Chapter 4

NUTRIENT PRESCRIPTION

GENERAL INFORMATION

Italicized recommendations are directly from the Clinical Practice Guideline for Nutrition in CKD: Update 2020. While the information here is appropriate for most patients, each patient should be assessed individually and thoroughly. Nutrient recommendations must be based on the findings in the nutrition assessment, clinical expertise, and common sense. Do not restrict the diet above what is necessary to maintain adequate clinical, nutrition, and metabolic status. Individualize recommendations to the patient and incorporate patient goals.

NUTRIENT RECOMMENDATIONS FOR METABOLICALLY STABLE CKD PATIENTS

	CKD (Stages 3-5)		5D: HD/PD
Protein g/kg BW/d	*Non-DM 0.55-0.6 Or 0.28-0.43 + KA to meet above*	*DM 0.6-0.8 Closely monitor*	*Non-DM or DM 1.0-1.2*
Protein Source	*Insufficient evidence to recommend a specific type of protein (animal or vegetable)*		
Energy kcal/kg	*25-35*		*25-35*
Calcium, Total Elemental mg/d	*800-1000 including all sources of Ca^{++} if not on active Vit D analogs; maintain neutral Ca^{++}balance*		*Adjust intake (diet, supplements, binders, dialysate) considering use of Vit D/calcimimetics; avoid hypercalcemia/Ca^{++} overload*
Phosphorus	*Recommend adjusting dietary P intake to maintain serum phosphate levels in the normal range* *Reasonable to consider bioavailability of P sources when applying restriction* *Posttransplantation or in hypophosphatemia to prescribe high phosphate diet and/or supplements to replete*		
Potassium	*CKD 1-5D, posttransplantation: Reasonable to adjust dietary K to maintain normal serum range* *In hyper- or hypokalemia, suggest dietary or supplemental K be based on individual needs/clinical judgment*		
Sodium	*CKD 3-5 and posttransplantation* *<100 mmol/d (<2300 mg/d) for BP, volume control (see page 5-7 for KDIGO BP recommendation)* *Modification/lifestyle strategy for volume control, more desirable BW*		*CKD 3-5 with proteinuria limit Na+ intake to < 100 mmol/d (2300 mg/d) synergistically with available pharmacological interventions*

Reference: Ikizler TA, Burrowes J, Byham-Gray L, et al; KDOQI Nutrition in CKD Guideline Work Group. KDOQI clinical practice guideline for nutrition in CKD: 2020 update. *Am J Kidney Dis.* 2020;76(suppl 1):S1-S107.

MICRONUTRIENT RECOMMENDATIONS

Dietary Intake	*CKD 3-5D, posttransplantation: reasonable to encourage eating a diet that meets RDA for all vitamins and minerals*
Assessment/ Supplementation	*CKD 3-5D, posttransplantation: reasonable to collaborate with MD/extender to assess dietary intake periodically and consider multivitamin supplementation for those with inadequate intake*
Micronutrient Supplements	*CKD 5D for those who exhibit inadequate dietary intake for a sustained time, consider supplementation MVT, including all water-soluble vitamins and essential trace elements*

Nutrient	CKD Stage(s)	Recommendation
Folic Acid	*3-5D, posttransplantation*	*Recommend not routinely supplementing folate to treat homocysteinemia* *Suggest prescribing folate, B_{12}, and/or B-complex to correct folate or B_{12} deficiency/insufficiency based on signs and symptoms*
Vitamin C	1-5D, posttransplantation	*Reasonable to consider supplementation to meet recommended intake of at least 90 mg/d for men and 75 mg/d for women for those who are at risk for Vit C deficiency*
Vitamin D	1-5D, posttransplantation CKD 1-5	*Suggest prescribing Vit D supplement in the form of cholecalciferol or ergocalciferol to correct 25(OH) D insufficiency/deficiency* *With nephrotic range proteinuria: reasonable to supplement as above or with other safe, effective 25(OH)D precursors*
Vitamin A & E	5D on dialysis	*Reasonable not to routinely supplement with A or E because of potential for toxicity; if supplementation is warranted, monitor closely for toxicity*
Vitamin K	1-5D, posttransplantation	*Reasonable to avoid supplementing pts receiving anticoagulant medications (ie, warfarin compounds) known to inhibit Vit K activity*
Selenium & Zinc	1-5D	*Suggest not routinely supplementing selenium or zinc since evidence of improved nutritional, inflammatory, or micronutrient status is lacking*
Bicarbonate Acid Load (NEAP)	3-5D 1-4	*Reasonable to maintain a serum bicarbonate level of 24-26 mmol/L* *Suggest reducing NEAP through increased intake of fruits and vegetables* *Suggest reducing NEAP through increased bicarbonate, citric acid/sodium citrate solution supplementation to reduce the decline of residual kidney function*

DIETARY PATTERNS

Pattern	CKD Stage(s)	Recommendation/Suggestion
Mediterranean diet	*1-4, posttransplantation*	*Suggest prescribing a Mediterranean diet (despite lipid status) for potential improvement in lipid profile*
Fruits and vegetables	*1-4*	*Suggest prescribing increased fruit and vegetable intake for potential weight reduction, control of BP, and reduction of NEAP*

NUTRITIONAL SUPPLEMENTATION

Type of Supplement	*CKD Stage(s)*	*Recommendation/Suggestion*	
Oral protein-energy	*3-5D, posttransplantation*	*For those at risk of PEW, suggest minimum 3-mo trial of oral nutritional supplements if dietary counseling alone does not achieve adequate intake*	*Effort to improve nutritional status*
Enteral nutrition	*3-5D*	*With chronically inadequate intake where protein/energy requirements cannot be reached w/counseling and oral supplements, reasonable to consider enteral tube feeding*	
Total parenteral nutrition (TPN) *Intradialytic parenteral nutrition (IDPN)*	*1-5* *5D (HD)*	*In adults with PEW, suggest a trial of TPN* *In adults with PEW on MHD, suggest trial of IDPN*	*Maintain/improve nutritional status if oral/enteral fail*

NUTRITIONAL SUPPLEMENTATION (cont.)

Type of Supplement	*CKD Stage(s)*	*Recommendation/Suggestion*	
Dialysate	*5D (PD)*	*In adults with PEW, suggest not substituting conventional dextrose dialysate with aa dialysate as general strategy to improve status, but reasonable to consider a trial of aa dialysate to improve/maintain nutritional status if existing oral/enteral therapies cannot meet requirements*	*Applies only to IPAA; no studies reviewed for IPN*
Long chain omega-3 polyunsaturated fatty acids (LC n-3 PUFA)	*5D (HD, PD), posttransplantation* *5D (HD)* *5D (PD)* *3-5* *5D (HD)* *Posttransplantation*	*Suggest not routinely prescribing LC n-3 PUFA to lower mortality or CV events* *Suggest 1.3-4 g/d may be prescribed to reduce TG and LDL CHOL, raise HDL levels* *As above, but to improve lipid profiles* *Suggest prescribing ~2 g/d to lower TG* *Suggest not routinely prescribing fish oil for access patency* *Suggest not routinely using to ↓ rejection/improve graft survival*	*Including those from fish, flaxseed, or other oils*

KETO ACID/AMINO ACID ANALOGS

KAs of EAAs have several potential advantages for those with advanced CKD. Because KAs lack the amino group bound to the α carbon of an aa, they can be converted to their respective aa without additional nitrogen. It is well established that a diet with 0.3-0.4 g of pro/kg/d supplemented with KAs and EAAs reduces the generation of potentially toxic metabolic products, as well as the burden of K, P, and possibly Na^+. Emerging studies suggest that restricted VLPD + KAs may improve kidney function and nutritional status, while preventing hyperparathyroidism, insulin resistance, and accumulation of URS. Interpretation of the literature is hindered by variations in study protocols. The appropriate initiation timing, dose, and composition of the KA/EAA supplement are not fully established. It is prudent to use KA/EAA supplements that have been formulated for CKD. Evidence strongly suggests that LP diet + KA can delay the need for maintenance dialysis therapy, but whether they slow the loss of GFR is less clear, especially with more vigorous BP control/use of ACEis/ARBs. Use of KAs is common in other countries but has previously been hindered by lack of availability in the United States.

Name	Content	Benefits/Indications	Dose/Form	
Ketosteril® Fresenius Kabi India Pvt. Ltd, 100% subsidiary of Fresenius Kabi AG, part of Fresenius Health Care Group, Homburg, Germany	One film-coated tablet contains: Calcium 3-methyl-2-oxovaleric acid (a-KA of isoleucine, Ca-salt) 67 mg Calcium-methyl-2-oxovaleric acid (a-KA of leucine, Ca-salt) 101 mg Calcium-2-oxo-3-phenylpropionic acid (a-KA of phenylalanine, Ca-salt) 86 mg Calcium-3-methyl-2-oxobutyric acid (a-KA of valine, Ca-salt) 68 mg Calcium-DL-2-hydroxy-4-(methylthio)-butyric acid (a-hydroxyanalog of methionine) 59 mg, Ca-salt 105 mg L-Lysine acetate (= L-lysine 75 mg) 53 mg L-Threonine 23 mg L-Tryptophan 38 mg L-Histidine 30 mg L-Tyrosine **Total nitrogen content per tablet: 36 mg** **Calcium per tablet: 1.25 mmol = 0.05 g**	Used as part of conservative tx of those with CKD. Contains aa, partly in form of their corresponding KAs, essential for CKD. Use w/protein-restricted diet pre-dialysis (stages 2, 3, 4) until GFR is 15 mL/min as kidney damage therapy/ prevention Not indicated for pediatrics/pregnancy	Film-coated tablets Dosage/Oral Use: If not otherwise prescribed, dose 4-8 tablets TID during meals. Swallow whole. This dosage applies to adults (70 kg BW) Contraindications: Hyper-calcemia, disturbed aa metabolism, contains phenylalanine if hereditary phenylketonuria Monitor serum Ca^{++} regularly, ensure adequate caloric intake Do not store above 25° C	Products may not be available in all countries (different registration status; approved indications/ contra-indications/ side effects/ warnings/ product features may differ between countries. Use nationally registered/ approved product information. Country-specific regulatory considerations affect information that can be provided

KETO ACID/AMINO ACID ANALOGS (cont.)

Name	Content	Benefits/Indications	Dose/Form	
Ketorena Nephcentric LLC Available to purchase at https://www.ketorena.com/ or by calling 1-844-980-9933. For questions: sales@nephcentric.com Nephcentric LLC was founded by a team of Health Care Professionals including a Board-Certified Nephrologist. Made in the USA, FDA inspected facility	Maltodextrin L-Lysine Acetate Alpha-ketoleucine calcium Alpha-ketovaline calcium Alpha ketoisoleucine calcium Alpha-ketophenylalanine calcium L-Ornithine HCL Natural flavors DL-Alpha-hydroxymethionine calcium L-Threonine L-Histidine L-Tyrosine L-Tryptophan Silica Sucralose No Mg/low in Ca^{++}	Ketorena is a KA analog of essential aa used to maintain or improve nutrition and slow the progression of CKD for those on an LP or very LP diet KAs lack of amino group bound to alpha carbon of an aa allows conversion to their essential aa counterpart without additional nitrogen	Vanilla flavored drink mix. Each dose contains 2100 mg (2.1 g) keto- and aa. Initiate 0.1 g/kg BW/d, usually 1 scoop TID mixed 2-3 oz of water or juice when initiating a LP diet. Individualize maintenance dose based on the level of protein restriction and pt BW. 60 kg pt: 0.1 g × 60 = 6000 mg 1 scoop = 2100 mg 3 scoops = 6300 mg Dose is 1 scoop TID 60 doses per canister	Conversion from 600 mg tablets: 1 scoop replaces 3-4 600 mg tablets Most, but not all tableted KAs contain 600 mg of keto/amino acids per tablet

References: Li A, Lee HY, Lin YC. The effect of ketoanalogues on chronic kidney disease deterioration: a meta-analysis. *Nutrients.* 2019;11(5).
Koppe L, Cassani de Oliveira M, Fouque D. Ketoacid analogues supplementation in chronic kidney disease and future perspectives. *Nutrients.* 2019;11(9).
Ketorena. Consensus Statement of International Keto Analogue Board Meeting (IKABM) on the use of low and very low protein diet supplemented with keto-analogues in CKD. https://www.ketorena.com/Articles.asp?ID=258. Accessed 7/30/2020.

AMINO ACID SUPPLEMENT (IV)

Nephrosteril® is an aa fluid supplement for use in TPN or partial parenteral nutrition or IDPN and is indicated for use in acute, chronic CKD, dialysis, and hemofiltration where aa supplementation is desired. It is not the ketoacid form of aa as described for use with a LP diet.

Name	Content	Benefits/Indications	Dose/Form
Nephrosteril® Fresenius Kabi India Pvt. Ltd, 100% subsidiary of Fresenius Kabi AG Germany, part of Fresenius Health Care Group, Homburg, Germany	per 1000 mL: L-Isoleucine 5.10 g L-Leucine 10.30 g L-Lysine monoacetate 10.01 g = L-Lysine 7.1 g L-Methionine 2.80 g Acetyl cysteine 0.50 g = L-Cysteine 0.37 g L -Phenylalanine 3.80 g L-Threonine 4.80 g L-Tryptophan 1.90 g L-Valine 6.20 g L-Arginine 4.90 g L-Histidine 4.30 g Aminoacetic acid 3.20 g L-Alanine 6.30 g L-Proline 4.30 g L-Serine 4.50 g L-Malic acid 1.50 g Glacial acetic acid 1.38 g Total amino acids: 70 g/L Water for injections q.s. Theor. osmolarity 770 mosm/L	Balanced supply of protein elements for acute/chronic renal insufficiency as well as during PD and HD treatment. 7% aa solution with 60% non-EAA and 40% non-EAA (13% conditionally indispensable, 27% non-essential), no carbohydrates or electrolytes 250 mL and 500 mL in glass bottles for IV infusion Storage: Protected from light and not above 25°C	If not otherwise prescribed up to 0.5 g aa/kg BW/d corresponding to 500 mL/d at 70 kg BW in AKI and CKD without dialysis treatment. Up to 1 g aa/kg BW and day corresponding to 1000 mL/d at 70 kg BW in AKI and CKD with HD, hemofiltration, or PD treatment

Reference: Fresenius Kabi. https://www.fresenius-kabi.com/in/products/nephrosteril. Accessed 7/30/2020

DIALYSIS-SPECIFIC VITAMIN FORMULATIONS

CKD and its treatment (including diet modification) can alter vitamin availability, function, and requirements. While optimal levels and specific effects of individual vitamins are not clear, the Dialysis Outcomes and Practice Patterns Study (DOPPS) cohort study indicates that water-soluble vitamin supplementation has the potential to improve nutritional status and decrease mortality in HD patients. As seen in the Clinical Practice *Guidelines for Nutrition in CKD: 2020 Update, there is insufficient high-quality evidence to recommend specific levels of most vitamins.* Historically, it has been suggested that dialysis patients meet vitamin needs with a daily, kidney-specific vitamin supplement or B-Complex and C.

Most dialysis-specific vitamin formulations are similar, although some may have slight variations in folate, B_6, B_{12}, C, E, or added micronutrients. For several reasons, it was decided to eliminate the list of dialysis-specific vitamins. An individual clinician would be more likely to get exactly the information needed with a specific search or by consulting with manufacturer representatives rather than relying on this resource that may become outdated due to new/discontinued products, changing formulations, provider or physician preferences, individual patient needs, or changes in recommended vitamin/micronutrient needs. Some common names are Dialyvite, Nephro-Vite, RenalTabs.

ESTIMATES OF CALORIES ABSORBED FROM PERITONEAL DIALYSATE

When developing a diet prescription and meal pattern for those on PD, it is important to consider the calories absorbed from dialysate and include those calories in the daily energy target to avoid or minimize weight gain. In early PD studies, the average weight gain reported at the end of 1 yr was 9-10% of the initial weight. While there is interpatient variation, many patients gain weight on PD, a result of the extra dialysate calories. There are several predictive formulas to estimate the dialysate calorie load, and they vary in their complexity and accuracy. The average daily glucose absorption depends on the dextrose concentrations, length of dwell, peritoneal membrane transport rate, and the number of exchanges. **Although formally measuring peritoneal glucose absorption is time consuming and requires patient co-operation, current predictive equations overestimate glucose absorption and do not provide accurate estimations of glucose absorption particularly for APD (Moore et al). Zuo et al found that the formulas underestimated glucose absorption compared to direct measurement. If not using a direct measure of glucose absorbed (measuring glucose in effluent) A simple estimate based on dextrose concentrations, volume, and estimated absorption rates can provide a rough estimate of calories absorbed, but it is imperative that the patient's weight gain or loss is monitored, and dietary calorie intake modified appropriately.**

Predictive Equations:
Grodstein formula (11.3 xa-10.9, where xa is the average glucose concentration of the dialysate used). This formula has several limitations: based on data from only 7 men, cannot be used for APD, and does not consider the peritoneal membrane transport characteristics.

The D/D0 formula (Bodner, et al.) uses the 4-hr D/D0 for CAPD and the cycler dwell time for D/D0 in APD. The PET 4-hr dextrose considers the ratio of remaining dialysate dextrose to the initial dialysate dextrose at zero hours (D/D0). The formula $[(1\text{-}D/D0)x_i]$. where x_i is the initial glucose instilled. should estimate the fraction of glucose absorbed from the dialysis. This formula considers the modality and membrane characteristics and was validated against glucose remaining in 24-hr spent dialysate in 50 CAPD and 17 APD patients.

A direct calculation of glucose absorption can be calculated easily if the glucose concentration in the 24-hr dialysate is measured using the following formula: [G instilled (G_{in}) – measured G_{out} (G_{out}) = G_{abs} g/d].

ESTIMATES OF CALORIES ABSORBED FROM PERITONEAL DIALYSATE (cont.)

For a simple imprecise estimate (based on dextrose concentrations, volume, and an estimated absorption rate (60-70% in CAPD and 30-50% absorption in APD), the following table can be used, understanding that monitoring weight change will enable the daily energy target to be modified to meet the actual needs of the patient as appropriate.

% Dextrose	G Dextrose	G × 3.4 = kcal Available	CAPD kcal Absorbed	CCPD kcal Absorbed
1.5%	15	51	31-36 kcal/L	20-26 kcal/L
2.5%	25	85	51-60 kcal/L	34-43 kcal/L
4.25%	42.5	145	87-102 kcal/L	58-73 kcal/L

This calculation does not consider the membrane characteristics. To estimate total potential calorie load, multiply the number of exchanges times the volume of each exchange in liters times the estimate of calories absorbed. For example: CAPD with four 2-L exchanges of 1.5% dextrose: 4 exchanges × 2 L each exchange × 31 kcal/L = 248 kcal. CCPD with 3 night and 1 daytime 2-L exchanges of 1.5% dextrose: 4 × 2 × 20 kcal/L = 160 kcal.

References: Tangwonglert T, Davenport A. Differences in predicting glucose absorption from peritoneal dialysate comparted to measured absorption in peritoneal dialysis patients treated by CAPD and APD cyclers. *Int J Artif Organs.* 2020;43:461-467.
Law S, Davenport A. Glucose absorption from peritoneal dialysate is associated with a gain in fat mass and a reduction in lean body mass in prevalent PD patients. *Br J Nutr.* 2020;123:1269-1276.
Bodner DM, Busch S, Fuchs J, et al. Estimating glucose absorption in peritoneal dialysis using peritoneal equilibration tests. Adv Perit Dial. 1993:9:114-118.
Moore HL, Prowant BF, Nolph KD, Khanna R. Predictive formulas for energy derived from peritoneal dialysis solutions significantly overestimate daily caloric intake from dialysate compared to caloric intake from measure dialysate glucose in CCPD patients. *Perit Dial Int,* 2007; 27:S22.

ESTIMATES OF CALORIES ABSORBED FROM PERITONEAL DIALYSATE (cont.)

CAPD	# Exch	Exch V	Dextrose Day	Dextrose Overnight	Icodextrin	Kcal
	4	2 L	1.5%	2.5%	0	332
	4	2.5 L	1.5%	2.5%	0	386
	4	3 L	1.5%	2.5%	0	432
	4	2.5 L	1.5%	0	7.5% (night)	187

CCPD	# Exch	Exch V	Last Bag V	Dextrose Night	Dextrose Day	Midday	Icodextrin	Kcal
	3	2 L	2 L	1.5%	2.5%	0	0	299
	3	2.5 L	2.5 L	1.5%	2.5%	0	0	350
	3	3 L	3 L	1.5%	2.5%	0	0	396
	3	2.5 L	2.5 L	1.5%	1.5%	2.5 L	0	342
	3	2.5 L	2.5 L	1.5%	0	0	7.5%	144

Exch, exchanges; V, volume of exchange.

Reference: : Burkhart J. Metabolic consequences of peritoneal dialysis. Semin Dial. 2004;17:498-504.
Additional topical reference: Law S, Davenport A. Glucose absorption from peritoneal dialysate is associated with a gain in fat mass and a reduction in lean body mass in prevalent peritoneal dialysis patients. British Med Journal. 2020;123:1269-1276.

NUTRITION EDUCATION RESOURCES

In previous editions of the Pocket Guide, information from the "National Renal Diet" was included for direction in translating the diet prescription into a meal pattern, food choices, and patient-specific sample menus. Kidney.org continues to have multiple resources for education of those with CKD. The Academy of Nutrition and Dietetics Renal Practice Group, in collaboration with the Council on Renal Nutrition, has created new tools for counseling those with CKD, based on updated guidelines, which are available at www.eatrightstore.org. As part of the new "National Kidney Diet," placemat-sized full color handouts feature sample healthy plates, advice for planning meals, and meal patterns. Food groups include Protein Foods; Breads, Cereals, and Grains; Fruits; Vegetables; Dairy and Milk Alternatives; Fats and Seasonings; Snacks and Sweets; and Fluids. These handouts are titled *Dish Up a Dialysis-Friendly Meal* and *Dish Up a Kidney-Friendly Meal.* Companion pieces will include a Professional Guide and topic-specific downloadable handouts.

COMPOSITION OF COMMON HIGH-FIBER CEREALS*

Cereal	Cup(s)	Pro (g)	Fiber (g)	K^+ (mg)	Ca^{++} (mg)	P^* (mg)	Na^+ (mg)
All Bran Buds, Kellogg's®	1/3	2.6	12.8	266	19	150	202
Bran Flakes, Post®	1	4	7.3	213	17.6	180	216
Cracklin' Oat Bran, Kellogg's®	1	7	6.7	294	43	203	204
Fiber One, General Mills®	1	4	14.2	224	200	120	214
Grape-Nuts, Post®	1/2	6.5	7.5	232	13.5	271	269
Kashi® 7 Whole Grain Flakes	1	5	5.2	178	26.3	121	74
Oat Bran Hot Cereal Quaker/Mothers® DRY	~1/2	7	5.72	232	31.6	278	2
Shredded Wheat-n-Bran, Post®	1 ¼	6.5	8.7	231	26	247	0
Uncle Sam, Toasted WW Berry Flakes with Flaxseed, Original	3/4	9	10	270	40.2	250	140

*Values do not consider digestibility or bioavailability of P or of phosphate additives.

These were chosen from an Internet search of the best high fiber cereals. There are other regional brands that may compare or exceed the nutrient contents of the above. The reference below should allow clinicians to search nutrient composition of other high fiber cereals not listed above.

Reference: USDA national nutrient database for standard reference. Available at: https://fdc.nal.usda.gov/. Accessed 7/30/2020.

COMPOSITION OF MILK, CREAM, AND SUBSTITUTES*

Product	Kcal	CHOL (g)	Pro (g)	Fat (g)	Na^{+} (mg)	K^{+*} (mg)	P^{*} (mg)	Ca^{++} (mg)
Cream substitute, liquid (USDA) (1 Tbsp)	38	5	0.3	2	10	57	19	<1
Cream substitute, powdered (USDA) (1 tsp)	10	1	<1	<1	2.5	14	4.28	0
DariFree™ 3 tsp (makes 8 fl oz)	70	20	0	0	120	50	NA	300
Half & Half, 2 Tbsp	40	1	0.4	3	15	20	28.5	40
Light cream, 1 Tbsp	29	0	0.4	3	10	20.4	13.82	0
Milk, 2% (1 oz)	15	1.5	1	0.6	14	42	28	37
Milk, 1% (1 oz)	13	1.5	1	0.3	13	46	29	38
Milk, non-fat (fat free or skim) (1 oz)	11	1.5	1	0.02	16	51	31	63
Milk, whole (1 oz)	19	1.5	1	1	13	40	25	34
Mocha Mix®, original, 1 Tbsp	20	1.0	0	1.5	5	20	NA	0

*Advise checking labels for K and phosphate additives.

References: Manufacturers' product information when available. The scope (flavors, forms, sweeteners, fats) of non-dairy creamers has expanded exponentially; thus, it is impossible to list them all. The original purpose of this table was to show non-dairy compared to dairy creamers and to allow clinicians to determine if it would be beneficial to recommend something like Mocha Mix/DariFree in place of milk, especially for protein-, P-, and K-restricted diets. When recommending a specific non-dairy creamer, it is prudent to check the manufacturer information for the most recent nutrient analysis.

Coffee mate. https://www.coffeemate.com/products/liquid/original/. Accessed 7/30/2020 (site says see product label for nutrient information).
Rich Products. http://www.richwhip.com. Accessed 7/30/2020.
Plant-based; coffee creamers/beverages. https://www.danonenorthamerica.com/our-business/. Accessed 7/30/2020.
Bay Valley Foods. Creamers. http://www.bayvalleyfoods.com/products/retail/creamers.html. Accessed 7/30/2020.
International Delight. http://www.internationaldelight.com. Accessed 7/30/20. Multiple flavors that likely vary from French vanilla.
DariFree. https://www.fooducate.com/product/DariFree-Original-Flavor-Non-Dairy-Milk-Alternative/04FE5F2A-ABB6-11E2-9B11-1231381A4CEA. Accessed 7/30/2020.

L-CARNITINE SUPPLEMENTATION IN HEMODIALYSIS PATIENTS

Supplementation of L-carnitine for dialysis patients has been controversial due to small studies, contradictory study results, and lack of long-term randomized studies of benefits and outcomes. Carnitine is considered safe, and the existing literature does not refute its use, but individual patient results vary greatly. Studies continue to confirm that both HD and PD patients have indicators of deficiency where serum free carnitine level is < 20 µmol/L (~25%) or insufficiency where the acyl/free carnitine ratio is > 0.4 (over 86%). Deficiency/insufficiency occur due to significant/ongoing dialysis losses, limits of carnitine-rich foods, and lack of kidney production. Approved medical indications for carnitine supplementation include primary deficiencies and secondary depletion (dialysis). CMS issued a Decision Memo on the use of carnitine for ESKD in 2002, with very specific requirements for initiation/continuation of the therapy. L-Carnitine is being studied as an osmotic agent in PD. Carnitine supplementation was not addressed in the CPG for CKD Nutrition, 2020 Update. This information is provided as a matter of record to indicate why and how carnitine was used in the past.

Potential Area of Impact	**Stated Effects of Carnitine Repletion From Various Studies** (not all studies confirm these reported effects)
Intradialytic complications	↓ incidence of intradialytic hypotension/muscle cramps
Patient well-being	Patient/staff report significant improvement of patient's sense of well-being
Muscle/cardiac function	Lower rate of arrhythmia, improved cardiac function, ↓ cardiomegaly/cardiomyopathy
Exercise tolerance	Reported improvement in muscle function and oxygen consumption
Protein/muscle metabolism	↓ BUN, creatinine, and phosphate due to ↓ pro/muscle catabolism; ↑ albumin/BW
Other	↓ LDL and CRP
Supplement Recommendations	IV dose: 10-20 mg/kg/d. Oral dose: underdetermined; may be limited by incomplete metabolism in CKD; poor regulation of content/bioavailability in OTC supplements

References: Eknoyan G, Latos D L, Lindberg J. National Kidney Foundation Carnitine Consensus Conference. *Am J Kidney Dis.* 2003;41:868-876.
Lynch KE, Feldman HI, Berlin JA, et al. Effects of dialysis-related hypotension and muscle cramps: A meta-analysis. *Am J Kidney Dis.* 2008;52:962-971.
Brass EP, et al. IV L-carnitine increases plasma carnitine, reduces fatigue, and may preserve exercise capacity in HD patients. *Am J Kidney Dis.* 2001;37:1018-1028.
Vesela E, Racek J, Trefil L, et al. Effect of L-carnitine supplementation in HD patients. *Nephron.* 2001;88:218-223.
Mercadal L, Coudert M, Vassault A, et al. L-carnitine treatment in incident HD patients: the multicenter, randomized, double-blinded, placebo-controlled CARNIDIAL trial. *Clin J Am Soc Nephrol.* 2012;7:1836-1842.
Chen Y, et al. L-Carnitine supplementation for adults with ESRD requiring maintenance a HD: a systematic review and meta-analysis. *Am J Clin Nutr.* 2014;99:408-422.
CMS Decision Memo. https://www.cms.gov/medicare-coverage-database/details/nca-decision-memo.aspx?NCAId=44&fromdb=true. Published 7/22/2002. Accessed 8/1/2020.
Bonomini M, DiLiberato LD, Arduini A, e al. Current opinion on usage of L-carnitine in ESRD on peritoneal dialysis. *Molecules.* 2019;24(19)3449.
Hatanaka Y, Higuchi T, Akiya Y, et al. Prevalence of carnitine deficiency/decreased carnitine levels in pts on hemodialysis. *Blood Purif.* 2019;47(suppl 2):38–44.

CONSIDERATIONS FOR A KOSHER DIET

There are 4 main branches of Judaism (Orthodox, Conservative, Reform, and Reconstructionist) and several other movements. Within these, however, there is a great degree of variation in practice and observance. It is important to identify and respect individual dietary practices when developing a nutrition plan and meal pattern.

Three Basic Concepts in Jewish Dietary Law	
Selection, preparation, and slaughtering of animal foods	Animals must chew a cud and have cloven hooves. Only forequarters are acceptable. Eating of the blood (including arteries, veins, and muscle tissue) is forbidden. Turkey, chicken, goose, pheasant, and duck are kosher. Birds of prey are not kosher. Eggs from kosher birds are kosher, but others are not kosher. All kosher animals must be slaughtered in a specific way as described by the Torah. Fish with fins and scales are kosher; crustaceans/shellfish/fish-like mammals are forbidden.
Koshering of meat and poultry foods	Koshering removes all the blood through soaking and salting. Liver must be broiled. Koshering is completed prior to cooking the food.
Separation of meat and dairy products	Meals have a meat or a dairy focus. Fish is neutral and can be eaten with either. There are 2 sets of cookware/dishes/utensils/drain boards: 1 for dairy and 1 for meat. There are 3 categories of food: meat, dairy, and Pareve. Pareve are neutral foods that can be served with meat or dairy. Examples are fruits, vegetables, grains, beans, legumes, and their derivatives. Margarine is considered dairy unless marked "Pareve."

Note: A rabbi can be consulted for information about exceptions for medical conditions.

References: Nichols D. What is a Kosher renal diet? *J Ren Nutr.* 1995;5:144-147.
Jewish Outreach Institute.

DISEASE-SPECIFIC FORMULAS FOR DETERMINATION OF ENERGY REQUIREMENTS

REE is the largest component of total energy expenditure and is most accurately measured in acute/chronic illness by indirect calorimetry. Although this would be the preferred method of measuring REE, it is not routinely done in the CKD setting. Alternately the REE is typically estimated from a predictive formula that has been validate in other disease states or patient populations and applied to CKD with noted limitations. Two formulas specific to CKD have been proposed as listed below. A comparison of these formula results compared to Handheld Indirect Calorimetry Device results showed that the MHD predictive equation using SCr was more accurate and precise than other predictive equations tested, but the measured REE was consistently lower that the estimated REE from all the predictive equations.

Vilar, et al:

REE (kcal/d) = -2.497 × age x $factor_{age}$ + 0.011 × ht $^{2.023}$ + 83.573 X BW $^{0.6291}$ + 68.171 × $factor_{gender}$

Age in yr, height in cm, BW in kg; $factor_{age}$ is 1 if ≥65 or 0 if not; factor $_{gender}$ is 0 if female, 1 if male

Byham-Gray, et al:

Male REE = 1024.41 – (4.90 x age) = (10.21 × wt $_{postdialysis}$) – (3.25 × SCr)

Female REE = 802.00 – (4.90 x age) + (10.21 × wt $_{postdialysis}$) – (3.25 × SCr)

Byham-Gray Alternatives:

Using CRP:

Male REE = 1027.8 – (5.19*age) + (9.67* $wt_{post\text{-}dialysis}$) + (2.71*CRP)

Female REE = 820.47 – (5.19*age) + (9.67* $wt_{post\text{-}dialysis}$) + (2.71*CRP)

Using A1C:

Male REE = 1128.06 – (4.62*age) + (10.33*$wt_{post\text{-}dialysis}$) – (21.79*A1C)

Female REE = 886.7 – (4.62*age $_{yr}$) + (10.33*$wt_{post\text{-}dialysis}$) – (21.79*A1C)

Age in yr; post-dialysis wt in kg; SCr in mg/dL; CRP in mg/dL; A1C in %.

References: Vilar E, et al. Disease-specific predictive formulas for energy expenditure in the dialysis population. *J Ren Nutr.* 2014;24:243-251.
Byham-Gray LD, et al. Modeling a predictive energy equation specific for maintenance hemodialysis. JPEN. 2017;42:587-596.
Morrow EA, et al. Comparison of Handheld Indirect Calorimetry Device and Predictive Equations Among Individuals on Maintenance HD. *J Ren Nutr.* 2017;27(6):402-411.

HARRIS-BENEDICT FORMULAS FOR RESTING ENERGY EXPENDITURE*

(Not recommended for CKD)

Female (kcal) = 655 + (9.6 × BW) + (1.8 × ht) - (4.7 × age)
Male (kcal) = 66 + (13.7 × BW) + (5.0 × ht) - (6.8 × age)

*May overestimate calorie needs/reported to overestimate RMR by 10-15%.

Resting energy requirements during acute illness = BEE × adjustment factor (see page 4–20)

Clinical outcomes with high protein (HP), hypocaloric feedings are like those with HP, eucaloric feedings in obese individuals. A trial of hypocaloric feeding (50-70% of estimated calorie needs or 14 kcal/kg actual BW) may be initiated in obese patients. Protein levels should start with 1.2 mg/kg actual BW or 2.0-2.25 g/kg IBW. [3]

If indirect calorimetry is unavailable, for critically ill obese patients, use Penn State University 2010 prediction equation or the modified equation for those over age 60.

Penn State Equation: RMR = Mifflin (0.96) + V_E (31) + T_{max} (167) – 6212
Modified Penn State Equation: RMR = Mifflin (0.71) + V_E (64) + T_{max}(85) – 3085

If indirect calorimetry is unavailable, for hospitalized obese patients, use the Mifflin St. Jeor equation with actual BW.

Mifflin-St. Jeor Equation (MSJE)
Men: RMR = (9.99 × wt^{kg}) + (6.25 × ht^{cm}) – (4.92 × age) + 5
Women: RMR = (9.99 × wt^{kg}) + (6.25 × ht^{cm}) – (4.92 × age) – 161

References: Academy of Nutrition and Dietetics. Evidence Analysis Library. Available at: http://www.adaevidencelibrary.com Accessed 3/19/2014.
FAO Corp Document Repository. Energy requirements of adults. Available at: http://www.fao.org/docrep/007/y5686e/y5686e07.htm#bm07.1 Accessed 3/19/2014.
Choban P, et al . American Society for Parenteral and Enteral Nutrition. A.S.P.E.N. Clinical guidelines: nutrition support of hospitalized adult patients with obesity. JPEN J *Parenter Enteral Nutr.* 2013;37:714-744.

SUGGESTED ADJUSTMENT FACTORS FOR ENERGY NEEDS DURING ILLNESS*

Stress	Adjustment Fraction × BEE
Acute kidney injury	1.25
Ambulatory	1.3[2]
Burns (based on % of body surface that is burned) 0-20% 21-40% 41-100%	1.9-2.1[2] 1.0-1.5[1] 1.5-1.85[1] 1.85-2.05[1]
CKD stage 5 ND	1.0[1]
CKD stage 5D (maintenance)	1.0-1.05[1]
Bed rest	1.1[2]
Fractures	1.2-1.25[1] or 1.3[2]
Infections Mild/moderate/severe	1.3[2] 1.0 1.2-1.4[1] 1.4-1.6[1]
Major trauma	1.7[2]
Malnutrition (ongoing, severe)	0.7[1]
Peritonitis	1.15[1]
Sepsis	1.7-1.9[2]
Soft-tissue trauma	1.15[1]
Surgery (elective) day 1-4/day 18-21 Surgery, minor/major	1.0/0.95[1] 1.1-1.3/1.5[2]

***Not specific to CKD.** Categories and recommendations vary slightly between references. The figures above only provide an estimate of additional energy needs for these specific situations.

References: [1] RxKinetics. Section 1 nutrition assessment. Available at: http://www.rxkinetics.com/tpntutorial Accessed 8/24/2020.
[2] Walker RN, Heuberger RA. Predictive equations for energy needs for the critically ill. *Respir Care.* 2009;54:509-521.

ESTIMATED ENERGY NEEDS IN SPINAL CORD INJURY PATIENTS

Step 1	Determine IBW
Step 2	Modify weight for paralysis Paraplegia = subtract 5-10% from IBW Quadriplegia = subtract 10-15% from IBW
Step 3	Use modified weight in Harris-Benedict equation to estimate energy needs

Not specific to CKD; reference uses Hamwi determination of IBW, which is not recommended for CKD patients. Body composition of those with spinal cord injury may be altered due to skeletal muscle atrophy, loss of muscle results in lower TBW.

References: Peiffer SC, et al. Nutritional assessment of the spinal cord injured patient. *J Am Dietetic Assoc.* 1981;78:501. Kocina P. Body composition of spinal cord injured adults. *Sports Med.* 1997;23:48-60.

Diabetes