Nuclear methodology for Al quantification in patients submitted to dialysis

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Abstract. Neutron Activation Analysis was applied to determine Al concentration in whole blood of patients submitted to a dialysis using small quantities of biological material. The results from this nuclear analysis suggesting its application for this clinical investigation. The advantages as well as the limitations of using this nuclear procedure were discussed.

Keywords. Aluminum, NAA, whole blood, dialysis

1 Introduction

In recent years we have applied the Neutron Activation Analysis (NAA) with success to investigate some element concentrations in whole blood, serum, urine, resulting in an agile and economic way to perform clinical investigations [1-7]. More recently, this methodology was used to predict iron level in whole blood of human being to diagnosis anemia (iron deficiency) [8] , that have high prevalence in Brazilian population (60 % of all anemias) [9], also confirming that this procedure can be one alternative technique for clinical investigations.

The basic principle of this nuclear methodology is the irradiation of the biological material with neutrons followed by the measurement of the γ-ray activities induced in the biological sample, where the elements can be identified by the nuclear properties of γ-rays.

In the present study we intend to use this methodology to quantify Al, using whole blood, in patients submitted a dialysis aiming its application, in the future, for checking the Al levels in blood , in fast and economic way . This study is part of a big project entitled: "Determination of reference values for concentrations of trace elements in human whole blood using nuclear methodology", nowadays in

development at IPEN (Instituto de Pesquisas Energéticas e Nucleares) in collaboration with Blood Banks and Hematological Laboratories from different regions of Brazil.

For the development of the present investigation Al concentration was first analyzed in healthy group (male and female blood donors), age between 25 and 60 years at 50 and 85 kg, select from Blood Banks, to obtain an indicative interval for their reference values. The necessity to perform measurements in whole blood is related to the fact that conventional analyses are performed using serum so, there are no previous reference value established in whole blood for Brazilian population. After that, this methodology was applied to quantify Al in blood of patients submitted to a dialysis for checking the reference levels in them. This control is important to check disease in metabolism that could resulting in lost of quality of life blood of patients with CRI (chronicle renal insufficiency).

2 Experimental Procedure

To obtain the Al concentration in whole blood, each biological sample (0.1ml of whole blood fixed in filter paper) is sealed into individual polyethylene bag, together with the Au detectors (small metallic foils) used for measurement of the flux distribution [10], and irradiated for 5 minutes in a pneumatic station in the nuclear reactor (IEA-R1, 2-4MW, pool type) at IPEN, allowing the simultaneous activation of these materials. Using this procedure the γ-ray activity induced in the Au detectors as well as in the biological sample are obtained under the exact same irradiation conditions. After the irradiation, the activated materials (biological sample and Au) are gamma-counted using a HPGe Spectrometer of High Energy Resolution and the areas of the peaks, corresponding to gamma transitions related to the nuclides of interest, are evaluated. The gamma spectra analysis evaluation is performed using the IDF computer code [11] and the calculation of the concentration for each element can be obtained from software developed by Medeiros et al. [12] To check the reproducibility of this methodology, a similar experimental procedure was used in the MB-01 nuclear reactor also at IPEN facilities but, due the low flux ($\sim 10^{9} n.cm^{-2}.s^{-1}$) comparatively from IEA-R1 ($\sim 10^{12} n.cm^{-2}.s^{-1}$) the irradiation time was fixed in 20 minutes using 0.5ml of biological material.

3 Results

The estimation for reference values for Al was evaluated as na interval encompassing 95% of normal population ($\pm$ 2SD). The mean values as well as the results related to the basic statistical treatment of the data are shown in Table 1. In Fig. 1 the concentration results in whole blood are shown and the indicative interval

defined by the mean value considering one and two standard deviations (SD). In addition, in Fig. 2 the frequency distribution of Al concentration is shown, with class intervals defined as 0.005, as well as the fitted normal distributions. According to these figures we can notice that the maximum of Gaussian curve distributions is in agreement with the frequency interval of the calculated arithmetic mean value (see Table 1).

Table 1 Indicative interval for the reference values of the element Al in whole blood by using the ANAA technique.

Element concentration	Al (mg/l)
Mean	0.029
1 SD (68%)	0.005
Minimum Value	0.017
Maximum Value	0.042
2 SD (95%)	0.016

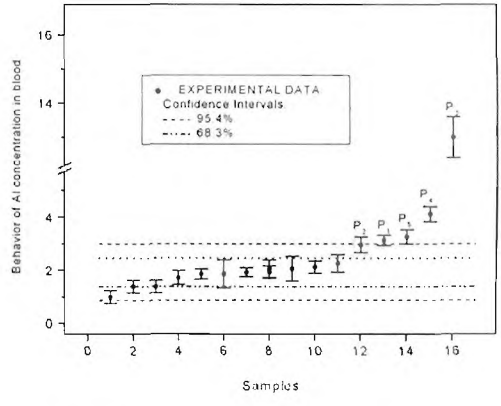

Figure 1 Concentration of Al in whole blood samples.

The Al concentration have also been determined in a group of five patients (denominated P_1, P_2,P_3, P_4 e P_5) submitted to dialysis during 5 years; these results were included in Fig. 1. A significantly variation in Al levels were obtained compared the samples from patients submitted a dialysis with those of the control group, suggesting that NAA could an alternative method for determining Al levels in blood.

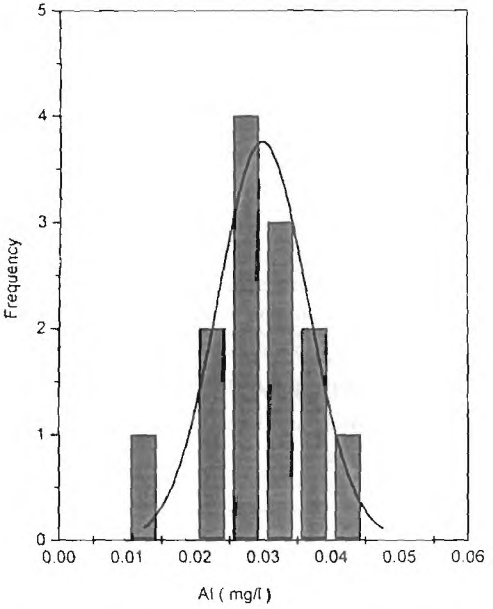

Figure 2 Histogram and Gaussian fit of Al concentration in whole blood samples

4 Conclusions

In this work a method for determination of Al, in whole blood of human being, have been proposed based on neutron activation analysis (NAA). Considering that its application for clinical analyses involve the measurements of hundreds of biological samples, this methodology could be considered fast. Of course, more systematic and large scale studies are needed to establish reference value with high precision aiming its application in for the clinical practical using whole blood helping the diagnostic of patients with CRI.

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