effects of oral nutritional supplements on the nutritional status and inflammatory markers in patients on maintenance dialysis: A systematic review and meta-analysis of randomized clinical trials. Clin Kidney J 2023;16:2271-88.
3. Hamrahian SM, Vilayet S, Herberth J, Fülöp T. Prevention of intradialytic hypotension in hemodialysis patients: Current challenges and future prospects. Int J Nephrol Renovasc Dis 2023;16:173-81.
4. Burrowes JD, Larive B, Cockram DB, Dwyer J, Kusek JW, McLeroy S, *et al*. Effects of dietary intake, appetite, and eating habits on dialysis and non-dialysis treatment days in hemodialysis patients: Cross-sectional results from the HEMO study. J Ren Nutr 2003;13:191-8.
5. Fotiadou E, Georgianos PI, Chourdakis M, Zebekakis PE, Liakopoulos V. Eating during the hemodialysis session: A practice improving nutritional status or a risk factor for intradialytic hypotension and reduced dialysis adequacy?. Nutrients 2020;12:1703.
6. Noce A, Marrone G, Wilson Jones G, Di Lauro M, Pietroboni Zaitseva A, Ramadori L, *et al*. Nutritional approaches for the management of metabolic acidosis in chronic kidney disease. Nutrients 2021;13:2534.
7. Mudunuru SA, Navarrete JE, O'Neill WC. Metabolic alkalosis in hemodialysis patients. J Am Soc Nephrol 2021;32:305.
8. Takahashi A. The pathophysiology of leg cramping during dialysis and the use of carnitine in its treatment. Physiol Rep 2021;9:e15114.
9. Fouque D. Nutritional requirements in maintenance hemodialysis. Adv Ren Replace Ther 2003;10:183-93.
10. Marx W, Kelly J, Marshall S, Nakos S, Campbell K, Itsiopoulos C. The effect of polyphenol-rich interventions on cardiovascular risk factors in haemodialysis: A systematic review and meta-analysis. Nutrients 2017;9:1345.
11. Xie LM, Ge YY, Huang X, Zhang YQ, Li JX. Effects of fermentable dietary fiber supplementation on oxidative and inflammatory status in hemodialysis patients. Int J Clin Exp Med 2015;8:1363-9.
12. Hendriks FK, Smeets JSJ, Broers NJH, van Kranenburg JMX, van der Sande FM, Kooman JP, *et al*. End-stage renal disease patients lose a substantial amount of amino acids during hemodialysis. J Nutr 2020;150:1160-6.
13. Ikizler TA, Burrowes JD, Byham-Gray LD, Campbell KL, Carrero JJ, Chan W, *et al*. KDOQI clinical practice guideline for nutrition in CKD: 2020 update. Am J Kidney Dis 2020;76:S1-S107.
14. Kawate Y, Miyata H. The importance of nutritional intervention by dietitians for hyperphosphatemia in maintained hemodialysis patients. Ren Replace Ther 2017;3.
15. D'Alessandro C, Piccoli, GB, Cupisti A. The "phosphorus pyramid": A visual tool for dietary phosphate management in dialysis and CKD patients. BMC Nephrol 2015;16:9.
16. Khalid MA, Iqbal J, Memon HL, Hanif FM, Butt MOT, Luck NH, *et al*. Dyspepsia amongst end stage renal disease undergoing hemodialysis: Views from a large tertiary care center. J Transl Int Med 2018;6:78-81.
17. Yasuda G, Shibata K, Takizawa T, Ikeda Y, Tokita Y, Umemura S, *et al*. Prevalence of constipation in continuous ambulatory peritoneal dialysis patients and comparison with hemodialysis patients. Am J Kidney Dis 2002;39:1292-9.
18. Alemañy GM. Benefits of physical exercise in patients with chronic kidney disease and hemodialysis: A mini review. UNOAJ 2017;5.
19. Choi E, Yang J, Ji GE, Park MS, Seong Y, Oh SW, *et al*. The effect of probiotic supplementation on systemic inflammation in dialysis patients. Kidney Res Clin Pract 2022;41:89-101.
20. van Vliet S, Skinner SK, Beals JW, Pagni BA, Fang HY, Ulanov AV, *et al*. Dysregulated handling of dietary protein and muscle protein synthesis after mixed-meal ingestion in maintenance hemodialysis patients. Kidney Int Rep 2018;3:1403-15.
21. Singh V. Combating protein energy wasting in end stage kidney disease: Role of exogenous proteolytic enzyme as an adjuvant to dietary protein. Int J Basic Clin Pharmacol 2019;8:1424.
22. Ashby DR, Ford HE, Wynne KJ, Wren AM, Murphy KG, Busbridge M, *et al*. Sustained appetite improvement in malnourished dialysis patients by daily ghrelin treatment. Kidney Int 2009;76:199-206.
23. Gebrie MH, Ford J. Depressive symptoms and dietary non-adherence among end stage renal disease patients undergoing hemodialysis therapy: Systematic review. BMC Nephrol 2019;20:429.
24. Caglar K, Fedje L, Dimmitt R, Hakim RM, Shyr Y, Ikizler TA. Therapeutic effects of oral nutritional supplementation during hemodialysis. Kidney Int 2002;62:1054-9.
25. Sahathevan S, Karupaiah T, Khor BH, Sadu Singh BK, Mat Daud ZA, Fiaccadori E, *et al*. Muscle status response to oral nutritional supplementation in hemodialysis patients with protein energy wasting: A multi-center randomized, open label-controlled trial. Front Nutr 2021;8:743324.
26. González-Ortiz A, Ramos-Acevedo S, Santiago-Ayala V, Gaytan G, Valencia-Flores M, Correa-Rotter R, *et al*. Sleep quality after intradialytic oral nutrition: A new benefit of this anabolic strategy? A pilot study. Front Nutr 2022;9:882367.
27. Ayala M, Marchant M, Hertz C, Castillo G. Intradialytic nutrition and quality of life in chilean older patients in hemodialysis with protein-energy wasting. Int Urol Nephrol 2022;54:1947-55.
28. Liu PJ, Guo J, Zhang Y, Wang F, Yu K. Effects of oral nutritional supplements on the nutritional status and inflammatory markers in patients on maintenance dialysis: A systematic review and meta-analysis of randomized clinical trials. Clin Kidney J 2023;16:2271-88.
29. Satirapoj B, Apiyangkool T, Thimachai P, Nata N, Supasyndh O. Intradialytic oral nutrition effects on malnourished hemodialysis patients: A randomized trial. Sci Rep 2024;14.
30. Swaminathan S, Vaz M, Kurpad AV. Protein intakes in India. Br J Nutr 2012;108:S50-8.
31. Krefting J. The appeal of pea protein. J Ren Nutr 2017;27:e31-3.

32. Fanti P, Asmis R, Stephenson TJ, Sawaya BP, Franke AA. Positive effect of dietary soy in ESRD patients with systemic inflammation—correlation between blood levels of the soy isoflavones and the acute-phase reactants. Nephrol Dial Transplant 2006;21:2239-46.
33. Sahathevan S, Se CH, Ng S, Khor BH, Chinna K, Goh BL, *et al*. Clinical efficacy and feasibility of whey protein isolates supplementation in malnourished peritoneal dialysis patients: A multicenter, parallel, open-label randomized controlled trial. Clin Nutr ESPEN 2018;25:68-77.
34. Yuvaraj A, Vijayan M, Alex M, Abraham G, Nair S. Effect of high-protein supplemental therapy on subjective global assessment of CKD-5D patients. Hemodial Int 2016;20:56-62.
35. Gharia SV, Ravichandran P, Periasamy S. Can ENZOTEIN (proteolytic enzyme fortified protein supplement) be an effective alternative as low dose protein supplement in malnourished low income end stage renal disease patients? Int J Nephrol Ther 2020;5:18-24.
36. Holeček M. Beta-hydroxy-beta-methylbutyrate supplementation and skeletal muscle in healthy and muscle-wasting conditions. J Cachexia Sarcopenia Muscle 2017;8:529-41.
37. Fitschen PJ, Biruete A, Jeong J, Wilund KR. Efficacy of beta-hydroxy-beta-methylbutyrate supplementation in maintenance hemodialysis patients. Hemodial Int 2017;21:107-16.
38. González-Espinoza L, Gutiérrez-Chávez J, del Campo FM, Martínez-Ramírez HR, Cortés-Sanabria L, Rojas-Campos E, *et al*. Randomized, open label, controlled clinical trial of oral administration of an egg albumin-based protein supplement to patients on continuous ambulatory peritoneal dialysis. Perit Dial Int 2005;25:173-80.
39. Usamah A, Mushahar L, Govin S.M, Lim Y.L, Leow C.W. Sun-082 Effects of oral collagen peptides on nutritional status of peritoneal dialysis patients. Kidney International Reports 2019;4:S188-9.
40. Hiroshige K, Sonta T, Suda T, Kanegae K, Ohtani A. Oral supplementation of branched-chain amino acid improves nutritional status in elderly patients on chronic haemodialysis. Nephrol Dial Transplant 2001;16:1856-62.
41. Bavi Behbahani H, Alipour M, Zare Javid A, Razmi H, Tofighzadeh P, Fayazfar F, *et al*. The association malnutrition-inflammation score with chronic kidney disease-associated pruritus and quality of life in hemodialysis patients: A multicenter cross-sectional study. Sci Rep 2024;14.
42. Kalantar-Zadeh K, Kleiner M, Dunne E, Lee GH, Luft FC. A modified quantitative subjective global assessment of nutrition for dialysis patients. Nephrol Dial Transplant 1999;14:1732-8.
43. Duong TV, Wong TC, Su CT, Chen HH, Chen TW, Chen TH, *et al*. Associations of dietary macronutrients and micronutrients with the traditional and nontraditional risk factors for cardiovascular disease among hemodialysis patients: A clinical cross-sectional study. Medicine (Baltimore) 2018;97:e11306.
44. Wang AY, Elsurer Afsar R, Sussman-Dabach EJ, White JA, MacLaughlin H, Ikizler TA. Vitamin supplement use in patients with CKD: Worth the pill burden?. Am J Kidney Dis 2024;83:370-85.