Nutrition of patients during the process of continuous support of renal function

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УНИВЕРЗИТЕТ У БЕОГРАДУ
МЕДИЦИНСКИ ФАКУЛТЕТ

The critically ill should be fed!

Special Communication | CARING FOR THE CRITICALLY ILL PATIENT

The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3)

JAMA. 2016;315(8):801-810. doi:10.1001/jama.2016.0287

SOFA: Sequential [Sepsis-related] Organ Failure Assessment

Table 1. Sequential [Sepsis-Related] Organ Failure Assessment Score[a]

	Score				
System	0	1	2	3	4
Respiration					
Pao_2/Fio_2, mm Hg (kPa)	≥400 (53.3)	<400 (53.3)	<300 (40)	<200 (26.7) with respiratory support	<100 (13.3) with respiratory support
Coagulation					
Platelets, $\times 10^3/\mu L$	≥150	<150	<100	<50	<20
Liver					
Bilirubin, mg/dL (μmol/L)	<1.2 (20)	1.2-1.9 (20-32)	2.0-5.9 (33-101)	6.0-11.9 (102-204)	>12.0 (204)
Cardiovascular	MAP ≥70 mm Hg	MAP <70 mm Hg	Dopamine <5 or dobutamine (any dose)[b]	Dopamine 5.1-15 or epinephrine ≤0.1 or norepinephrine ≤0.1[b]	Dopamine >15 or epinephrine >0.1 or norepinephrine >0.1[b]
Central nervous system					
Glasgow Coma Scale score[c]	15	13-14	10-12	6-9	<6
Renal					
Creatinine, mg/dL (μmol/L)	<1.2 (110)	1.2-1.9 (110-170)	2.0-3.4 (171-299)	3.5-4.9 (300-440)	>5.0 (440)
Urine output, mL/d				<500	<200

Abbreviations: Fio_2, fraction of inspired oxygen; MAP, mean arterial pressure; Pao_2, partial pressure of oxygen.

[a] Adapted from Vincent et al.[27]

[b] Catecholamine doses are given as μg/kg/min for at least 1 hour.

[c] Glasgow Coma Scale scores range from 3-15; higher score indicates better neurological function.

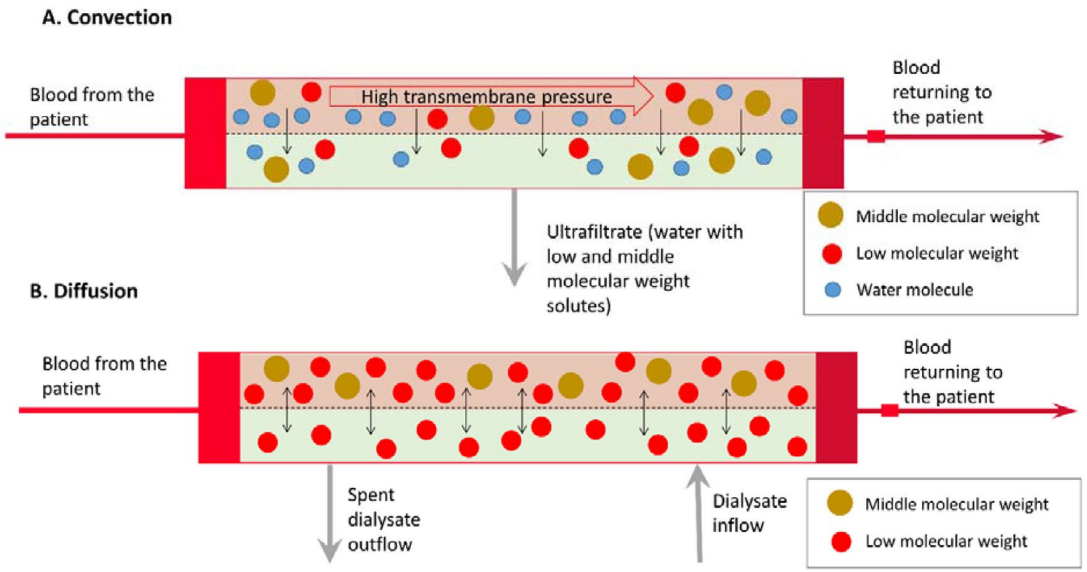
Metabolic changes during acute impairment of renal function

- Hyperglycemia
- Hypertriglyceridemia
- Negative balance of protein metabolism
- Electrolyte imbalance
- Decreased concentrations of water-soluble vitamins
- Reduced concentration of microelements
- Increased circulatory volume, organ edema
- Hyperparathyroidism
- Resistance to erythropoietin
- ……

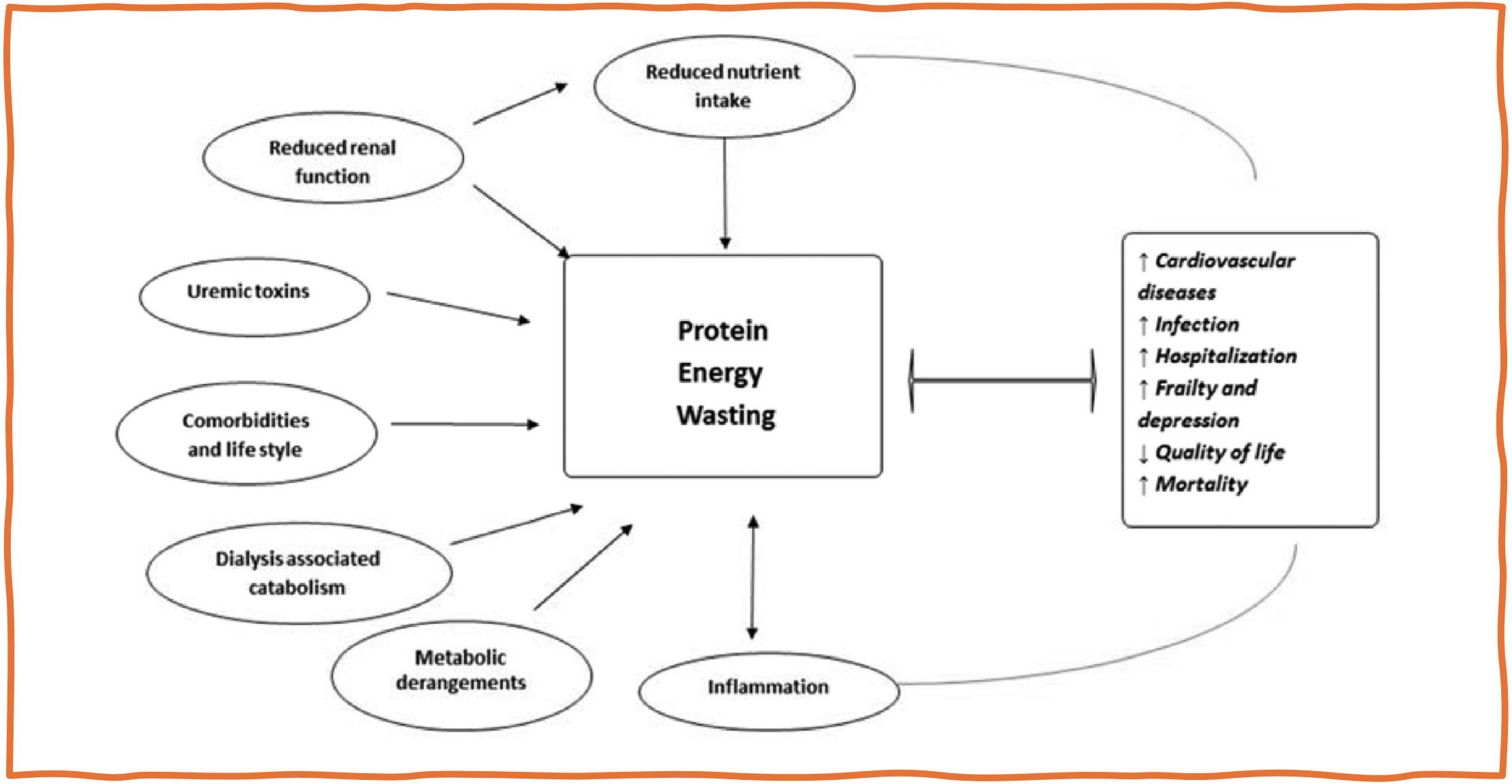
- The International Society of Renal Nutrition and Metabolism (ISRNM), introduced the term "**protein-energy wasting**" which indicates "a state of reduced protein and energy reserves (for example, body muscle mass and fat reserves), which occurs both during acute and during chronic renal failure, regardless of cause and may be associated with reduced functional capacity associated with metabolic stress".

Metabolic changes caused by:

- Comorbidities of the patient
- The underlying disease
- Critically ill
- By applying continuous processes



Principles of solution removal



A cycle of constant worsening of the patient's condition

The result of all this:

The patient is malnourished!

Optimal intake of nutrients in patients with AKI depends on:

- Nature, causes, diseases leading to AKI
- Sizes of catabolism in patients
- By type and frequency of CRRT

Different methods of supporting kidney function - different impact on metabolism

- The process lasts 24 hours
- Decrease in temperature (increased energy needs)
- Losses of amino acids by diffusion (up to 25 g/24 hours)
- Acceleration of catabolism
- Activation of the inflammatory process (application of liquids, materials,...)

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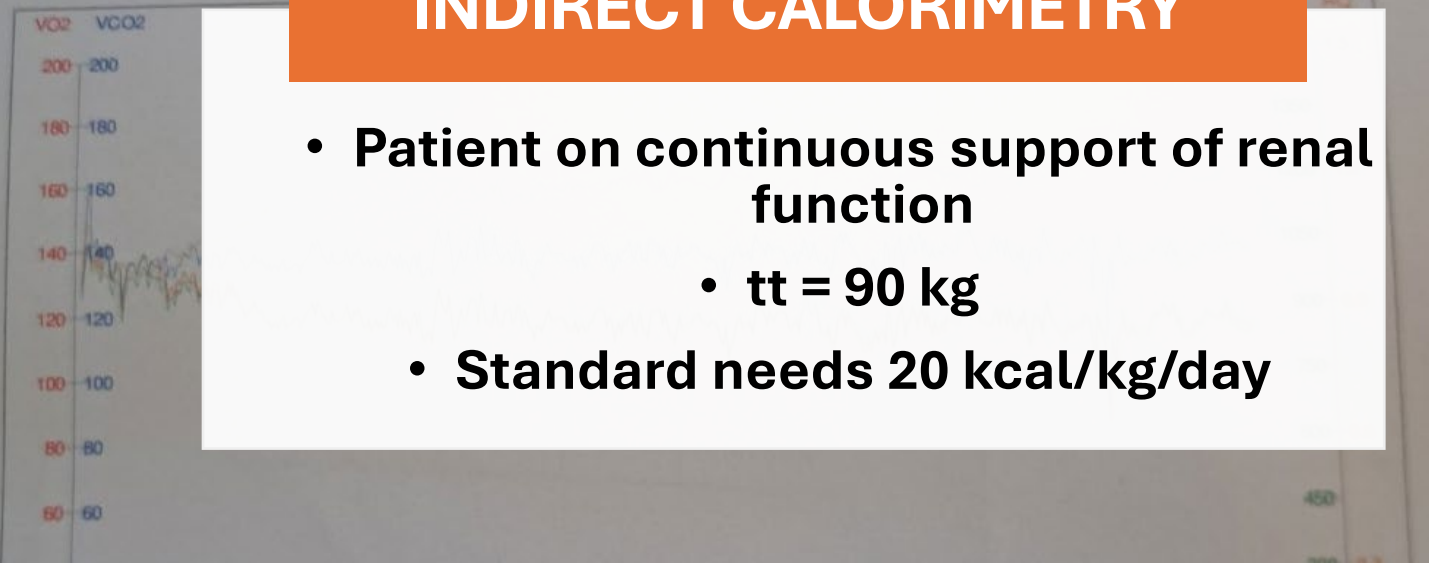
The new term "dialytrauma" – exposing the patient to extracorporeal circulation, filter membranes leads to immune activation AND heat loss - this increases metabolism and increases REE.

- There are no clear guidelines for nutritional therapy in these patients
- It is based on the individual application of nutritional support
- Patients with malnutrition and at risk of malnutrition
- The best overestimates are obtained based on the measurement of consumption at rest (REE - Resting energy expenditure).
- Indirect calorimetry!

Go to Tools, Site Editor to change this header.

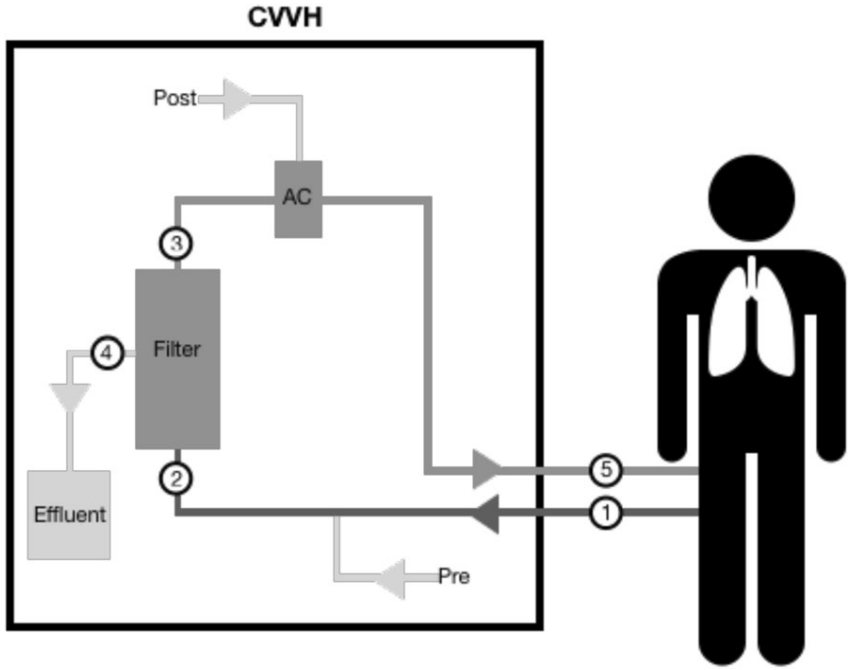
Name:	BLAZEVIC, RANISLAV	ID:	577923	BMI:	26.30
Tech:		Height:	185.00	Age:	74
Doctor:		Weight:	90.00	Gender:	Male

	Mean Value	Pred
Time(min)	30:01	
FIO2(%)	44.44	
REE(Kcal/day)	884	1730
RQ	1.16	
REE/Pred(%)	51	
RR(br/min)	16.00	
Vt BTPS(mL)	270	
VE BTPS(L/min)	4.32	
VCO2(mL/min)	136	
VO2(mL/min)	117	
Urinary N2(g/day)		
CHO/REE(%)	151	
Fat/REE(%)	-50	
Prot/REE(%)		
REE_Covar(%)	5	



INDIRECT CALORIMETRY

- **Patient on continuous support of renal function**
- **tt = 90 kg**
- **Standard needs 20 kcal/kg/day**



Indirect calorimetry is not exactly accurate with CVVH either

-26 ml/min of CO_2 is lost in effluent (14% of expiratory VCO_2)

CO_2 and O_2 removal during continuous veno-venous hemofiltration: a pilot study. Jonckheer et al. BMC Nephrology (2019) 20:222 https://doi.org/10.1186/s12882-019-1378-y

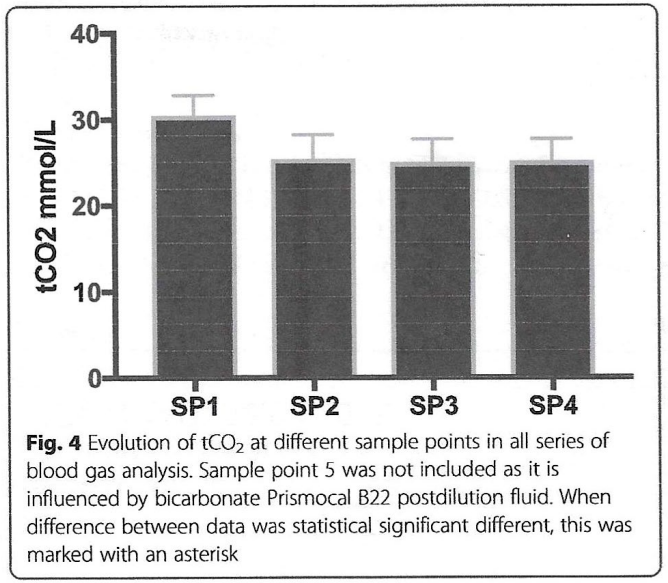


Fig. 4 Evolution of tCO_2 at different sample points in all series of blood gas analysis. Sample point 5 was not included as it is influenced by bicarbonate Prismocal B22 postdilution fluid. When difference between data was statistical significant different, this was marked with an asterisk

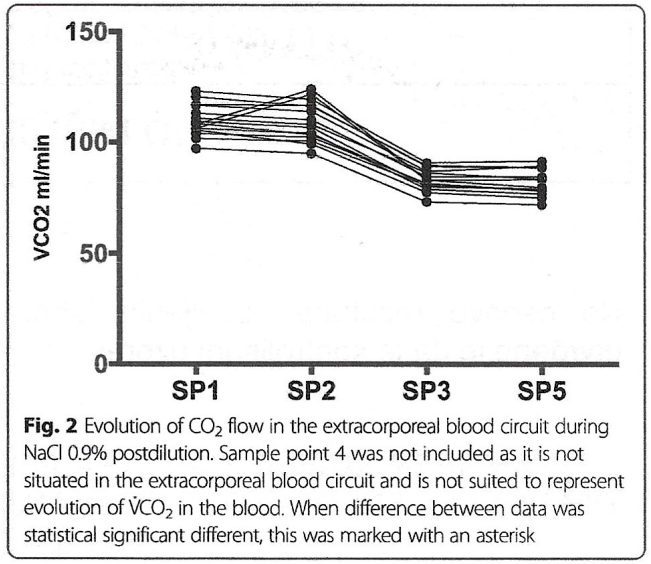


Fig. 2 Evolution of CO_2 flow in the extracorporeal blood circuit during NaCl 0.9% postdilution. Sample point 4 was not included as it is not situated in the extracorporeal blood circuit and is not suited to represent evolution of $\dot{V}CO_2$ in the blood. When difference between data was statistical significant different, this was marked with an asterisk

Enteral or parenteral

-Enteral always has an advantage!

- .....

- Among other benefits: enteral nutrition promotes blood flow through the kidneys and their function

ESPEN guideline on clinical nutrition in hospitalized patients with acute or chronic kidney disease. Clinical Nutrition 2021;

- If the oral route of nutrition is not possible, early EN (within 48 hours) is recommended in critically ill adult patients (better than delayed EN)
- If the oral route of nutrition is not possible, early EN (within 48 hours) is recommended in critically ill adult patients (better than early PN)
- In case of contraindications for oral and EN, PN should be started within three to seven days of admission.

How much energy does a patient with AKI have?

- The latest guidelines that talk about the critically ill patient in the ICU, with AKI recommend:
- 20-30 kcal/kg/d of non-protein calories, or 20 to 30 kcal/kg/d of total calories

- After the third day, caloric intake should increase by 80 to 100% of measured energy needs

How much energy does a patient with AKI have?

- Hypercaloric intake was not shown to be better than hypocaloric intake (40 kcal/kg/day versus 30 kcal/kg/day). There was more complication.

- Do not reach full energy intake before the third day.

- Substances used during continuous processes have a certain energy value (take it into account):

- Citrate (3 kcal/g)

- ACD-A (2.2% citrate), TSC (4% trisodium citrate), or newer citrate solutions (citrate 12 or 18 mmol/l)

- Glucose (3.4 kcal/g) from ACD-A (2.45% dextrose) and replacement fluid and dialysis fluid (0 - 110 mg/dl)

- Lactate (3.62 kcal/g), used as a buffer

How much protein?

- A patient who is on continuous processes is always in a negative nitrogen balance.

- It loses 15 to 20 grams of amino acids per day (depending on the mode of support, the length of the process and the membrane).

How much protein?

- Hospitalized patient with AKI, AKI with CKI without acute/critical illness: 0.8-1.0 g/kg BW/d
- Hospitalized patient with AKI, AKI with CKI, CKI with acute/critical illness, not on HRT: start with 1 g/kg BW/d, and gradually increase to 1.3 g/kg BW/d, if tolerated.
- **Critically ill** patient with AKI or AKI in HKI with renal impairment on conventional intermittent renal support: 1.3 -1.5 g/kg/d
- Critically ill patient with AKI or AKI within CKI, or CKI with renal impairment on continuous renal support or prolonged intermittent renal support: 1.5 g/kg/d to 1.7 g/kg/d

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How much protein?

- The goal is to achieve a positive nitrogen balance!

How many lipids and carbohydrates

- The latest evidence shows that patients with AKI use (oxidation) carbohydrates much less (56.7%) and much more lipids (150.7%) than expected.

- Unfortunately, we do not have such preparations.

Electrolytes

- In real clinical situations, the most common electrolyte disturbances (before starting continuous processes) are:

- hyponatremia
- hyperkalemia
- hyperphosphatemia
- hypocalcemia

- (Most normalize as the ongoing process begins.)

- With long-term intensive continuous processes we see:

- hypophosphatemia
- hypokalemia
- hypomagnesemia

Microelements and vitamins

- Due to increased needs during renal failure, critical illness, large effluent losses during continuous processes, trace elements (Se, Zn and Cu) should:

- monitor

- keep adding

- Due to the increased needs during renal failure, critical illness, large effluent losses during continuous processes, water-soluble vitamins (with special attention to vitamin C, folates and thiamin) should:

- monitor

- keep adding

-

Guy Fishman , Pierre Singer . Metabolic and nutritional aspects in continuous renal replacement therapy. Journal of Intensive Medicine 3 (2023) 228–238

Summary of different recommendations for nutritional support in CRRT.

Reference	Energy	Fats	Protein/amino acids	Micronutrients	Water-soluble vitamins	Fat-soluble vitamins
McClave et al. [33]	Consider non-nutritional calories Beware of overfeeding	Monitor triglyceride level	2.0– 2.5 g/kg/IBW/day	Monitor	Monitor	No recommendations
Singer et al. [32]	IC Consider non-nutritional calories Beware of overfeeding	Monitor triglyceride level	1.5–1.7 g/kg/day	Monitored and supplemented, especially selenium, zinc, and copper	Monitored and supplemented especially vitamin C, folate, and thiamine	E: 10 IU K: 4 mg/week A: Decrease the amount
Onichimowski et al. [24]	Catabolic phase: 20–25 kal/kg/IBW/day Anabolic phase: 25–35 kal/kg/IBW/day	0.7–1.5 kal/kg/IBW	1.7– 2.0 g/kg/IBW/day	A doubled dose of commercial preparations for PN, additional intravenous substitution for EN	B1: 100 mg/day B2: 2 mg/day B3: 20 mg/day B5: 10 mg/day B6: 100 mg/day B7: 200 μg/day B9: 1 mg/day B12: 4 μg/day C: 250 mg/day A doubled dose of commercial preparations for PN, additional intravenous substitution for EN	E: 10 IU K: 4 mg/week A: Without supplementation In practice, the dose of commercial multivitamin preparations may be doubled
Honoré et al. [16]	IC 25–35 kal/kg/IBW/day Carbohydrates 60–70% Lipids 30–40%	Monitor triglyceride level	1.5– 1.8 g/kg/IBW/day	Selenium: + 100 μg/day Zinc: 50 mg/day Copper: 5 mg/day A triple dose of intravenous trace elements-containing solutions	B1: 100 mg/day B2: 2 mg/day B3: 20 mg/day B5: 10 mg/day B6: 100 mg/day B7: 200 mg/day B9: 1 mg/day B12: 4 μg/day C: 250 mg/day	E: 10 IU K: 4 mg/week A: Reduce supplementation
Ostermann et al. [71]	IC 25–30 kal/kg/day	No recommendations	>1.5 g/kg/day	Selenium: 50–70 μg/day Zinc: 5–10 mg/day Chromium: 0.01 mg/day Manganese: 0.5 mg/day Copper: 1–2 mg/day A double or triple dose of intravenous trace elements-containing solutions	B1: 100–200 mg/day B2: 2 mg/day B3: 20 mg/day B5: 10 mg/day B6: 50–100 mg/day B7: 200 mg/day B9: 1 mg/day B12: 4 μg/day C: 0.5–6.0 g/day	No recommendations

CRRT: Continuous renal replacement therapy; EN: Enteral nutrition; IBW: Ideal body weight; IC: Indirect calorimetry; PN: Parenteral nutrition.

Conclusion

- A state of increased loss of amino acids
- Constant electrolyte monitoring
- Supplementation of microelements and vitamins
- Indirect calorimetry
- Individual evaluation, individual formula creation
- Pay attention to the content of dialysis solutions
- Nutritional therapy in patients with AKI must be monitored much more than in some other diseases

Literature

- 1. Enrico Fiaccadori, et al. ESPEN guideline on clinical nutrition in hospitalized patients with acute or chronic kidney disease. Clinical Nutrition 2021;40:1644-1668.
- 2. Nikolina Bašić Jukić, i ostali. Prehrana u akutnom oštećenju bubrega. In Petar Kes, editor. Akutno oštećenje bubrega. Medicinska naklada . Zagreb 2019.
- 3. CO2 and O2 removal during continuous veno-venous hemofiltration: a pilot study. Jonckheer et al. BMC Nephrology (2019) 20:222 https://doi.org/10.1186/s12882-019-1378-y
- 4. Guy Fishman , Pierre Singer . Metabolic and nutritional aspects in continuous renal replacement therapy. Journal of Intensive Medicine 3 (2023) 228–238