Rationale

Anorexia has been documented in a very large number of patients on both HD and continuous ambulatory peritoneal dialysis and has been shown to be multifactorial. Most patients entering HD are on protein-restricted diets, which is liberalized after starting on MHD. Indian patients who consume a lower protein may be at a particularly higher risk of developing malnutrition if high-protein diet is not accepted by them. Malnutrition and low serum albumin have been shown in the dialysis population to directly correlate with mortality. As development of malnutrition may be subtle in patients on dialysis who are losing or gaining weight due to fluid shifts, extremely close monitoring by subjective and objective, clinical and biochemical parameters is required to assess nutritional status and avoid hypercatabolism and malnutrition.

Description of board guidelines and tables

**Guideline 1: Prevalence of malnutrition and goals of nutritional intervention**

We recommend that nutritional status be assessed at the start of MHD and then periodically thereafter.

In the absence of malnutrition, we recommend reassessing nutritional status every 2 months in patients <50 years of age and in patients >50 years of age, nutritional status should be monitored every month.

Protein–energy malnutrition (protein–energy wasting [PEW]) is common (18%–70%) among patients on MHD. PEW is one of the strongest predictors of morbidity and mortality, therefore the goals of nutritional therapy in dialysis patients are (i) to prevent malnutrition, (ii) improve nutritional status, (iii) build up body stores for good transplant outcome (if planned), and (iv) improve quality of life.

**Guideline 2: Evaluation of protein-energy nutritional status**

- Measurements that should be performed routinely (every visit, monthly, or three monthly) (Category I)
  - Serum albumin
  - Serum prealbumin (optional)
  - aBW
  - Three monthly
  - SGA
  - Assessment of dietary intake
- Measurements that can be useful to confirm the findings of category I (as and when needed) (Category II)
  - Anthropometric measurements
    - BMI
    - MUAC
  - Skinfold thickness (biceps, triceps, subscapular, and suprailiac)
  - Body composition assessment (optional)
  - Clinically useful measures if low might suggest more rigorous examination of protein energy wasting (Category III)
    - Predialysis serum creatinine
    - Serum cholesterol
    - Protein equivalent of total nitrogen appearance (PNA) (optional)

**Guideline 3: Metabolic acidosis (a must do)**

**Guideline 4: Inflammation**

**Guideline 5: Management of dietary protein and energy intake**

- Eliminate/treat any potentially reversible condition (a must do)
- Anorexia
- Detailed nutrition counseling on patient’s first visit
- Dedicated renal dietician
- DPI
- Intradialytic protein intake
- Dietary energy intake
- Individualize dietary prescription

**Guideline 6: Management and treatment of undernutrition**

- Correct inadequate DPI
- Assess patient’s compliance
- Detect lack of appetite
Therefore, we recommend that the patient should be put on high-protein diet, but the target should be achieved gradually over a period of time (weekly increment) depending on how much the patient can tolerate and digest.

We recommend that the patient should be given high-calorie diet to ensure proper utilization of protein.

**Guideline 2: Evaluation of protein–energy nutritional status**

Nutritional status in MHD patients should be assessed with a combination of valid complementary measures rather than by any single measure alone because no single measure provides a comprehensive indication of nutritional status.

We recommend that these be divided into three categories:

- **Category I:** Measurements that should be performed routinely (every visit, monthly or three monthly)
- **Category II:** Measures that can be useful to confirm the findings of category I (as and when needed) and
- **Category III:** Clinically useful measures if low might suggest more rigorous examination of PEW.

**2a (i) Assessment on every visit**

We suggest using a protocol that should include (a) medical history, (b) physical examination (including deficiency signs on skin), (c) hydration status, and (d) difference between actual weight and dry weight. Malnutrition may be identified with greater sensitivity and specificity using a combination of factors including calculating weight loss <85% of ideal weight. Stabilized serum albumin, percent of usual edema-free post dialysis weight, and dietary diaries (dietician’s role) should be evaluated monthly.

**2a (ii) Serum albumin**

A valid and clinically useful measure of protein–energy nutritional status in MHD patients is recommended for routine measurement as normal albumin values are defined. As the half-life of albumin is ~20 days, predialysis or stabilized serum albumin should be checked monthly and maintained at ≥4.0 g/dL.

**2a (iii) Serum prealbumin (optional)**

Serum prealbumin is a valid and clinically useful measure of protein–energy nutritional status in MHD patients. Its advantage is a much shorter half-life of ~2–3 days. Depending on affordability, we suggest that serum prealbumin can be used as a marker of nutritional status. Prealbumin should be >30 mg/dL.

**2a (iv) Adjusted edema-free body weight**

Body weight should be obtained post dialysis. For individuals whose edema-free body weight is between
95th and 115th percent of the median standard weight, the actual edema-free body weight may be used. The following equation can be used to calculate edema-free adjusted body weight ($aBW_{ef}$):

$$aBW_{ef} = BW_{ct} + SBW - BW_{ct} \times 0.25$$

where $BW_{ct}$ is the actual edema-free body weight and $SBW$ is the standard body weight as determined from the NHANES II data. Because of interdialytic weight gain, $aBW_{ef}$ should be calculated based on postdialysis values.

2a (vi) Subjective global assessment

Subjective global assessment (SGA) is recommended because it gives a comprehensive overview of nutritional intake and body composition including a rough assessment of both muscle and fat mass and because it is correlated with mortality rates. It is recommended that SGA scoring be determined by a 4-item, 7-point scale used in the CANUSA study. SGA score correlates with objective measures (albumin/weight/intake/anthropometry). Change in SGA rating by 1 point decreases relative risk (RR) of death by 25%. A higher SGA score is associated with a lower RR of death and fewer hospitalized days/year (CANUSA study).

We recommend the use of SGA 6 monthly.

Recommendations: Body mass index (BMI) and serum albumin be included in SGA scoring as is done in Malnutrition Inflammation Score. This SGA can be named as SGA-1. For quick assessment of nutritional status, SGA can be used and for detailed and more objective assessment, SGA-1 can be used (which will include i) medical history with BMI; (ii) physical examination; and iii) serum albumin for biochemical test.

2a (vii) Assessment of dietary intake

We recommend that dietary intake assessment should be done using
1. Diet history questionnaires
2. Food weighing and
3. Observation.

Food weighing is difficult for patients who visit dialysis units on an outpatient basis. Assessment of food intake using diet history questionnaires is therefore more appropriate for such patients. Dietary interviews and diaries can be used to assess intake not only of protein and energy but also of other essential nutrients as well as pattern and frequency of meals. Dietary interviews and diaries should be followed once in 3 months.

2b: We suggest that the following measures can be useful to confirm the findings of category I (as and when needed)

2b (i) Anthropometric measurements are valid and clinically useful indicators of protein–energy nutritional status in MHD patients. These measures include percent usual body weight, percent standard body weight, height, BMI, mid-upper arm muscle circumference (MUAC), skinfold thickness (biceps, triceps, subscapular, and suprailliac), and waist/hip ratio. For anthropometric calculations, post dialysis actual edema-free body weight should be used.

2b (ii) BMI: Because height may decrease with aging and mineral bone disorder in MHD patients, we recommend that height should be measured once a year. Skeletal frame size must also be determined to calculate individual’s SBW percent (%SBW).

2b (iii) MUAC should preferably be measured every 3 months.

2b (iv) Skinfold thickness (biceps, triceps, subscapular, and suprailliac) should preferably be measured every 6 months.

2b (v) Body composition assessment (optional): Depending on the availability of the equipment, we suggest that bioelectrical impedance analysis (BIA), infrared reaetion, or (DEXA) dual emission X-ray absorptiometry can be used to assess the adequacy of protein–energy (nutritional) and mineral (BIA and DEXA) status. Measurement can be repeated every 6 months. Whole-body DEXA scan is less influenced by abnormalities in hydration status which are common in HD patients. However it does not distinguish between intracellular and extracellular water compartments and it is not a bed-side tool. Hence, routine use of DEXA is not recommended.

2c Clinically useful measures, if low, might suggest more rigorous examination of protein energy wasting

They are predialysis creatinine, BUN, cholesterol, serum and urine electrolytes, serum and urine urea nitrogen, and serum and visceral protein. A low predialysis or stabilized serum urea level may indicate a low intake of protein and amino acids. Depending on the availability of test facility and reliability and financial affordability, serum and blood cell vitamin levels (folate, B12, and D) and plasma amino acid levels (essential/nonessential and valine/glycine) (optional) are measured.

2c (i) Predialysis serum creatinine

We recommend that low stabilized predialysis creatinine of between 2.0 and 4.5 mg/dL in patients with decreased muscle mass and negligible renal function should be investigated for low dietary protein intake (DPI), metabolic acidosis, inflammation, skeletal muscle wasting (PEW), and risk for high mortality.

A predialysis serum creatinine of >10 mg/dL is barely tolerated by Indian patients and they become highly uremic (anorexia, vomiting, and loss of taste). Therefore, the threshold levels of predialysis serum creatinine for Indian
patients are much lower than those recommended by the NKF/KDOQI (National Kidney foundation/kidney diseases outcome quality initiative) guidelines.

Recommendations for future research: To create threshold for predialysis creatinine for Indian patients for the evaluation of PEW.

2c (ii) Serum cholesterol

We suggest that individuals with low normal <150–180 mg/dL or declining serum cholesterol concentrations should be evaluated for nutritional deficit as they have increased mortality risk. In stable patients, the recommended dietary intake of cholesterol is <200 mg/day.

2c (iii) Protein equivalent of total nitrogen appearance (PNA) (optional)

PCR is a valid and clinically useful measure of net protein degradation and protein intake in MHD patients. In a clinically stable patient, PNA provides a valid estimate of protein intake.

There are a number of technical problems with measuring PNA in individuals undergoing HD. PNA approximates protein intake only when the patient is in zero nitrogen equilibrium. PNA may fluctuate from day to day as a function of protein intake and a single measurement may not reflect usual protein intake. When DPI is high, total nitrogen appearance (TNA) underestimates protein intake. PNA may overestimate DPI when protein intake is <1 g/kg/d possibly due to endogenous protein catabolism. Finally, normalizing PNA to body weight can be misleading in obese, malnourished, and edematous patients.

Guideline 3: Management of acid–base status

Guideline 3a: Measurement of serum bicarbonate

We recommend that serum bicarbonate be measured in MHD patients once in a month. Low serum bicarbonate concentrations in MHD patients indicate metabolic acidosis. Acidemia associated with metabolic acidosis is associated with increased oxidation of branched chain amino acids (valine, leucine, and isoleucine), increased protein degradation (muscle breakdown) and PNA, and decreased albumin synthesis.

Guideline 3b: Treatment of low serum bicarbonate

Predialysis or stabilized serum bicarbonate levels should be maintained at or above 22 mmol/L. Normalization of predialysis or stabilized serum bicarbonate concentrations can be achieved by higher basic anion concentrations in the dialysate and/or by oral supplementation with bicarbonate salts. Higher concentrations of bicarbonate in hemodialysate (38 mmol/L) have been shown to safely increase predialysis serum bicarbonate concentrations. Oral dose of sodium bicarbonate usually about 2–4 g/day or 25–50 mEq/day can be used to increase bicarbonate concentration.

Guideline 4: Inflammation

We suggest that C-reactive protein (CRP) levels should be checked every 3 months. An elevated CRP is often associated with reduced serum albumin levels secondary to impaired albumin synthesis. In this context, hypoalbuminemia is an inflammatory marker, rather than an index of poor dietary intake.

Guideline 5: Management of dietary protein and energy intake

Guideline 5a

We recommend eliminating/treating any potentially reversible or treatable condition (anemia) or medication that might interfere with appetite or cause malnutrition.

Guideline 5b: Anorexia

Major proportion of patients treated with HD consume less protein and energy than is recommended due to loss of appetite. Factors that contribute to anorexia are (i) underdialysis (patients should switch over to thrice-weekly dialysis in the place of twice-weekly dialysis therapy); (ii) comorbidity; (iii) medications such as phosphate binders, iron and calcium preparations (discontinuing phosphate binders and iron and vitamin supplements for a short period of time helps improve appetite); and (iv) psychosocial factors. These factors should be eliminated.

Guideline 5c

We recommend that the dialysis regimen should be regularly monitored and modified/intensified to treat the patient’s uremic state that is caused by superimposed illness. Maintain $Kt/V$ of 1.2 in HD patients.

We suggest that new patients require proper counseling on disease; its causes, etiology, and progression; and importance of nutritional management. Clinician’s personal involvement in nutritional counseling is important for better compliance.

Guideline 5d: Dedicated renal dietician

We suggest that each center should have a dedicated renal dietician who can follow-up the patients. Patients must visit dietician regularly.

We recommend that patients be advised to maintain dietary diaries. The dietician should evaluate nutritional status every month.

Guideline 5e: Dietary protein intake

We recommend that DPI for clinically stable MHD patients should be 1.2 g/kg/bw/day [Table 1]. This amount is necessary to ensure neutral or positive nitrogen balance. At least 50% of protein should be of high biological value, for sources see Boxes 1 and Figure 1. Egg white, an unusually rich source of high biological value protein, has one of the lowest phosphorus protein ratios and is also
devoid of cholesterol. Include two cereals in one meal, for example, rice and wheat to improve protein quality, and the ratio of cereal protein to pulse protein should be 4:1. One gram of protein contains 13–15 mg phosphate. Foods with low phosphorus-to-protein ratio should be preferred. The bioavailability of phosphorus from plant-derived food is relatively low, usually <50%, and that from animal protein is 80%, therefore plant protein should be preferred.

**Guideline 5f: Intradialytic protein intake**

We suggest that patients with stable BP should be advised to eat high-protein food (high-protein snack/chenna/curd/egg whites/protein biscuits, etc.) during dialysis to prevent protein catabolism and to make up for losses due to dialysis procedure. Protein snacks should be taken any time after half an hour of initiation of dialysis.

**Guideline 5g: Dietary energy intake**

Recommended energy intake for MHD patients is 35 kcal/kg/bw if the patient is <60 years of age and 30 kcal/kg bw if the patient is more than 60 year. Recommendations for children are based recommended daily allowance RDA for chronological age [Table 2] It is recommended that 50%–60% of total calories should come from carbohydrate, 30% of total calories should come from fat (saturated fats <7%), and 20% of total calories should come from protein. Energy intake of patients having diabetes mellitus should be 25–30 kcal/kg/day. Blood sugar levels should be monitored to avoid hyperglycemia. The National Institute of Nutrition (NIN 2010) recommends combination of either rice bran oil/groundnut + oil mustard oil or rice bran oil/groundnut + soyabean or rice bran oil/groundnut + sunflower or safflower for cooking. However, any safe refined oil can be consumed by the patients. Refer to Table 3 for composition and use of cooking oils.

**Guideline 5h: Individualize dietary prescription**

Renal diet has numerous restrictions, therefore, adherence to such a diet can be difficult and stressful. We suggest that prescribed diets should be individualized to help accommodate each patient’s unique circumstances in terms of palatability, cost, comorbid medical conditions, and cultural eating habits.

**Guideline 6: Management and treatment of undernutrition**

**Guideline 6a**

We recommend the following measures to correct inadequate DPI: Patients who do not have adequate DPI should first receive dietary counseling and education. If DPI remains inadequate oral supplementation should be prescribed. If oral supplements are not tolerated or effective and protein malnutrition is present, consider tube feeding to increase protein intake. If with tube feeding, the target is not achieved, parenteral nutrition (amino acid infusion) should be initiated either during dialysis session or otherwise keeping in mind hydration status (volume overload). For specific approach to management of undernutrition/malnutrition refer to Box 1.

**Guideline 6b**

We suggest that assessment of patient compliance to dietary prescription and nutritional intervention should be done on every visit. Patients who do not have adequate dietary intake should first receive dietary counseling and education.

**Guideline 6c: Detect lack of appetite**

Appetite assessment tools are a valid and clinically useful measure of estimating nutritional intake. It is recommended...
to use one or more of these tools. We recommend the use of the SGA for assessing intake.

**Guideline 6d: Indications of nutritional support**

We recommend that patients who are unable to meet protein/energy requirements with food for an extended period of time should receive nutrition support. Extended period is defined as days to 2 weeks depending on the severity of patient’s clinical condition, degree of malnutrition, and degree of inadequacy of their nutritional intake. Complete nutritional assessment is needed before intervention.

**(i)** Protein Supplementation: We recommend that in dialysis patients if DPI remains inadequate renal specific oral nutritional supplementation should be prescribed.

**(ii)** Oral Supplements: (1). Special calorie dense commercial formulas provide 2 kcal/ml with high protein and low electrolytes. In dialysis patients, alpha keto-analogs (optional) may improve protein utilization and reduce degree of catabolism. We suggest that in case of children, supplemental nutritional support should be considered when a patient is not growing normally or fails to consume the RDA for protein and/or energy. Supplementation by oral route is preferred followed by enteral tube feeding.

**(iii)** Nasogastric feeding: We suggest that if oral supplements are not tolerated or effective and malnutrition is present tube feeding should be considered as it provides balanced nutrients.

With tube feeding, overnight enteral supplements can improve nutritional status. Tube feeding provides smaller water load than IV feeds, lowers risk of infection than TPN, and it is less expensive.

**Recommendations for tube feeding:**

1. Start with 50–100 ml feeds every 6 h and gradually increase to 300–400 ml per feeding.
2. If continuous feedings are started, then start feeding 20–50 ml/h, and increase 20 ml every 2–8 h until requirement is reached.

**(iv)** Indications for intradialytic parenteral nutrition (IDPN): We suggest that if tube feedings are not used then IDPN should be considered. In any case, IDPN should be given if spontaneous intake of energy is >20 and <25 kcal/kgIBW and if protein is > 0.8 g but < 1 g/kgIBW.

We suggest considering regular use of IDPN during HD or sustained low-efficiency dialysis (SLED) in anuric or oliguric patients as, because of fluid restriction, IV nutrition cannot be used aggressively. An equiloluminous degree of UF should be added to regular UF rate to maintain fluid balance. Minerals include sodium, potassium, and magnesium in the IDPN/TPN solution as per patient’s requirement.

**(v)** Indications for total parenteral nutrition (TPN): We suggest that if combination of oral and IDPN is insufficient, then TPN should be considered.

We recommend that TPN should be given if spontaneous intake is <20 kcal/kgIBW and < 0.8 g protein/kgIBW.

**Guideline 6e: Monitoring side effects of parenteral nutrition**

It is recommended to monitor side effects of parenteral nutrition. 15%–25% of the patients may get nausea and vomiting when IDPN is initiated. In such cases, (1) decrease infusion rate, (2) reduce total IDPN by half for 1–2 weeks. Intradialytic cramping may occur in rare cases. It is recommended that 1 g NaCl/250 mL of infusion should be added to IDPN. (3) Glucose metabolism should be checked. (4) Prevent hyperglycemia (>300 mg/dL) by administering 2–6 units short-acting insulin.

**Guideline 7 Electrolytes**

**Guideline 7a: Sodium**

It is recommended that patients on HD should restrict sodium intake to <2.0 g/day. Patients with limited residual renal function and uncontrolled HTN should restrict its use to 1.5 g/day. Restrict foods with high salt content (papadams, pickles, chutney, and sauce), dry fruits, popcorns, and coconut water in patients with uncontrolled BP [Box 3].

**Guideline 7b: Potassium**

Potassium intake for a patient on HD should be <1 mEq/kg/bw/d.

We suggest that patients should be advised to leach potassium from green vegetables. Fruit juices and vegetable soup should be avoided. Patients on HD should be allowed to take fruits with low potassium content (<100 mg/100 g). Recommended fruits are apple, banana, pineapple, pear, guava, and papaya (approximately 50–60 g/day). Patients should avoid green leafy vegetables and vegetables with very high (>300 mg/g) potassium content. Diabetic patients should avoid banana in order to regulate energy intake [Box 4].

We recommend that anuric patients on HD should have stricter control of potassium and advised to stop fruit intake if serum potassium level approaches 4.9 mEq. Potassium binders should be prescribed to correct hyperkalemia [refer to food pyramid for patients on hemodialysis Figure 2.

**Guideline 8: Fluid restriction and controlling thirst**

Recommended fluid intake for HD patients is 24 h urine output + 500 ml for insensible losses.

We suggest education of patients that fluid includes all liquids for example water, tea, milk, and curd consumed by the patient. Rinsing mouth whenever patient feels thirsty may bring down fluid intake.
Guideline 9: Monitoring serum calcium and serum phosphate levels (to prevent hyperphosphatemia)

- Despite dietary counseling and treatment with phosphate-binding agents, adequate phosphate control is not achieved in many dialysis patients. This can be due to noncompliance or intake of food with high phosphorous: protein ratio. Use of food additives increase phosphorus content of food by as much as 80%, therefore, foods with phosphorus as additive should be avoided.
- We recommend restricting dietary phosphorus to 800–1000 mg/day. Box 2 addresses the management of hyperphosphatemia. We suggest that phosphorus pyramid can be used for choosing foods with low phosphorus content [Figure 3].

Guideline 10: Minerals and vitamins

Recommended daily dietary intake of minerals and vitamins is given in Table 4.

Zinc supplements are recommended for patients having proteinuria.

In children, 100% of the recommended dietary allowance is a reasonable starting point for water soluble vitamin (thiamine, pyridoxine B₁₂, and folic acid) requirement in children on MHD. Nutritional status of water-soluble vitamins be monitored. Supplementation should be considered if dietary intake alone does not meet or exceed the RDA, if measured blood vitamin levels are below normal values (monitor 4–6 months), or if clinical evidence of deficiency is present (low folic acid or Vitamin B₁₂ levels giving rise poor responsiveness to recombinant human erythropoetin). An intake of 100% of RDA should be the goal for Vitamins A, C, E, K, zinc, and copper. Supplements of fat-soluble vitamins should be avoided due to reduced renal clearance. Vitamin K supplementation may be considered during antibiotic therapy [Box 5].

Guideline 11: Monitoring lipids

We recommend a therapeutic goal should be to achieve a low-density lipoprotein cholesterol of <100 mg/dL and a fasting triglyceride level of <150 mg/dL. Therapeutic lifestyle changes diet, weight reduction, increased physical activity and treatment of hyperglycemia if present.

We recommend that diet should contain < 7% saturated fats, with polyunsaturated fat <10% of total calories and monounsaturated fat <20% of total calories and with total fat at 20%–30% of total calories. Carbohydrates should not exceed 60% of total calories.

We recommend that in HD patients, 20–30 g of fiber per day should be consumed to reduce dyslipidemia. If required drug therapy should be started.

Guideline 12: Protein intake during acute illness

- We recommend that acutely ill patients on HD should receive at least 1.2–1.3 g/kg/day depending on catabolic rate. WE recommend a reference to Table 5 for nutritional management of AKI.
- We recommend that patients who have not eaten for more than 5 days should have nutrition support introduced at no more than 20 kcal/kg/24 h initially to avoid refeeding syndrome. For patients at risk of developing refeeding syndrome, start nutrition support at ≤10 kcal/kg/day, increase levels slowly to meet full requirements by day 4 to 7. Avoid overfeeding patients with raised or increasing inotropic requirements. Table 6 shows NICE (2006) criteria for determining which patients are at high risk of developing refeeding problems.

We recommend that nutritional support should be initiated within 24–48 h of hospitalization or as soon as the patient becomes hemodynamically stable to correct deficits.

Guideline 13: Energy intake during acute illness

Recommended energy intake for a maintenance dialysis patient who is acutely ill is at least 35 kcal/kg/day for those who are below 60 years and 30–35 kcal/day for those above 60 years of age. In diabetic patients, blood sugar levels should be monitored to avoid hyperglycemia.

Guideline 14: Role of dialysis nurse

- Hemodialysis nurses play an important role in educating patients who come to the dialysis unit for the first time.
- We suggest that a nurse should talk to their patients about their health condition, dialysis procedure and importance of intradialytic nutritional intake. The nurse should advise patients on interdialytic weight gain to avoid volume overload. The nurse should be well versed with general information on patient’s protein and energy intake.

Guideline 15: Prevention of hypoglycemia in diabetic patients [Box 6]

We recommend that patients who are at risk of going into hypoglycemia should be prescribed 30–35 kcal/kg/day of energy intake. Advise small but frequent meals. Patients should not skip meals or snacks. Advise slow energy-releasing foods for late night snack (corn flour-based foods).

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Box 2: Management of hyperphosphatemia

A simple and effective approach toward reducing the dietary phosphorus intake without affecting adequate protein intake consists of avoiding foods which are high in phosphorous or foods that contain phosphorus additives.

Preferring foods with lower phosphorus-to-protein ratio, and boiling as the preferred initial cooking method.

Avoid dry fruits, cola beverages, enhanced or restructured meats, frozen meals, cereals, snack bars, processed cheese, instant products, and refrigerated bakery products.
preparation). Advise patient to take two biscuits or one slice of bread when he wakes up in the night to prevent early morning hypoglycemic episode. Advise whole fruits as they contain fiber such as apples, guava, pears, berries, and grapes and unsweetened canned fruits. Whole grain cereal, whole wheat bread, pasta brown rice, sprouted pulses, and legumes can be prescribed which should be taken with phosphate binder to prevent hyperphosphatemia. Advise whole grain starches and foods with moderate glycemic index instead of low glycemic index foods.

### Table 1: Protein requirement and dietary allowance for Indian infants, boys, girls, and adults on hemodialysis

| Age group          | Requirement (g/protein/kg/day)* | Body weight (kg) | For HD patients’ total daily requirement (g protein/day + 0.4 g/kg/day and + 0.2 for adults) | Requirement (g protein/day) | Body weight (kg) | For HD patients’ total daily requirement (g protein/day + 0.4 g/kg/day and + 0.2 g/kg for adults) |
|--------------------|---------------------------------|------------------|---------------------------------------------------------------------------------------------|-----------------------------|------------------|---------------------------------------------------------------------------------------------|
| Infants (1-5 months) | 2.2                             | 5.0              | 11.0                                                                                        | 1.47                        | 9.6               | 17.9                                                                                        |
| Infants (6-9 months) | 1.69                            | 7.9              | 16.5                                                                                        | 1.69                        | 8.8               | 18.39                                                                                       |
| 1-2 years          | 1.47                            | 10.3             | 19.26                                                                                       | 1.47                        | 9.6               | 17.9                                                                                        |
| 2-3 years          | 1.25                            | 12.8             | 21.1                                                                                        | 1.25                        | 12.1              | 19.9                                                                                        |
| 3-4 years          | 1.16                            | 14.8             | 23.0                                                                                        | 1.16                        | 14.5              | 22.6                                                                                        |
| 4-5 years          | 1.11                            | 16.5             | 24.9                                                                                        | 1.11                        | 16.0              | 24.1                                                                                        |
| 5-6 years          | 1.09                            | 18.7             | 27.8                                                                                        | 1.09                        | 17.7              | 26.3                                                                                        |
| 6-7 years          | 1.15                            | 20.4             | 31.62                                                                                      | 1.15                        | 20.0              | 31.0                                                                                        |
| 7-8 years          | 1.17                            | 22.7             | 35.6                                                                                        | 1.17                        | 22.3              | 35.0                                                                                        |
| 8-9 years          | 1.18                            | 25.2             | 39.8                                                                                        | 1.18                        | 25.0              | 39.5                                                                                        |
| 9-10 years         | 1.18                            | 28.0             | 44.2                                                                                        | 1.18                        | 27.6              | 43.6                                                                                        |
| 10-11 years        | 1.18                            | 30.8             | 48.6                                                                                        | 1.18                        | 31.2              | 49.2                                                                                        |
| 11-12 years        | 1.16                            | 34.1             | 53.1                                                                                        | 1.15                        | 34.8              | 53.9                                                                                        |
| 12-13 years        | 1.15                            | 38.0             | 58.9                                                                                        | 1.14                        | 39.0              | 54.6                                                                                        |
| 13-14 years        | 1.15                            | 43.3             | 67.1                                                                                        | 1.13                        | 43.4              | 66.4                                                                                        |
| 14-15 years        | 1.14                            | 48.0             | 73.9                                                                                        | 1.12                        | 47.1              | 71.5                                                                                        |
| 15-16 years        | 1.13                            | 51.5             | 78.7                                                                                        | 1.09                        | 49.4              | 73.6                                                                                        |
| 16-17 years        | 1.12                            | 54.3             | 82.5                                                                                        | 1.07                        | 51.3              | 75.4                                                                                        |
| 17-18 years        | 1.10                            | 56.5             | 84.75                                                                                      | 1.06                        | 52.8              | 75.9                                                                                        |
| Adult male         | 1.0                             | 60               | 72                                                                                          |                             |                   |                                                                                             |
| Adult female       | 1.0                             | 55               | 66                                                                                          |                             |                   |                                                                                             |

*Values are based on Indian Council of Medical Research-published Indian standards. In terms of mixed Indian vegetarian diet, protein digestibility corrected amino acid score varies from 77.4% to 79.0% for different age groups. In children, protein loss is inversely proportional to age. Hence, protein requirement/day + 0.4/kg/day = 0.4 is the increment to achieve positive nitrogen balance.

### Table 2: Energy requirement and dietary allowance for Indian infants, boys, girls, and adults on hemodialysis

| Age group          | Energy (kcal/kg/day) | Body weight (kg) | HD patients’ total daily requirement kcal/kg/day | Energy (kcal/kg/day) | Body weight (kg) | HD patients’ total daily requirement kcal/kg/day |
|--------------------|----------------------|------------------|-----------------------------------------------|----------------------|------------------|-----------------------------------------------|
| Infants (0-1 month) | 115                  | 4.58             | 526                                           |                      |                   |                                               |
| Infants (2 months) | 105                  | 5.50             | 577                                           |                      |                   |                                               |
| Infants (3 months) | 95                   | 6.28             | 596                                           |                      |                   |                                               |
| Infants (6-9 months) | 80                   | 7.9              | 632                                           |                      |                   |                                               |
| Infants (9-12 months) | 80                   | 8.8              | 704                                           |                      |                   |                                               |
| 1-2 years          | 85                   | 10.3             | 875.5                                         | 80                   | 9.6              | 768                                           |
| 2-3 years          | 85                   | 12.8             | 1088                                          | 80                   | 12.1             | 968                                           |
| 3-4 years          | 80                   | 14.8             | 1184                                          | 75                   | 14.5             | 1087                                          |
| 4-5 years          | 80                   | 16.5             | 1320                                          | 75                   | 16.0             | 1200                                          |
| 5-6 years          | 80                   | 18.7             | 1496                                          | 75                   | 17.7             | 1327                                          |
| 6-7 years          | 75                   | 20.4             | 1530                                          | 70                   | 20.0             | 1400                                          |
| 7-8 years          | 70                   | 22.7             | 1589                                          | 70                   | 22.3             | 1561                                          |

*Contd...*
Table 2: Contd....

| Age group | Energy kcal/kg/day | Body weight (kg) | HD patients’ total daily requirement kcal/kg/day | Energy kcal/kg/day | Body weight (kg) | HD patients’ total daily requirement energy kcal/kg/day |
|-----------|--------------------|------------------|-----------------------------------------------|-------------------|------------------|-----------------------------------------------------|
| Age       | Boys               | Girls            |                                               |                   |                  |                                                     |
| 8-9 years | 70                 | 25.2             | 1764                                          | 65                | 25.0             | 1625                                               |
| 9-10 years| 70                 | 28.0             | 1960                                          | 65                | 27.6             | 1794                                               |
| 10-11 years| 65               | 30.8             | 2002                                          | 60                | 31.2             | 1872                                               |
| 11-12 years| 65              | 34.1             | 2216                                          | 60                | 34.8             | 2088                                               |
| 12-13 years| 60               | 38.0             | 2280                                          | 55                | 39.0             | 2145                                               |
| 13-14 years| 60               | 43.3             | 2598                                          | 50                | 43.4             | 2170                                               |
| 14-15 years| 60               | 48.0             | 2880                                          | 50                | 47.1             | 2355                                               |
| 15-16 years| 55               | 51.5             | 2832                                          | 50                | 49.4             | 2470                                               |
| 16-17 years| 55               | 54.3             | 2986                                          | 45                | 51.3             | 2308                                               |
| 17-18 years| 55               | 56.5             | 3107                                          | 45                | 52.8             | 2376                                               |

Adults: <60 years=35 kcal/kg bw/day >60 years=30 kcal/kg bw/day because of sedentary lifestyle

| Age group | Energy kcal/kg/day | Body weight (kg) | HD patients’ total daily requirement kcal/kg/day | Energy kcal/kg/day | Body weight (kg) | HD patients’ total daily requirement energy kcal/kg/day |
|-----------|--------------------|------------------|-----------------------------------------------|-------------------|------------------|-----------------------------------------------------|
| Infants (0-1 month) | 115 | 4.58             | 526                                          |                   |                  |                                                     |
| Infants (2 months) | 105 | 5.50             | 577                                          |                   |                  |                                                     |
| Infants (3 months) | 95  | 6.28             | 596                                          |                   |                  |                                                     |
| Infants (6-9 months) | 80  | 7.9              | 632                                          |                   |                  |                                                     |
| Infants (9-12 months) | 80  | 8.8              | 704                                          |                   |                  |                                                     |

Age group | Boys | Girls |
|---------|------|-------|
| 1-2 years | 85 | 10.3 | 875.5 | 80 | 9.6 | 768 |
| 2-3 years | 85 | 12.8 | 1088 | 80 | 12.1 | 968 |
| 3-4 years | 80 | 14.8 | 1184 | 75 | 14.5 | 1087 |
| 4-5 years | 80 | 16.5 | 1320 | 75 | 16.0 | 1200 |
| 5-6 years | 80 | 18.7 | 1496 | 75 | 17.7 | 1327 |
| 6-7 years | 75 | 20.4 | 1530 | 70 | 20.0 | 1400 |
| 7-8 years | 70 | 22.7 | 1589 | 70 | 22.3 | 1561 |
| 8-9 years | 70 | 25.2 | 1764 | 65 | 25.0 | 1625 |
| 9-10 years | 70 | 28.0 | 1960 | 65 | 27.6 | 1794 |
| 10-11 years | 65 | 30.8 | 2002 | 60 | 31.2 | 1872 |
| 11-12 years | 65 | 34.1 | 2216 | 60 | 34.8 | 2088 |
| 12-13 years | 60 | 38.0 | 2280 | 55 | 39.0 | 2145 |
| 13-14 years | 60 | 43.3 | 2598 | 50 | 43.4 | 2170 |
| 14-15 years | 60 | 48.0 | 2880 | 50 | 47.1 | 2355 |
| 15-16 years | 55 | 51.5 | 2832 | 50 | 49.4 | 2470 |
| 16-17 years | 55 | 54.3 | 2986 | 45 | 51.3 | 2308 |
| 17-18 years | 55 | 56.5 | 3107 | 45 | 52.8 | 2376 |

Adults: <60 years=35 kcal/kg bw/day >60 years=30 kcal/kg bw/day because of sedentary lifestyle

Table 3: Composition of cooking oils and their uses

| Type of oil or fat | Saturated | Monounsaturated (%) | Polyunsaturated | Smoke point | Uses |
|-------------------|-----------|---------------------|-----------------|-------------|------|
| Butter            | 66        | 30                  | 4               | 150°C (302°F) | Cooking, baking, condiment, sauces, flavoring |
| Ghee, clarified butter | 65       | 32                  | 3               | 190-250°C (374-482°F) | Deep frying, cooking, sautéing, condiment, flavoring |
| Canola oil        | 6         | 62                  | 32              | 204°C (399°F) | Frying, baking, salad dressings |
| Coconut oil, (virgin) | 92       | 6                   | 2               | 177°C (351°F) | Commercial baked goods, candy and sweets, whipped toppings, nondairy coffee creamers, shortening |

Contd...
### Table 3: Contd...

| Type of oil or fat     | Saturated | Monounsaturated (%) | Polyunsaturated | Smoke point       | Uses                                                                 |
|------------------------|-----------|---------------------|------------------|-------------------|----------------------------------------------------------------------|
| Rice bran oil          | 20        | 47                  | 33               | 254°C (489°F)     | Cooking, frying, deep frying, salads, dressings. Very clean flavored and palatable |
| Mustard oil            | 13        | 60                  | 21               | 254°C (489°F)     | Cooking, frying, deep frying, salads, dressings. Very clean flavored and palatable |
| Margarine, soft        | 20        | 47                  | 33               | 150-160°C (302-320°F) | Cooking, baking, condiment                                          |
| Olive oil (extra virgin) | 14      | 73                  | 11               | 190°C (374°F)     | Cooking, salad oils, margarine                                       |
| Olive oil (virgin)     | 14        | 73                  | 11               | 215°C (419°F)     | Sauté, stir frying, deep frying, cooking, salad oils, margarine      |
| Olive oil (refined)    | 14        | 73                  | 11               | 225°C (437°F)     | Sauté, stir frying, deep frying, cooking, salad oils, margarine      |
| Olive oil (extra light) | 14      | 73                  | 11               | 242°C (468°F)     | Sauté, stir frying, deep frying, cooking, salad oils, margarine      |
| Peanut oil             | 18        | 49                  | 33               | 231°C (448°F)     | Frying, cooking, salad oils, margarine                                |
| Safflower oil          | 10        | 13                  | 77               | 265°C (509°F)     | Cooking, salad dressings, margarine                                  |
| Soybean oil            | 15        | 24                  | 61               | 241°C (466°F)     | Cooking, salad dressings, vegetable oil, margarine, shortening       |
| Sunflower oil (linoleic) | 11     | 20                  | 69               | 246°C (475°F)     | Cooking, salad dressings, margarine                                  |
| Sunflower oil (high oleic) | 9       | 82                  | 9                | 160°C (320°F)     | Cooking                                                               |

### Table 4: Recommended daily dietary intake of minerals and vitamins for patients on maintenance hemodialysis

| Nutrients                | RDA                                      |
|--------------------------|------------------------------------------|
| Sodium                   | <2 (g)                                   |
| Potassium                | 2.0 (mmol)                               |
| Calcium                  | 2000 mg (total elemental calcium provided by phosphate binders should not exceed 1500 [mg/day]) |
| Phosphorus               | 800 mg (serum phosphorus >5.5 mg/dL)     |
| Magnesium                | 0.2-0.3 (g)                              |
| Iron                     |                                          |
| Vitamin A                | None                                     |
| B-carotene               | None                                     |
| Retinol                  | None                                     |
| Thiamine (mg)            | 1.5                                      |
| Riboflavin (mg)          | 1.7                                      |
| Vitamin B₆ (mg)          | 10                                       |
| Vitamin B₁₂ (mg)         | 0.006                                    |
| Niacin (mg)              | 20                                       |
| Folic acid (mg)          | >1.0                                     |
| Pantothenic acid (mg)    | 10                                       |
| Biotin (mg)              | 0.3                                      |
| Vitamin C (mg)           | 60-100                                   |
| Vitamin E (mg)           | None                                     |
| Vitamin D                | In nonuremic patients, 200-400 (IU)      |
| Vitamin K                | 7.5 mg/week deficiency occurs if patient is taking antibiotic |

EAA: Essential amino acid, NEAA: Nonessential amino acid, RDA: Recommended daily dietary intake
Table 5: Nutritional management of acute kidney injury according to the extent of catabolism. Patient classification according to substrate requirement extent of catabolism

| Mild catabolism | Moderate catabolism | Severe catabolism |
|----------------|---------------------|-------------------|
| Excess urea appearance (above nitrogen intake) | <6 (g) | 6-12 (g) | >12 (g) |
| Dialysis/HF | Rarely not require dialysis | As needed | Frequent |
| In all the studies, PCR is 1.5 (g/kg/day) AKI patients on RRT | | | |
| Clinical setting (examples) | Drug toxicity | Elective surgery + infection | Severe injury or sepsis or burns |
| Protein | 0.8 (g/kg/day) | 1.0-1.5 (g/kg/day) | up to 1.7 (g/kg/day) |
| Polyuric phase 0.97-1.3 g/kg bw/day protein leads to a positive nitrogen balance | | | |
| Dialysis/HF | Oral | Enteral/parenteral | Enteral/parenteral |
| Nutrients used (monitor serum triglyceride fat emulsions >400 stop fat emulsion) | Foods: Able to eat | Glucose 50%-70% fat emulsions 10% or 20% IDPN | Glucose 50%-70% + fat emulsions 10% or 20% |
| Energy recommended (kcal/kg/day) not exceed 30 (kcal/kg/day) | 25 | 25-30 | 25-30 |
| Energy substrates | Glucose | Glucose+fat | Glucose+fat |
| Glucose (g/kg/bw/day) | 3.0-5.0 | 3.0-5.0 | 3.0-5.0 (maximum 7.0) |
| Fat (g/kg/bw/day) | 0.6-1.0 | 0.5-1.0 | 0.8-1.5 |
| Amino acids/protein | EAA (NEAA) | 0.8-1.2 EAA NEAA | 1.0-1.5 (g/kg/day) |

PCR: Protein catabolic rate, AKI: Acute kidney injury, RRT: Renal replacement therapy, NEAA: Nonessential amino acid, EAA: Essential amino acid, IDPN: Intradialytic parenteral nutrition, HF: Hemofiltration

Table 6: NICE (2006) criteria for determining which patients are at high risk of developing refeeding problems

| One or more of the following | Two or more of the following |
|-----------------------------|-----------------------------|
| BMI <16 kg/m² | BMI >18.5 kg/m² |
| Unintentional weight loss >15% within the last 3-6 months | Unintentional weight loss >10% within the last 3-6 months |
| Little or no nutritional intake for >10 days | Little or no nutritional intake for >5 days |
| Low levels of potassium, phosphate, or magnesium prior to feeding | History of alcohol abuse, or drugs including chemotherapy |
| BMI: Body mass index |

Figure 2: Food pyramid for Indian hemodialysis patients for adequate nutrition

- Footnotes: Names of foods in the pyramid: Turai: Ridge gourd; Lauki: Bottle gourd; Bhindi: Ladies finger; Tinda: Indian round gourd; Moong Dal: Red Lenti; Chilka: Exocarp Lentil urad: black gram/Bengal gram; Rajma: Kidney beans; Sevai : Vermicelli; Paneer: Cottage cheese; Potato: Leached potato
- Edible oil: Peanut, ricebran, sunflower, safflower, mustard, olive, soy margarine

Figure 3: Phosphorus pyramid

The “phosphorus pyramid”: A visual tool for dietary phosphate management in dialysis and CKD patients

D’Alessandro et al. BMC Nephrology 2015, 16:9 Taken from Open-Access article.
Box 3: CAUTION
Restrict foods with high fat and sodium content in patients with uncontrolled BP:

- High-fat foods: Bakery products such as cake, pastry patties, biscuits, chocolate, deep fried food.
- Coffee can increase BP.
- High sodium content: Baking soda, ajinomotto, eno salt, salted butter, picke, chutney, namkeen mixture, papad, processed cheese, canned foods, popcor.

Box 4: CAUTION
Restrict foods with high potassium content in hyperkalemic patients:

- Green leafy vegetables such as spinach, mustard leaves, bathua, chaulai, kathal (kackfruit) karela (bitter gourd), shalgam (turnip), chukandar (beetroot), sahjan, kamal kakri (lotus stem), gohar phalli (cluster beans), french beans, sem (broa) beans, tomatoes, cauliflower, sweet lime, lemon, gajar (carrot), mooli (raddish), raw salad, mango, awala (Indian gooseberry), mushroom, singhara (water chestnut), dry fruits (almond, cashew, coconut, groundnut, pistachio, walnut etc.), fruit juice, vegetable soup, coconut water, melon, water melon and bhel fruit, bajra, pesarattu, drumsticks, gur (jaggery).

Box 5: CAUTION
Food restrictions for patients on anticoagulants (warfarin and clopidogrel)

- Avoid foods with high Vitamin K such as arhar (tur), channa (horse gram), matar dal (split peas), green peas, dal sprouts, cauli flower, cabbage, green leafy vegetables , tomato, soyabean, soyaben oil, olive oil, papaya, pine apple, guava, mango, raw salad, egg yolk.
- Patients are allowed 1 serving of urad dal and moong dal.

Box 6: CAUTION
Prevent hypoglycemia in diabetic and malnourished patients.

- Advise not to skip meals
- Advise small meals at short intervals. Patients must have regular meal time
- Advise use of slow energy-releasing foods (corn flour) for late-night snack
- Advise whole fruits which contain fiber like apples, pear, guava, berries, grapes and unsweetened canned fruits
- Advise whole grain cereal, whole wheat bread, pasta brown rice, sprouted pulses and legumes along with phosphate binders to maintain serum phosphorus within normal range
- Advise whole grain starches
- Advise foods of moderate glycemic index instead of foods with low glycemic index
- Final insulin dose must take into account exercise and blood glucose levels.