Enteral Nutrition

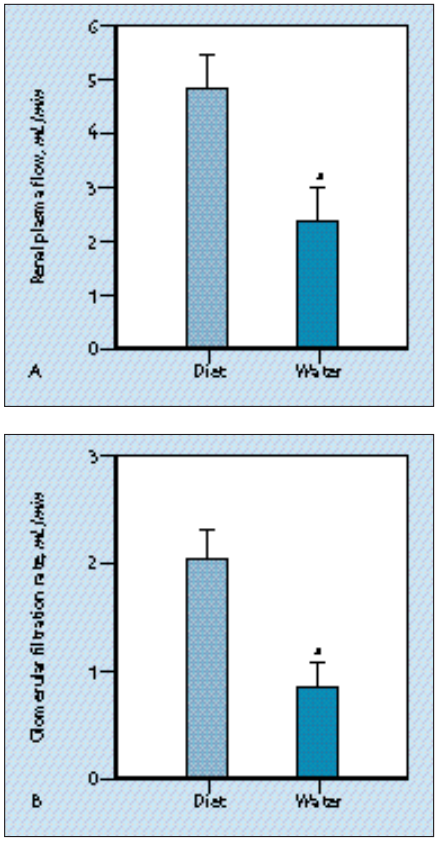

FIGURE 18-30

Enteral nutrition (tube feeding). The gastrointestinal tract should be used whenever possible because enteral nutrients may help to maintain gastrointestinal function and the mucosal barrier and thus prevent translocation of bacteria and systemic infection [61]. Even small amounts of enteral diets exert a protective effect on the intestinal mucosa. Recent animal experiments suggest that enteral feeds may exert additional advantages in acute renal failure (ARF) patients [63]: in glycerol-induced ARF in rats enteral feeding improved renal perfusion, **A**, and preserved renal function, **B**. For patients with ARF who are unable to eat because of cerebral impairment, anorexia, or nausea, enteral nutrition should be provided through small, soft feeding tubes with the tip positioned in the stomach or jejunum [61]. Feeding solutions can be administered by pump intermittently or continuously. If given continuously, the stomach should be aspirated every 2 to 4 hours until adequate gastric emptying and intestinal peristalsis are established. To avoid diarrhea, the amount and concentration of the solution should be increased gradually over several days until nutritional requirements are met. Undesired, but potentially treatable side effects include nausea, vomiting, abdominal distension and cramping and diarrhea. (*From* Roberts *et al.* [62]; with permission.)

SPECIFIC ENTERAL FORMULAS FOR NUTRITIONAL SUPPORT OF PATIENTS WITH RENAL FAILURE

	Amin-Aid	Travasorb renal*	Salvipeptide nephro†	Survimed renal‡	Suplena§	Nepro§
Volume (mL)	750	1050	500	1000	500	500
Calories (kcal)	1467	1400	1000	1320	1000	1000
(cal/mL)	1.96	1.35	2.00	1.32	2.00	2.00
Energy distribution						
Protein:fat:carbohydrates (%)	4:21:75	7:12:81	8:22:70	6:10:84	6:43:51	14:43:43
kcal/g N	832:1	389:1	313:1	398:1	418:1	179:1
Proteins (g)	14.6	24.0	20.0	20.8	15.0	35
EAA (%)	100	60	23			
NEAA (%)	—	30	20			
Hydrolysate (%)	—	—	23	100		
Full protein (%)	—	—	34	—	100	100
Nitrogen (g)	1.76	3.6	3.2	3.32	2.4	5.6
Carbohydrates (g)	274	284	175	276	128	108
Monodisaccharides (%)	100	100	3		10	12
Oligosaccharides (%)	—	—	28			
Polysaccharides (%)	—	—	69	88		90
Fat (g)	34.6	18.6	24	15.2	48	47.8
LCT (%)		30	50		100	100
Essential GA (%)		18	31	52	22	
MCT (%)		70	50	30	0	0
Nonprotein (cal/g N)	502	363	288	374	393	154
Osmol (mOsm/kg)	1095	590	507	600	635	615
Sodium (mmol/L)	11	—	7.2	15.2	32	34.0
Potassium (mmol/L)	—	—	1.5	8	27.0	28.5
Phosphate (mmol)	—	16.1	6.13	6.4	11.0	11.0
Vitamins	b	a	a	a	a	a
Minerals	b	b	a	a	a	a

* 3 bags + 810 mL = 1050 mL

† component I + component II + 350 mL = 500 mL

‡ 4 bags + 800 mL = 1000 mL

§ Liquid formula, cans 8 fl oz (=237.5 mL), supplemented with carnitine, taurine with a low-protein (Suplena) or moderate-protein content (Nepro)

a 2000 kcal/d meets RDA for most vitamins/trace elements

b Must be added

EAA—essential amino acids; FA—fatty acids; LCT—long-chain triglycerides; MCT—medium-chain triglycerides; N—nitrogen; NEAA—non-essential amino acids.

FIGURE 18-31

Enteral feeding formulas. There are standardized tube feeding formulas designed for subjects with normal renal function that can also be given to patients with acute renal failure (ARF). Unfortunately, the fixed composition of nutrients, including proteins and high content of electrolytes (especially potassium and phosphate) often limits their use for ARF.

Alternatively, enteral feeding formulas designed for nutritional therapy of patients with chronic renal failure (CRF) can be used. The preparations listed here may have advantages also for patients with ARF. The protein content is lower and is confined to high-quality proteins (in part as oligopeptides and free amino acids), the electrolyte concentrations are restricted. Most formulations contain recommended allowances of vitamins and minerals.

In part, these enteral formulas are made up of components that increase the flexibility in nutritional prescription and enable adaptation to individual needs. The diets can be supplemented with additional electrolytes, protein, and lipids as required. Recently, ready-to-use liquid diets have also become available for renal failure patients.

Parenteral Nutrition

RENAL FAILURE FLUID—ALL-IN-ONE SOLUTION

Component	Quantity	Remarks
Glucose 40%–70%	500 mL	In the presence of severe insulin resistance switch to D30W
Fat emulsion 10%–20%	500 mL	Start with 10%, switch to 20% if triglycerides are < 350 mg/dL
Amino acids 6.5%–10%	500 mL	General or special "nephro" amino acid solutions, including EAA and NEAA
Water-soluble vitamins	Daily	Limit vitamin C intake < 200 mg/d
Fat-soluble vitamins*	Daily	
Trace elements*	Twice weekly	Caveats: toxic effects
Electrolytes	As required	Caveats: hypophosphatemia or hypokalemia after initiation of TPN
Insulin	As required	Added directly to the solution or given separately

* Combination products containing the recommended daily allowances.

FIGURE 18-32

Parenteral solutions. Standard solutions are available with amino acids, glucose, and lipids plus added vitamins, trace elements, and electrolytes contained in a single bag ("total admixture" solutions, "all-in-one" solutions). The stability of fat emulsions in such mixtures should be tested. If hyperglycemia is present, insulin can be added to the solution or administered separately.

To ensure maximal nutrient utilization and avoid metabolic derangements as mineral imbalance, hyperglycemia or blood urea nitrogen rise, the infusion should be started at a slow rate (providing about 50% of requirements) and gradually increased over several days. Optimally, the solution should be infused continuously over 24 hours to avoid marked derangements in substrate concentrations in the presence of impaired utilization for several nutritional substrates in patients with acute renal failure. EAA, NEAA—essential and nonessential amino acids; TPN—total parenteral nutrition.