Lead detection from Blood Sample using Biosensor

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Abstract

Devices based upon bio sensors that work with biomaterials such as blood, urine, or saliva are being developed to improve ability to detect chemical exposures in environment and disease. Different types of pollutants like heavy metals are present in the environment. Among these toxic metals, lead composition is maximum in atmosphere. Despite of the considerable works to identify and eliminate lead sources, this metal still remains a significant health concern, particularly in young children and to those who travels in heavy traffic for three to four hours. Even Infants and frequent travelers are also exposed to lead emitted by different automobiles. As lead gets accumulated in lungs and cause severe congestion, breathing problem and sometimes it leads to cancer. So, in order to keep a precise check of the level of lead in the human blood a detection device is necessary to be deduced. A basic device which works on the idea of signal transmission and conversion to detectable signals. This device would be able to detect the trace amounts of lead in blood which would be helpful in the field of medical science.

Keywords: Biosensor, Blood sample, Lead detection, Abnormality, Signal transmission

Introduction

In today’s date the pollution is increasing with a tremendous rate affecting humans as well as other organisms. As the world further steps into rapid industrialization along with increased urbanization human beings are getting more exposed to Pollutants. The exposure of pollutants is specifically more in case of air because it is a very quick way to spread in the environment rather than the other sources. Air pollution contains several pollutants which includes heavy metals, harmful gases and other microbial organisms including bacteria, fungi and viruses. However, among heavy metals, lead is one of the most dangerous pollutant, which is received by automobile exhaust as well as industrial chimney outlets. Data suggest a much as 1,43,000 deaths every year and 0.6% of the global burden of diseases is due to lead. However, there are many technologies and considerable efforts are being made to identify and eliminate this metal.

Lead is a chemical element in Group 14 (Iva). It is malleable, ductile and is highly durable as well as resistant against corrosion. However, lead and its compounds are highly toxic and is retained in the human body accumulating over prolonged exposure called as cumulative poisoning. The toxicity increases as the solubility increases. Due to which neurotoxic effect of lead ions has been observed which is damaging the central and peripheral nervous systems resulting in stunted growth, behavioral problems, as well as learning disabilities. Recent studies showed that quantity of 10 µg/dL of lead ions in blood affects the child’s learning ability along with behavior. A much higher level (≥70 µg/dL) can cause severe health problems, which includes coma, seizures, and even death. Exposure of lead to children ageing under 1–5 years can affect almost every organ system in body with increased risks in damage of the brain and the nervous system, which results in slow growth, learning behavior problems, as well as hearing and speaking deficiencies.
So, in order to keep a precise check of the level of lead in the human blood a detection device is necessary to be deduced. A basic device which works on the idea of signal transmission and conversion to detectable signals. The aim of this work is to put forward a concept of simple and effective lead detecting device that can easily determine the concentration of lead in blood. This device would be able to detect lead concentrations before it can reach an alarming situation creating complexity. Till date different types of biosensor has been developed for detection of various metabolites such as glucose level in blood and urine.\(^1\) Biosensor construction involves combining two elements with different characteristics. This entails three steps. Firstly, a bioreceptor is chosen, then a transducer, and finally the biological component is fixed to the transducer.\(^2\)

Biorecognition element is tightly bound on to physico-chemical transducer by physical or chemical immobilization methods. Transducers are able to measure signal arising from producing interactions and five groups of transducers are generally known: electrochemical and optical followed by mass-based are the most common but thermal and magnetic biosensors are well known.\(^3\)

Till date various analytical methods has been developed. They are atomic absorption spectroscopy (AAS), inductively coupled plasma–mass spectrometry (ICP-MS), inductively coupled plasma–optical emission spectroscopy (ICP–OES), mass spectrometry (MS) and X-ray fluorescence spectroscopy (XPS).\(^4\) Currently, methods for lead ions detection in water, vegetables and many other food products mainly depend on laboratory instrument analysis including graphite furnace atomic absorption spectrometry (GFAAS), inductively coupled plasma atomic emission spectroscopy (ICP-AES).\(^5\) ELISA has been developed as an effective alternative tool for the detection of some metal ions by many groups.\(^6\) Atomic absorption spectrometry method is based on the fact that free atoms absorb light at specific wavelengths characteristic to the element of interest. The amount of light absorbed can be correlated in a linear fashion to the concentration of the analyte in the sample.\(^7\) The other method called graphite furnace atomic absorption spectrometry (GFAAS) method uses an electrically heated graphite tube to vaporize and atomize the analyte at temperatures up to 3000 °C prior to its detection. In this method sample volumes of 10-50 μL can be analysed.\(^8\) GFAAS is currently one of the most commonly used methods for determining lead concentrations in blood. Nano-material of calcium hydroxyapatite (n-CaHAP), with particle size ranging from 50 to 57 nm which was prepared from phosphogypsum waste (PG), was used for the removal of lead ions (Pb (II)) from aqueous solutions.\(^9\)

Despite the considerable efforts that have been made till date to identify and eliminate Pb sources, this metal still remains a significant health concern, particularly for young children.\(^10\)

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**Proposed Method**

The aim of this work is to put forward a concept of simple and effective lead detecting device that can easily determine the concentration of lead in blood. This device would be able to detect lead concentrations before it can reach an alarming situation creating complexity.

Measuring the lead quantity using such robust devices are expensive as well as can be complex. So, in order to overcome this challenge, we have proposed a device which will be smaller, less expensive and less complex. This device would be based on the principle of ASV( anodic stripping Voltammetry) which states that when a negative potential is applied to a mercury coated graphite electrode in a blood sample the lead ions gets accumulated on the surface of negatively charged electrode and when we reverse the potential then the current produced will be proportional to number of lead ions produced.

At present, there are devices which are specifically used to measure the concentration of glucose in blood. These devices provide more elaborate information regarding the amount of glucose in blood. Glucose meter uses a biosensor in which the immobilized GOx catalyzes the oxidation of β-D-glucose by molecular oxygen producing gluconic acid and hydrogen peroxide.\(^11\)

A similar device can be deduced in order to measure the concentration of lead in blood using a suitable biosensor. In present work a hypothesis has been proposed to develop a biosensor for lead detection from blood. In this device a strip would be present coated or immobilized with mercury which can detect lead.\(^12\) The sensor used in this device would give a signal when the lead concentration is above 10 micro liters, when detected in blood.\(^13\)

**Proposed Result**

The device would generate fluorescence/signal indicating the presence of lead in blood. This device would be somewhere similar to that of the glucose meter but its main priority will be to measure the concentration of lead in blood. This will ultimately safeguard the health before reaching the alarming situation. This device will be portable in size and can be easily carried.

Since many abnormalities such as abdominal pain, constipation, frequent headaches, kidney dysfunction, aggressiveness in behavior along with other abnormalities are being caused nowadays at an alarming rate due to accumulation of lead. So, introduction of this device would be helpful towards those people who are unable to go for the tests as it is highly out of their budget. This device would also help to detect any abnormalities which may become fatal later. Further scopes of detecting other heavy metal such as mercury and cadmium will be considered in later stages of work.
Enormous progresses are being made to counter the challenges faced by lead toxicity in blood. So, to successfully deduce the quantity of lead toxicity in blood, several equipments have been developed earlier. But, these equipments are expensive and cannot be used feasibly. These equipments also consumes time. In order to overcome this situation presently a user-friendly device has been proposed which would be able to detect the lead toxicity level in blood without any haste. This device would be able to detect lead toxicity levels in blood at an early stage. This will reduce the chances of many abnormalities and defects such as brain development in children, behavioral problems, growth delays and other health complexities in adults as well.

Conflict of Interest: None

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