Micronutrient Deficiencies in Patients Being Evaluated for Liver Transplantation While Receiving Continuous Renal Replacement Therapy: A Retrospective Review

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Background

Continuous renal replacement therapy (CRRT) is an effective alternative renal replacement therapy (RRT) in critically ill patients with acute and chronic renal dysfunction. A consequence of CRRT is marked losses of macro and micronutrients during this therapy which may result in decreased patient survival and undesirable clinical and metabolic disturbances. Micronutrient depletion (thiamine, pyridoxine, ascorbic acid, copper zinc, selenium) has been associated with CRRT.[1-2] Given that RRT is applied continuously, there are large losses of certain micronutrients. Additionally, critically ill patients requiring CRRT are in high catabolic states thus requiring higher nutritional needs for maintenance.[3-4]

To date, there is limited data exploring the impact of CRRT on micronutrient status and the potential negative clinical outcomes associated with deficiency.

Micronutrient	Risk Factors	Signs and Symptoms
Thiamine/B1	GI malabsorption, poor oral intake or poor diet quality, alcohol use, RRT, diuretic use	Dry/wet beriberi, lactic acidosis, nausea, vomiting, bowel dilation, WE* (altered mental status, unsteady gait), KS* (hallucinations, psychosis, memory deficits, confabulation)
Pyridoxine/B6	Poor diet quality or poor oral intake, alcoholic liver disease, impaired metabolism	Microcytic anemia, seizures, angular stomatitis, depression, confusion, seborrheic dermatitis
Ascorbic Acid/C	Physiological stress, dialysis losses, poor diet quality or poor oral intake	Poor wound healing, gingivitis, glossitis, anemia, fatigue, perifollicular petechiae, ecchymosis
Copper	Alcoholic liver disease, GI losses, high-dose zinc supplementation	Microcytic anemia, leukopenia, pancytopenia, delayed wound healing, sensory ataxia, lower extremity spasticity, myeloneuropathy, optic neuropathy
Zinc	Malabsorption, diarrhea, oxidative stress, altered protein metabolism	Skin lesions, poor wound healing, angular cheilosis, taste and smell alterations, altered mental status, insulin resistance
Selenium	Alcoholic liver disease, hepatocellular carcinoma	Erythema, myositis, cardiomyopathy, hair loss, dry skin

WE = Wernicke Encephalopathy, KS = Korsakoff Syndrome

Methods

As part of a quality improvement project, micronutrient levels of patients on CRRT were evaluated. Patients on CRRT who had at least 1 micronutrient level drawn (thiamine, pyridoxine, ascorbic acid, copper zinc, selenium) within 48 hours of starting CRRT were included in this study. A retrospective chart review was completed on patients who were being evaluated for liver transplantation from May 2019 through November 2019 at Keck Medical Center of USC. The CRRT modality was predominately continuous venovenous hemodiafiltration (CVVHDF) with a goal dose of 25 ml/kg/hr and utilizing AN69 filter without utilization of citrate or heparin anticoagulation. All feeding methods (enteral nutrition, parenteral nutrition, oral diet, or nil per os) were included. Patients who expired within 48 hours of CRRT initiation were excluded. All patients were prescribed a renal vitamin or multivitamin with mineral tablet on admission to the intensive care unit.

Results

A total of 20/55 (36.7%) had low whole blood thiamine levels, 34/54 (63.0%) had low serum pyridoxal 5'-phosphate levels, 35/50 (70.0%) had low serum ascorbic acid levels, 28/53 (52.8%) had low copper levels, 39/53 (73.6%) had low zinc levels, and zero patients had low serum selenium levels. 2/58 (3.4%) patients did not have any altered micronutrient levels.

Micronutrient	Reference Range	% deficient	Total subjects (n=58)
Thiamine	70-180 nmol/L	36.7%	20/55
Pyridoxine	20-125 nmol/L	63.0%	34/54
Ascorbic acid	23-114 mcmol/L	70.0%	35/50
Copper	70-140 mcg/dL	52.8%	28/53
Zinc	60-120 mcg/dL	73.6%	39/53
Selenium	23-190 mcg/L	0%	0/54

Conclusions/Next Steps

There are significant gaps in research exploring CRRT and micronutrient losses. There is growing evidence to support the need for micronutrient monitoring, replacement and possible prophylactic supplementation early in patients requiring CRRT.

High dose vitamin and trace element supplementation may be needed routinely in patients starting CRRT as deficiencies are seen as early as within 48 hours of initiating CRRT. Large prospective studies are needed to explore the incidence of vitamin and trace element deficiencies, identify best practice monitoring strategies of patients on CRRT, determine if prophylactic micronutrient supplementation is needed, and compare micronutrient losses between different RRT modalities. Additionally, given the fact the authors found no elevated baseline levels of micronutrients, it should be strongly considered that patients are started on empiric supplementation with initiation of CRRT.

References

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Acknowledgements/Conflicts of Interest

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