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Assessment of Heavy Metals Content in Sewage Discharges from Health Structure in Mauritania

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Abstract: This study was carried to assess the quality of liquid waste produced by the Nouakchott Friendship Hospital in Mauritania, the aim is to quantify different heavy metals obtained from discharge of the hospital waste six heavy metals (arsenic, lead, cobalt, chromium, cadmium and copper) were object of evaluation. Analysis was carried using inductively coupled plasma - optical emission spectrometry (ICP-OES) method and the standards used are those of the WHO. The average content of heavy metals in different samples is different: Arsenic (4.625 µg/L), Lead (3.800 µg/L), Cyanide (0.05 µg/L), Chromium (0.013 µg/L), Cadmium (< LD (0.000000012 µg/L) and Copper (60 µg/L). Results showed that the samples of liquid waste from the Nouakchott Friendship Hospital were very loaded with pollutants, this may constitute a threat to the environment and a potential health risk for human, since the continuous introduction of these heavy metals into aquatic medium could be harmful through bioaccumulation and biomagnifications.

Key words: Heavy metals, waste, ICP-OES, pollutants, health risk.

1. Introduction

In view of the nature and importance of specific substances (drug residues, chemical reagents, antiseptics, detergents, developers and x-ray fixators, etc.) contained in the waste generated by hospital activities, as well as its evacuation (like conventional urban waste, to the municipal sanitation network without prior treatment), it may cause potential hazards to humans and their environment [1].

In recent years, the health establishments produce waste in large quantities, and of very diverse nature. In developed countries, the majority of wastewater (domestic, hospital and industrial) is passed through sanitation networks and collected and then treated in wastewater treatment plants before being released into the natural environment. This process thus makes it possible to limit the excessive inputs of organic matter and mineral pollutants into the natural environment [2].

The management of medical waste in general is seen as a serious problem in some countries especially developing countries. A study conducted by the World Health Organization (WHO) in 2002 among 22 developing countries showed that 18 to 64% of health establishments do not properly dispose of their health care waste. This showed that the current management of medical waste poses a real public health and environmental problem in developing countries. In these countries, an additional danger is added, that of excavation of landfills and manual sorting of waste

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collected at the exit of health care establishments without discrimination [3], which further complicates this problem and takes it on a different scale [4].

The relative problems of risky substances are thus one of the major current concerns [5-7]. In this context, the issue of discharges of hospital waste is becoming increasingly important. Indeed, these establishments generate substantial volumes of liquid waste which contain specific xenobiotics (metals, chemical reagents, disinfectants, detergents, radiographic developers and fixers, etc.) which will thus be disseminated in the environment [8].

Indeed, as occurs in all chains of human activity, medical care generates solid waste, liquid discharges and gaseous waste, and therefore causes transfers of pollutants to natural environments that can compromise the biological balance of ecosystems, aquatic life and the health of living beings [9]. Heavy metals like copper can disrupt in high doses the proper functioning of the enzymatic system of humans [10]. These heavy metals therefore represent a danger of water pollution since they can modify the physicochemical characteristics of the water and adversely affect the proper functioning of the treatment plant by destroying its purification flora [11].

In Mauritania, management of medical waste is a major challenge for national hospitals. Despite the large quantities produced at these hospitals, there is a poor management of effluents, which is mainly due to the lack of an establishment specialized in the treatment and disposal of hospital effluents.

In Nouakchott, capital of Mauritania, out of 13,650 m^3 of wastewater collected per day including hospital liquid effluents, only 4,250 m^3 are treated. Thus, 9,400 m^3 of wastewater (68.86%) is untreated and discharged directly into the sea through a public collection network. In view of this observation, it is necessary to implement planned integrated management systems for hospital waste. Mauritania's environmental and sanitation codes stipulate that producing establishments, namely hospitals and other health facilities are responsible for the biomedical waste they discharge [12].

The objective of the study is to evaluate the discharges of waste water at the Friendship Hospital by the quantification of heavy metals by ICP-OES method.

2. Material and Methods

2.1 Study Location

The Friendship Hospital was chosen as the study site because it is not directly linked to the city's sewerage network. The hospital has 9 departments, including surgery, internal medicine, pediatrics, obstetrics and gynecology, emergency, ENT, ophthalmology, anesthesia, resuscitation/hemodialysis/ outpatient, and medical analysis laboratory, with 91 beds. The friendship hospital has a unit responsible for public hygiene, which deals only with the cleaning of the premises and not with the treatment of waste from the various departments.

2.2 Sampling

Samples of liquid waste were collected from the internal sewage network of the Nouakchott Friendship Hospital. Four samples were collected in sterile bottles from August to September 2019, with an interval of 10 days.

The trace metal analysis was conducted using ICP-OES, which limit of detection (LOD) is 0.001 mg/kg. Hg was analyzed using Direct Mercury Analyzer (LOD = 0.003 mg/kg) according to the method [13].

3. Results and Discussion

The liquid waste produced by the Friendship Hospital of Nouakchott has a great variability in characteristics and this variability depends upon the rejection of services. The results show that the concentrations of heavy metals in liquid waste varied at the Friendship Hospital of Nouakchott during the study (Figures 1-5).

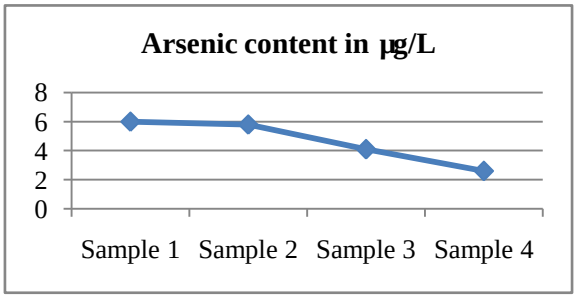

Fig. 1 Arsenic variation in samples.

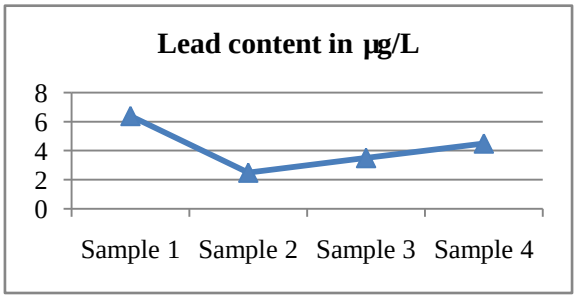

Fig. 2 Lead variation in samples.

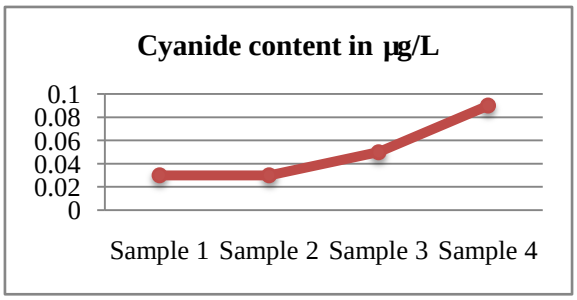

Fig. 3 Cyanide variation in samples.

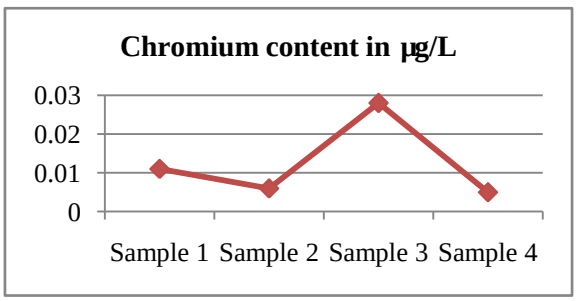

Fig. 4 Chromium variation in samples.

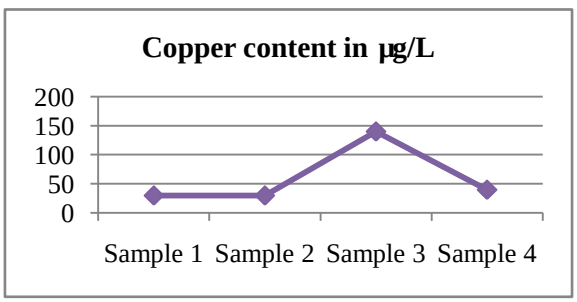

Fig. 5 Copper variation in samples.

The results obtained from the analysis of heavy metals in samples of liquid waste from Nouakchott Friendship Hospital are presented in Table 1. The results revealed a variation in contents of different heavy metals. The averages of the heavy metal concentrations of for samples from the liquid waste collection point of the Friendship Hospital are respectively presented in Table 2.

Table 1 Overview of heavy metals content in different samples.

Element (μg/L)	Sample 1	Sample 2	Sample 3	Sample 4
Arsenic	6	5.8	4.1	2.6
Lead	6.4	5.2	2.5	2.1
Cyanide	0.03	0.03	0.05	0.09
Chromium	0.011	0.006	0.028	0.005
Cadmium	< LD	< LD	< LD	< LD
Copper	30	30	140	40

LD = limit of detection (0.000000012 μg/L).

Table 2 Comparison results with different countries standards.

Element (μg/L)	Range	Mean ± SD	Standards				
			Morocco	Senegal	Benin	South Africa	OMS
Arsenic as As	2.6-6	4.625 ± 1.597	1,000	1,000	500	500	-
Lead as Pb	2.1-5.4	3.800 ± 1.742	5,000	500	1,000	100	500
Cyanide as Cn	0.03-0.09	0.050 ± 0.028	1,000	-	1,000	-	-
Chromium as Cr	0.005-0.028	0.013 ± 0.011	100	-	2,500	500	-
Cadmium as Cd	< LD	-	-	-	1,000	50	-
Copper as Cu	30-140	60.000 ± 53.541	100	1,000	2,500	1,000	200

One of the main environmental problems posed by liquid hospital waste is its discharge, like conventional urban effluents, to municipal sanitation networks without prior treatment [14]. Indeed, the use of measuring devices and solutions based on metals in hospitals in developing countries facilitates the presence of these metals in the liquid discharges of the various medical services [15].

The sewage discharge from services of the Friendship Hospital of Nouakchott does not reveal a high concentration of heavy metals (Arsenic, Lead, Cyanide, Chromium, Cadmium and Copper). Our results showed a variation of different heavy metals content in period of sampling. Arsenic and lead contents (Figures 1 & 2) decreased in the period of the study, while cyanide (Figure 3) increased. However, the contents of chromium and copper (Figures 4 & 5) had a variation during the study.

In Mauritania, there is no regulation about the standards for heavy metals in hospital sewage discharge. In our study, we compared our results with those of the WHO standards and those of other countries standards in Africa (Table 2). In our study, the content of heavy metals found in liquid waste from Friendship Hospital is not significant and are below the sewage discharge standards, except for copper which in Sample 3 (140 μg/L) was above the limit of copper by the Moroccan regulation. Arsenic concentrations varis from 2.6-6 μg/L, the lead content varied between 2.1-5.4 μg/L, and the cyanide, chromium and copper contents varied between 0.03-0.09 μg/L, 0.005-0.028 μg/L, 30-140 μg/L, respectively. The cadmium concentration was lower than the detection limit of 0.000000012 μg/L, which was consistent with the determination result [16].

Other studies have shown that there are low concentrations of heavy metals in hospital liquid wastes, such as arsenic, cadmium, lead, copper and

chromium [16-18].

4. Conclusions

The study is the first to measure heavy metal emissions from health facilities in Mauritania. The concentration of heavy metals in liquid wastes provides valuable information; the toxicity of these metals should be taken into account when comparing the potential impact of these metallic elements on the environment and on aquatic animals. This preliminary study highlights the presence of heavy metals in the liquid wastes from the Nouakchott Friendship Hospital, which are toxic even at very low concentrations.

The evaluation of metal pollution degree in this study shows that metal pollution can be seen in all samples (arsenic, lead, cyanide, chromium, cadmium and copper). In order to reduce the risk of these toxic elements in hospital emissions, it is necessary to treat this wastewater.

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