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Characterization of Ions in Urine of Animal Model with Acute Renal Failure using NAA

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Abstract. Neutron Activation Analysis (NAA) technique has been used to determine elements concentrations in urine of rats Wistar (control group) and rats Wistar with Acute Renal Failure (ARF). These data contribute for applications in health area related to biochemical analyses using urine to monitor the dialyze treatment.

Keywords: Acute Renal Failure, Urine, NAA.
PACS: 82.80 Jp

INTRODUCTION

In last the years, important advances had been obtained in the investigation of the ARF (Acute Renal Failure) what is defined as an abrupt and rapid decline of the renal function[1,2]. However, the incidence of the mortality had not diminished in the last few decades[3]. Recent investigations have emphasized that protein calorie malnutrition found in patients with ARF is a major factor in its evolution and, basically, the treatment consists of dialysis, electrolyte replacement and nutritional monitoring. The periodicity of the dialyses depends on the patient (one a three times by week); in the nutritional terms the restriction of sodium in 2-4g/day, the smallest possible intake of magnesium, as well as the potassium intake limited 40mEq/day and phosphorus to 800mg/day facilitates the treatment. Yet, following the recommendations from National Health Surveillance Agency (ANVISA) Resolution – RDC N 154 - 15 June (2004)[4], the efficiency of the treatments can be checked by monitoring the levels of Ca, Cl, K, Mg and Na in serum[5] (before and after the dialysis treatment) and Na in urine[5] (after the dialysis treatment) aiming to verify the maintenance of the normal range from these ions for regulating the kidneys functions.

In this investigation we intend to quantify ions (Br, Ca, Cl, I, K, Mg, Na and S) in urine of Wistar rats (control group) and in Wistar with ARF (during and after ARF caused by renal ischemia induced)[1,2] using NAA. This nuclear procedure (NAA) is as

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an alternative to perform biochemical analysis using small quantities of biological material (urine, whole blood or serum)[6-9]. The knowledge of the elements concentration in urine before, during and after ARF in this model animal can be used to study in more details this anomaly, as well to check the possibility of using urine to monitor the dialyze treatment. The elements Ca, Cl, K, Mg and Na were selected in function of the clinical relevance for evaluation of electrolyte disorders; Br because the bromides are usually present in drugs (highly consumed by Brazilian patients with renal failure); iodine because small variations can lead to metabolic dysfunction (hyper or hypothyroidism) and sulfur due its nutritional significance, considering that patients with renal insufficiency have a controlled diet, usually rich in vegetables, and some of them can present a higher level of sulfur[10] due the use of elemental-S as a fertilizer in tropical soils[11]. Recent data, related to investigation of ration administrated in equines[12], indicated the presence of S at high level (factor 100 above nominal specification) emphasizing its nutritional relevance.

EXPERIMENTAL

For this study urine samples were collected from adults rats Wistar (males) created in the bioterio of the UNIFESP (Federal University from São Paulo). The urine collection was obtained from mice previously anesthetized. The clinical procedure for ischemia- and reperfusion induced (I/R) was performed in the Laboratório de Nefrologia (UNIFESP). The urine samples were collected with a catheter and packed in a plastic tube (about 0.5mL) and 50μL was transferred to filter paper (Whatman - N^{o} 41). For the ARF group the urine samples were collected before, during and after the ARI. All the samples were prepared in duplicate. To determine the concentration of the elements, each biological sample was sealed into individual polyethylene bag and irradiated under a thermal neutron flux of $3 \cdot 10^{12}$ n/cm^{-2}s^{-1} in the nuclear reactor IEA-R1 (2MW, pool type) at IPEN. The irradiation time of 3 minutes was used and the counting time of 15 minutes. The measurements were performed using an ORTEC Model GEM-60195 and ORTEC 671 amplifier (in pile-up rejection mode) coupled to a MCA ORTEC Model 919E. The data was analyzed using in-house software.

RESULTS and DISCUSSION

The Br, Ca, Cl, I, K, Mg, Na and S concentrations (gL^{-1}) determined in urine samples of the control group are presented in Table 1. The reference interval (95%) and the detection limit (DL) of the control group are also presented.

The Br, Ca, Cl, I, K, Mg, Na and S concentrations determined in urine samples of the ARF group are presented in Figure 1. In this figure the concentration result for each element (Before, During and After) was normalized in relation to the concentration value obtained before the renal ischemia (where: CB is the concentration result before I/R, in gL^{-1}; CD is the concentration results during I/R, in gL^{-1} and CA is the concentration results after I/R, in gL^{-1}).

TABLE 1. Elements Concentration in Urine of Wistar Rats (Control Group).

Elements, gL^{-1}	M	1DP	Reference Interval	DL (3σ)
Br	0.0058	0.0010	0.0038 – 0.0078	5
Ca	0.15	0.05	0.05 – 0.25	397
Cl	6.8	0.3	6.2 – 7.4	47
I	0.0081	0.0008	0.0065 – 0.0097	0.3
K	4.3	0.3	3.7 – 4.9	34
Mg	0.15	0.03	0.09 – 0.21	228
Na	3.2	0.1	3.0 – 3.4	32
S	3.8	1.7	0.4 – 7.2	233

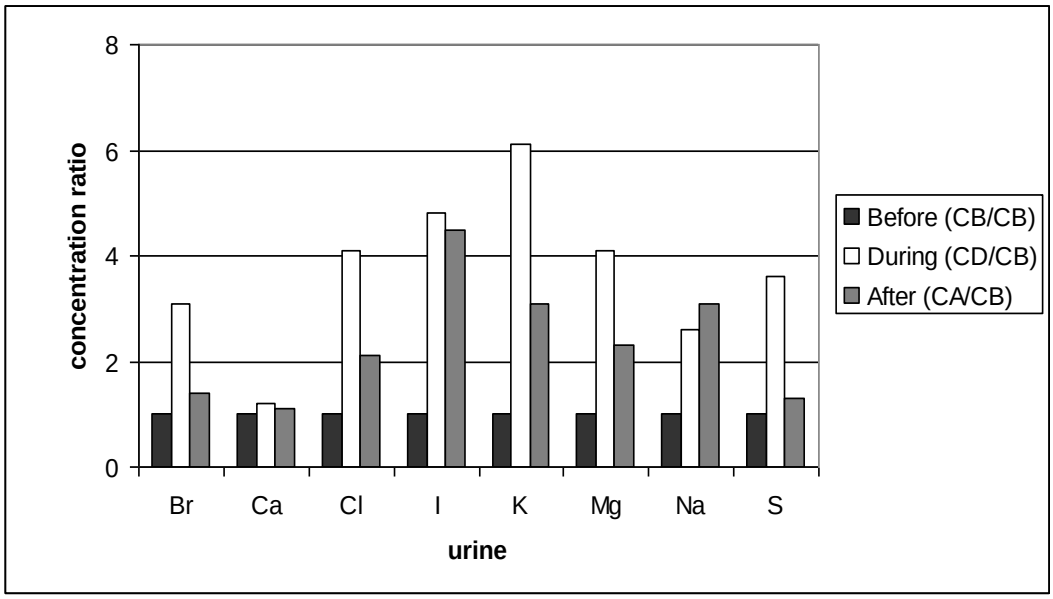

FIGURE 1. The Behavior of the Elements Concentration Ratio in Urine During (CD/CB) and After (CA/CB) the Renal Failure induced. The data were normalized in relation of CB (concentration result before I/R) for each element.

According to Figure 1 a significant increase was observed for all elements during the renal ischemia (CD/CB), except for Ca. The ratio after the renal ischemia (CA/CB) for Br, Ca and S were kept: (1.0; 3.1; 1.4), (1.0; 1.2; 1.1) and (1.0; 3.6; 1.3) respectively, considering the associated uncertainty, but only a partial reduction was observed for Cl, I, K, Mg and Na. The behavior of Cl, K, Mg and Na in urine suggest that these elements can be used as an alternative to check the efficiency of the dialyze treatment. Although iodine is not used as monitor in the conventional renal treatment (serum analysis), it can be a good monitor in analysis performed in urine.

CONCLUSION

This investigation was proposed to understand in more details the behavior of the Br, Ca, Cl, I, K, Mg, Na and S in urine during and after the renal ischemia. The comparative analyses between the ratios CB/CB and CA/CB for Cl, K, Mg and Na showed the viability to perform biochemical analyses in urine to monitor the dialyze treatment.

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