Determination of Uranium Concentration in Blood Samples for Patients with Kidney Failure in Salah din Governorate

Asmaa A Aziz¹, Fareed M Majed² and Nada F Tawfiq³
¹Department of Physics, College of Education for Science, Tikret University, Tikret, Iraq
²Department of Physics, College of Science, Tikret University, Tikret, Iraq
³Department of Physics, College of Science, Al-Nahrain University, Baghdad, Iraq

Email: asmaa.jamal@tu.edu.iq

Abstract. Analysis of human biological samples, such as blood, is generally used to verify human exposure to uranium. The uranium content in the blood of patients with kidney disease in Salah al-din governorate was determined using the Fission Track Analysis (FTA) of the detector CR39. Uranium concentrations of blood samples taken from kidney failure patients ranged between 1.636 ppb to 7.477 ppb, with a mean value of 5.496 ppb. And the health group values ranged between 0.301 ppb to 2.332 ppb with a mean value 1.089 ppb.

1. Introduction
The blood's job is to deliver nutrients, hormones, and oxygen to tissues. The wastes of cellular metabolism are eliminated, and specialized cells are delivered to tissues external environmental protection agent prevents leakage by closing the holes in the blood vessels [1]. The total blood volumes in woman’s are about (4-5) litter, while man are (5-6) litter, cell and cell fragmentation was 55%. Most blood cells grow from stem cells or precursors produced by the bone marrow [2]. The blood consists of cell-free plasma (50-60%) and erythrocytes (45%). And all blood cells, white cells (WBC) and platelets are 1% by volume [3].

Due to its radioactivity, uranium is considered a dangerous element. Therefore, uranium and its compounds pose a threat pollute the climate and endanger people's wellbeing [2]. Uranium is taken into account one of the most dangerous pollutants due to its radioactivity and hazardous substances that endanger public health and environmental balance. [4]. It absorbed after inhalation, oral ingestion, or skin contact, and the amount absorbed depends on the dissolution of the uranium compounds. These soluble compounds are absorbed for days while the less absorbed compounds settle in the lung and lymphocytes for long periods of time [5].

General, the kidneys are affected by the toxic effect of uranium, and some cells can be damaged while affected by the body, and cancer is the result of a physical mutation in the cell. The annual dose of natural radiation is about 1 mSv or more for the average citizen of the world [6]. Solid nuclear trace reagents (SSNTDs), technique for measuring the level of uranium in blood. Fleischer et al. proposed the fission pathway technique (FTA) [7]. This technique is suitable for uranium in blood quantification [8, 9]. Solid-state nuclear path detector (SSNTDs), and fission path technology were used in Salah al-din governorate, the CR-39 detector was used to determine the amount of uranium in patients with kidney disease.
The aim of the research to find levels uranium blood patients with kidney failure in this governorate, which witnessed a significant increase in the rates of kidney failure recorded after ISIS events (2014-2016).

2. Materials and Methods

2.1. Sample collection
This research was carried out on 80 male and female blood samples collected from two groups. First group included 60 samples of kidney failure patients from Dialysis Center at Tikrit Teaching Hospital in Salah al-din governorate. And the second group included 20 samples of healthy people living in these governorates. Figure1 and Figure 2 it depicts the cities of Salah din governorate as well as the number of kidney disease patients in this governorate.

![Figure 1. City locations in Salah al-Din governorate.](image)

![Figure 2. Number of patients in Salah Al-Din regions.](image)
Table 1 shows characteristics of the patient group (number and gender), and the healthy group are shown.

| Classification       | Kidney failure group | Healthy people |
|----------------------|----------------------|----------------|
| No. of samples       | 60                   | 20             |
| No. of man           | 31                   | 7              |
| No. of woman         | 29                   | 13             |
| Age range (years)    | 20-75                | 20-70          |

2.2. Experimental work

The presence of uranium in the blood of patients was discovered by using the fission path technique. Where a drop of blood (70 μl) is placed on the detector using a pipette and dried on an area about (1.5 x 1.5) cm² of the detector CR-39 [8,9]. Irradiation in (Ibn Al Haytham College, University of Baghdad, Iraq). Thermal neutrons from a neutron source is used to irradiate the blood (Americium - Barium) For a period one week in thermal neutrons flood of (3.024x10⁹ n/cm²) to produce fission tracks in the detector (CR-39).

After the reagents were exposed to a flood of neutrons, the reagents were etching from solutions of 6.25 N NaOH at 60 °c for about more four hours. Then clean etching detectors with water. The microscopic inspection was done using a light microscope. Calculate the intensity of traces ($\rho$) using the equation:

$$\text{Fission path density (\rho) = } \frac{\text{Total track}}{\text{Area of view}}$$  \hspace{1cm} (1)

The level of uranium in the blood was found by the following relationship:

$$C_x = \rho_x \cdot (C_s/\rho_s)$$  \hspace{1cm} (2)

$C_x$ (ppb): Level of uranium in unknown samples, $C_s$: level of uranium in standard samples. $\rho_x$ and $\rho_s$: Trace intensity of unknown and standard samples.

The slope between the trace intensity and the uranium concentration of the standard sample in Figure 3 which represents relationship trace density and uranium level (ppb) for a standard samples, the equation becomes:

$$C_x = \frac{\rho_x}{\text{slope}}$$  \hspace{1cm} (3)

3. Analyze samples statistically

All results obtained from the uranium level (ppm) in blood of patients were analyzed by Statistical program.

4. Results and discussion

Lower, higher, and average level of uranium (ppb) using the density of fission fragments in the sample of patients in kidney failure and healthy group as shows in Table 2.

We note from the figure (4). The average concentration of the infected group has a higher concentration than the normal individuals on average. As level concentration the blood the patient group is 5.00 times more than the concentration it from healthy group.
Table 2. Definition of data for concentration (ppb) in the blood of patients

| Statistical values     | Patients group | Healthy group |
|------------------------|----------------|--------------|
| No. subjects           | 60             | 20           |
| Minimum                | 1.636          | 0.301        |
| Maximum                | 7.477          | 2.332        |
| Av. ± Std. Errer dev.  | 5.496 ± 0.850  | 1.089 ± 0.150|
| Value of P *           | P = 0.004      | P = 0.004    |

* One - way independent sample ANOVA

Figure 3. Path density (tr/mm²) and uranium concentration (ppb) of standard blood samples

Figure 4. A mean value of uranium (ppb) of patients group and healthy group.
Table 3 shows effect of a gender bias on uranium concentration in patients and healthy subjects is demonstrated. Figure 5 shows the average values in man and woman patients and healthy subjects. And shows that average level for the two groups in man is higher than in woman. The reasons for that, the blood volume of woman’s are (4.5) liters, and in mans the blood volume are (5-6) liters [3].

**Table 3. Uranium levels (ppb) as a function of gender patients and health.**

| Group type      | Gender | Number of samples | Mean ± Std. Error | P-Value* |
|-----------------|--------|-------------------|-------------------|----------|
| Kidney failure  | Man    | 31                | 6.320±1.850       | P = 0.004|
|                 | Woman  | 29                | 4.672±1.340       |          |
| Healthy people  | Man    | 7                 | 1.101±0.814       | P = 0.004|
|                 | Woman  | 13                | 1.077±0.635       |          |

* One-way independent sample ANOVA

![Figure 5. Uranium level (ppb) for kidney failure patients and a healthy people as a result of sex](image)

Table 4 and figure 6 shows the average blood level of uranium in renal failure patients and healthy patients with age. Note that largest level of it in patients with kidney failure in the age group 20-40 years. In healthy group, we note that the level of uranium increases with age. Many researchers found these results [8-10].
Table 4. Uranium levels (ppb) as a function of age group for the two groups.

| Group type  | Age (years) | Number of samples | Mean ± Std. Error |
|-------------|-------------|--------------------|-------------------|
|             |             | man    | woman | total |                      |
| Kidney failure | 20 - 40    | 8      | 8      | 16    | 7.870 ± 2.24         |
| n=60        | 41 - 60    | 11     | 9      | 19    | 4.698 ± 1.109        |
|             | 61 - 80    | 13     | 12     | 25    | 4.654 ± 1.465        |
| Healthy people | 20 - 40    | 3      | 6      | 9     | 0.580 ± 0.041        |
| n=20        | 41 - 60    | 2      | 5      | 7     | 1.103 ± 0.1738       |
|             | 61 - 80    | 2      | 2      | 4     | 2.193 ± 0.1716       |

Figure 6. Level uranium (ppb) in patients and a healthy, with the age.

5. Conclusions
The results obtained showed that the average uranium level in the patient group's blood samples was 5.00 times higher than the uranium level in the stable group's blood samples. The male participants (both kidney disease patients and healthy people) had higher uranium levels than the females. In stable individuals, concentrations rose as the group became older. The results showed that the uranium concentration in the blood of patients and a healthy group was less than to the permissible limit from the ICRP 0.115 ppm (115 ppb).

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