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Background

- Newborns with acute kidney injury (AKI) or end-stage kidney disease (ESKD) often receive prolonged CRRT when the early initiation of peritoneal dialysis is either contraindicated or unable to be performed.
- These patients often receive total parenteral nutrition (TPN) to meet their nutritional goals.
- Little to no information exists on the loss of blood amino acids (AA) and carnitine during CRRT in these patients.
- The objective of this study was to determine the amino acids and carnitine losses in newborns receiving prolonged CRRT and TPN.

Material and Methods

- Three newborns who received prolonged (> 2 weeks) CRRT and TPN were included in the study. Blood and CRRT effluent were simultaneously collected from these patients.
- The effluent specimens were collected over 8-12 hours and the results were extrapolated to 24 hrs. Plasma was separated from blood for the analysis of 30 amino acids and free carnitine.
- Amino acids in plasma and CRRT effluent were analyzed using an amino acid analyzer which uses ion-exchange chromatography and post-column ninhydrin derivatization (Biochrom System). Free carnitine was determined by HPLC-tandem mass spectrometry (HPLC-MS/MS) using flow injection, electrospray ionization and precursor ion scan.
- The total amount of amino acids and carnitine received by each patient was calculated from the amino acids concentrate and carnitine added to the TPN solution.
- The sieving coefficients (SQ) for each measured amino acid and carnitine was determined, while the amino acids and carnitine losses were calculated as mg/day, and as a percentage of the intake.

Results

- The blood flow was 50 mL/min for all three cases, and the CVVHDF clearance ranged from 68 – 115 mL/kg/hr (1.4 – 3.2 L/hr/1.73 m^2).
- The AA intake varied from 3.8 – 4.5 gm/kg/day. Carnitine intake was 20 mg/kg/day in two patients and 50 mg/kg/day in the third.
- The SQ for all essential AAs was >0.8; in contrast, acidic AAs (glutamic and aspartic acid) had a SQ <0.4, while the SQ for cystine always exceeded 1.
- Overall, between 10 – 30% of all AAs were lost in the effluent, with the exception of glutamic and aspartic acid whose losses were <10%.
- For the eight essential AAs, the average percentage losses were 11% with a clearance of 68 mL/kg/hr, 16% with a clearance of 76 mL/kg/hr, and 21% with a clearance of 115 mL/kg/hr.
- SQ for carnitine was >0.84 and carnitine losses were 80% of the daily intake.
- At the given high protein intake, all three patients achieved a positive N_2 balance ranging from 0.45 to 0.59 gm/day.

Amino acid and carnitine profile of Case# 3 (weight – 4.4 kg; BSA 0.27 m^2); CVVHDF clearance: 115 mL/kg/hr (3.2 L/hr/1.73m^2) with HF1000 filter. TPN contained 15% Clinisol® AA solution (4 gm/kg) and carnitine 20 mg/kg/day.

Amino acid	Intake *(mg/day)*	Serum Conc. (mg/L)	Effluent Conc. (mg/L)	SQ	Amount lost (mg/day)	Percentage loss
Leucine	*1220*	*19.4*	*16.1*	*0.83*	*180*	*15*
Isoleucine	*879*	*11.2*	*10.4*	*0.93*	*116*	*13*
Lysine	*1384*	*35.5*	*29.6*	*0.83*	*331*	*24*
Valine	*1126*	*31.5*	*28.7*	*0.91*	*321*	*29*
Histidine	*1049*	*19.1*	*16.9*	*0.88*	*189*	*18*
Phenylalanine	*1220*	*29.6*	*23.6*	*0.80*	*264*	*22*
Threonine	*879*	*28.1*	*25.4*	*0.90*	*284*	*32*
Methionine	*879*	*11.9*	*10.9*	*0.92*	*122*	*14*
Tryptophan	*293*	--	--	--	--	--
Tyrosine	46	8.5	8	0.94	90	195
Cystine	0	3.6	8.4	2.33	94	--
Arginine	1724	22.6	19.9	0.88	223	13
Proline	1049	33.4	28.1	0.84	314	30
Alanine	2545	47.2	42.1	0.89	471	19
Glutamic acid*	879	28.8	6.8	0.24	76	9
Serine	694	16.4	13.9	0.85	156	22
Glycine	1220	36	28.2	0.78	316	26
Aspartic acid*	509	3.1	0.8	0.26	9	2
Taurine	0	2.3	1.3	0.57	15	--
Carnitine	**88**	**7.66**	**6.47**	**0.84**	**72.4**	**88**

- The 9 essential amino acids are in "italics." (Tryptophan is currently not included in the AA profile results.)
- Cysteine and taurine are not included in the Clinisol® preparation.

Conclusions

- During CRRT, most of the AAs (including all essential AAs) are freely filtered and the quantity lost is influenced by the CRRT clearance.
- In our very small sample of patients, positive nitrogen balance was achieved in all three patients with a very high (3.8 – 4.5 gm/kg/day) protein intake.
- As carnitine is rapidly and freely filtered during CRRT, these patients are at risk of significant carnitine depletion.
- The impact of serum AA and carnitine losses on nutritional outcome in patients with renal disease receiving CRRT is not known at this time.
- Additional studies are needed to determine if these patients require special AA formulations and the degree of carnitine supplementation in their TPN to account for the AA and carnitine losses that regularly occur.

References

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