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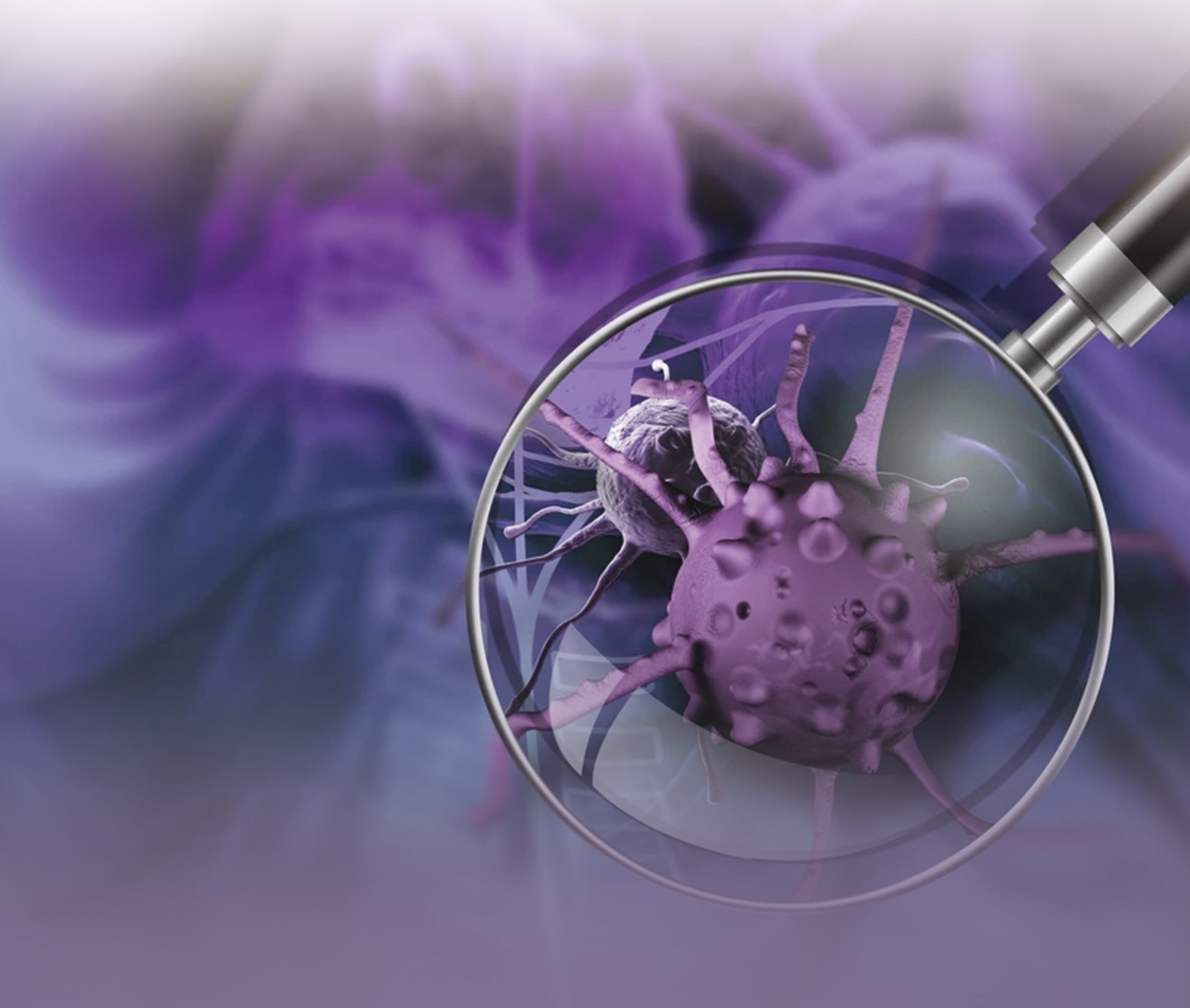

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ARTICLE

# Abound Hepatic Mitosis: Unusual Morphology in the Intrahepatic Cholelithiasis Patient

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ABSTRACT

To explore the clinicopathological features of abound mitosis of the hepatocytes in intrahepatic cholelithiasis. The clinicopathological data of one case diagnosed as intrahepatic cholelithiasis was collected from Yantai Yuhuangding Hospital and the clinicopathological characters were discussed. A 68-year-old man suffered from the pain in the right upper quadrant and radiology showed multiple stones in the gallbladder and left liver. The images suggested intrahepatic cholelithiasis. The patient received gallbladder and partial hepatectomy. A large number of mitosis was observed and twelve nuclear fissions were found under high magnification, even in some area pathological nuclear fission could be observed in morphology. On the basis of detection in laboratory, the diagnosis of intrahepatic cholelithiasis was made. The patient did not receive any therapy after surgery. The patient was in a good condition after 18 months follow-up. Increased number of hepatic mitosis might be due to the stimulation from stones, hepatic biliary or secondary inflammatory. High index of proliferation should be prevented from the potential misdiagnosis of hepatic tumor.

## 1. Introduction

The liver is one of the few organs with regenerative ability in human body. When the injury caused by trauma or chronic diseases, hepatocellular regeneration is actived and new cells are produced by mitosis. A number of studies have shown that liver regeneration requires the participation of both parenchymal cells and interstitial cells, which carry out complex internal interaction and coordination [1,2]. In spite of this, hepatocellular mitosis is

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really unusual to be seen under the microscope except for viral infection or neoplasm interestingly. Intrahepatic bile duct stone is one kind of bile duct stones, which refer to stones in the bile ducts above and below the junction of the left and right hepatic ducts. Intrahepatic bile duct stones are mostly primary stones, but they can also be secondary to cholecystolithiasis, which is relatively common in western countries [3]. Therefore, hepatolithiasis is mainly choledocholithiasis, but also cholesterol calculi. The disease is related to biliary bacterial infection, bile retention and parasite infection. The main symptoms of the patients are epigastric pain, jaundice, chills and fever. If the disease develops further, it can be complicated with biliary liver abscess, severe hepatocholangitis, liver function decompensation and other symptoms, seriously threatening the life and safety of patients. It is reported in the literature that there is a tendency to increase the number of cholesterol stones in the intrahepatic bile duct. Classification according to stone distribution and pathological changes of bile duct. The most famous is Nakayama classification [4], which mainly classifies hepatolithiasis according to the distribution of bile duct stones, bile duct stricture and bile duct dilatation, in addition to considering the difference of stone composition and the presence or absence of cholecystolithiasis. According to the left and right hepatic ducts and the hepatic ducts above the hepatic segment, they were divided into central type and peripheral type, and according to the presence of extrahepatic stones, they were divided into intrahepatic type and extrahepatic type. At the same time, according to the different distribution of stones in the left and right hepatic lobes, they can be divided into L type (left lobe), R type (right lobe) and LR type (left and right lobe), bile duct stricture and dilatation are represented by S and D respectively, and according to the diameter of bile duct, 0, 1 and 2 are used to indicate the degree of stricture or dilatation, such as S0 for no stricture and D1 for mild dilatation. The stricture and dilatation of bile duct can be divided into common bile duct, common hepatic duct, central part and terminal part. The disease mostly occurs in China, Japan, South Korea and other Asia-Pacific regions, with an incidence of about 3.1% to 21.2% [5]. Generally it is a bilirubin stone. Intrahepatic bile duct stones often associated with extrahepatic ble duct stones, concurrent bile duct obstruction, induced local infection and secondary bile duct stenosis which make stones difficult to discharge automatically. The disease is prolonged and could cause serious complications. Intrahepatic cholelithiasis is an important cause of death of benign biliary tract diseases [6]. In recent years, surgical operation is the main treatment of hepatolithiasis, and the principles are as follows: removal of stones, relief of biliary stricture and obstruction, removal of stone sites and infectious lesions, unobstructed drainage and prevention of stone recurrence. The operative methods include choledocholithotomy, choledochojejunostomy and hepatectomy, which can be combined with ultrasound, cholangiography, choledochoscopy and lithotripsy during and after operation. Among them, hepatectomy is the most effective and thorough surgical method in addition to liver transplantation, which can not only remove stones, but also remove the common sites of stones and damaged liver parenchyma at the same time. Surgical methods include traditional open hepatectomy and laparoscopic hepatectomy. Robotic surgery provides a new method for the treatment of hepatolithiasis [7]. Precision hepatectomy has become the most effective first-line treatment for hepatolithiasis. Combined with intraoperative ultrasound to accurately locate bile duct lesions and the extent of stones, the focus can be effectively removed, and the stone clearance rate is up to 95%. However, the postoperative recurrence rate is still as high as 3% to 15% [8-10]. The main reason is that (1) improper application of operation. For example, bilateral extensive multiple bile duct stones with liver parenchyma damage, because there is no technique of hepatectomy, only choledocholithotomy or choledochojejunostomy, or even choledochoduodenostomy, did not remove the stones and bile duct stricture, resulting in postoperative stones and residual lesions, repeated attacks of cholangitis, requiring multiple operations, which not only increased the pain, trauma and economic burden of the patients, but also brought difficulties to the follow-up treatment. (2) expand the application of hepatectomy blindly. Hepatectomy is mainly used for local liver parenchyma damage or bile duct stricture can not be corrected. But some liver tissues that were basically normal and could have been preserved were removed; (3) blind application of laparoscopic surgery. For example, patients with a history of biliary tract surgery still use laparoscopic surgery, and the conversion rate is very high, which increases the cost and burden of patients. (4) the procedure of laparoscopic hepatectomy is not reasonable. Choledocholithotomy is often performed first, and then hepatectomy. During the operation, a large amount of bile overflows and pollutes the abdominal cavity, and it is difficult to absorb under the endoscope, resulting in postoperative abdominal pain, fever and even residual peritonitis, which interferes with the judgment of the disease. The treatment of intrahepatic bile duct stone depends on accurate preoperative evaluation and scientific classification. The reasons for the above confusion are as follows: (1) the limitation of treatment technology itself. There are many treatment methods for the disease, but except for liver transplantation, other methods are not easy to cure, and there are many postoperative complications, high residual stone rate and recurrence rate. Even for hepatectomy, for bilateral extensive intrahepatic stones, only one side of the hepatic lobe with severe lesions can be removed, and the other side with mild lesions should be removed by intraoperative choledocholithotomy and choledochoscopy. For patients with many previous biliary tract operations, it is difficult to perform laparotomy or laparoscopy because of abdominal adhesion and changes of anatomical structure around the hepatic hilum. The general condition of the patient is poor, no matter what kind of operation, it is limited. The traditional operation requires multiple dilatation of the sinus, patients need to undergo multiple anaesthesia, and the hospital stay is longer [11]; (2) lack of scientific classification of hepatolithiasis, (3) lack of scientific, authoritative treatment system for hepatolithiasis widely accepted by surgeons. Most of the operators refer to the experience of other units to carry out the treatment of hepatolithiasis. At present, three-dimensional imaging technology has been gradually applied to surgical clinic, which is beneficial to accurate preoperative evaluation and classification of hepatolithiasis. 3D printing technology can make a simulated tissue and organ model, which can be used to simulate surgical operation [12]. It can also be used to verify the classification of hepatolithiasis before operation, so as to guide the operation more accurately. With the development of artificial intelligence, microelectronics and genetic biology, it is worth looking forward to the "parade diagnosis" and "lithotripsy" or gene regulation of bile duct micro-robot to remove stones.

Recently, in a pathological examination of a patient with intrahepatic bile duct stones, we found a large amount of mitosis in the liver. In view of this situation, we analyzed the patient.

## 2. Materials and Methods

### 2.1 Clinical Data Collected

In our study, the case diagnosed as intrahepatic cholelithiasis with abound mitosis was obtained from Department of Pathology, Yantai Yuhuangding Hospital. We collected the clinical data. This study was approved by the Ethics Committee of Yuhuangding Hospital in Yantai, Shandong Province.

## Sample process and morphological observation

The samples were immersed in 10% buffered formalin for complete fixation after surgery, and then the tissue dehydration and paraffin embedding were carried out. 4 μm sections were cut from tissue blocks for hematoxylin and eosin (HE) staining. Tissue morphology was observed under microscope.

The wax blocks were re-paraffin-embedded and sectioned and stained with conventional HE. Three pathologists with senior professional titles re-read the diagnosis by double-blind method and re-checked the results of immunohistochemical staining.

**Table 1.** Main reagent and production company

| Main reagents | production company |
|---|---|
| Mouse anti-human K67 monoclonal antibody; clone: IMB-1 | Beijing Zhongjinqiao Biotechnology Co., Ltd. |
| Secondary antibody and cell pretreatment cleaning buffer(Tris buffer) | ROCHE Company |
| DAB chromogenic solution kit, EDTA repair solution | ROCHE Company |
| absolute ethyl alcohol | Tianjin Beichen Founder Chemical Reagent Factory |
| Tris-HCL, BSA ,ammonium persulfate | fresco, Inc |

### 2.2 Hematoxylin-eosinstaining

Hematoxylin-eosinstaining, referred to as HE staining, is one of the commonly used staining methods in paraffin section technology. Hematoxylin dye is alkaline, which mainly makes the chromatin in the nucleus and nucleic acid in the cytoplasm purplish blue; eosin is an acid dye, which mainly makes the components in the cytoplasm and extracellular matrix red. HE staining is the most basic and widely used technical method in histology, embryology, pathology teaching and scientific research.

(1) Paraffin tissue is sliced and baked at 80 °C× 30 min

(2) Soak slices in xylene solution for 5 minutes × 3 times

(3) Soak the slices in 100% alcohol solution for 2 minutes

(4) Soak the slices in 90% alcohol solution for 2 minutes

(5) Soak the slices in 80% alcohol solution for 2 minutes

(6) Soak the slices in 70% alcohol solution for 2 minutes

(7) Rinse the slices for 5 minutes

(8) Soak slices in hematoxylin solution for 5 minutes

(9) Rinse the slices for 2 seconds

(10) Soak in 1% hydrochloric acid ethanol solution for 2 seconds

(11) Rinse the slices with running water

(12) Soak the slices in eosin staining solution for 2

minutes

(13) Rinse the slices with distilled water for 2 seconds

(14) Wash the slices slightly in 80% alcohol solution

(15) Soak the slices in 95% alcohol solution for 3 seconds

(16) Soak the slices in 100% alcohol solution for 5 seconds

(17) Soak the slices in xylene solution for 2 minutes × 3 times

(18) Seal the slices with neutral gum

### 2.3 Immunohistochemical Staining

EnVision two-step method was adopted by automatic immunostainer (VENTANA) for immunohistochemical staining and DAB color. Each slice was stained with known positive tissues as the positive control, while negative control replaced the first antibody with PBS. All the antibodies used in this study were bought from Roche Company.

### 2.4 Immunohistochemical Procedure

(1) The slides were placed in a mixture of potassium dichromate and concentrated $H_2SO_4$, then washed in clean water, soaked in alcohol, then placed on a shelf and placed in a 37 °C incubator, and polylysine was coated on the surface of the slides.

(2) First, add some liquid paraffin to the mold, cool it slightly, then put the tissue to be embedded in the paraffin and arrange it neatly, and finally add a little liquid paraffin to freeze the paraffin to make the paraffin solid.

(3) Paraffin tissue sections were placed at 60 °C for 60 minutes.

(4) Soak the slides in xylene I-xylene II-100% alcohol-95% alcohol-90% alcohol-80% alcohol-70% alcohol sequentially and soak 10min in each reagent.

(5) After tissue dewaxing, rinse in clean water for a period of time, add 3% hydrogen peroxide to soak 10 mins, wash twice in clean water, then add citric acid buffer, cook twice in microwave oven, each time 3 mins

(6) After cooling to room temperature, pour out the citric acid buffer, wash it twice, 5 min the slides in PBS, wash twice, dry the excess PBS solution, immediately add the serum, and then put it in the 37 °C temperature box for half an hour.

(7) Remove the slide from the incubator, dry the serum around the slide tissue with absorbent paper, add primary antibody, and store it overnight in a 4 °C refrigerator.

(8) Remove the slide from the refrigerator, wash it in PBS for 3 times, 5 mins each time, dry the PBS around the tissue, add secondary antibody, and place it in a 37 °C incubator for half an hour.

(9) Remove the slide from the incubator, wash it in PBS for 3 times, 5 mins each time, dry the PBS around the tissue, add SABC, and place it in a 37 °C incubator for half an hour. SABC dilution 100x.

(10) Remove the slide from the incubator and wash it in PBS for 3 times, each time 5 mins, dry the PBS around the tissue and add a chromogenic agent.

(11) After rinsing the colored slides with clean water for a period of time, soak them in hematoxylin and dye them.

(12) After rinsing the re-dyed slides in water, put the slides in 70% alcohol-80% alcohol-90% alcohol-95% alcohol-100% alcohol-xylene-xylene in turn. 2 min was placed in each reagent, then soaked in xylene and placed in the ventilation cabinet.

(13) Drop the neutral gum next to the tissue and cover it with a cover slide to avoid bubbles. Seal the slices and place them in a ventilation cabinet to dry.

## 3. Results

### 3.1 Clinical Data

A 68-year-old Chinese male was sent to the hospital due to the pain in the right upper quadrant for three months ago. During the physical examination, the taps pain of the liver area was revealed obviously. No enlarged lymph nodes were touched in bilateral neck, axillary and groin. Multiple stones were found in the gallbladder and left liver by Magnetic Resonance Cholangiopancreatography (Figure 1A). The blood, liver function and virus hepatitis detection were normal by the laboratory examination. The patient did not take hormone drugs and denied the medical history of gout, hepatitis and tuberculosis. The patient had the habit of drinking a small amount of alcohol occasionally. Then, the patient received gallbladder and partial hepatectomy.

### 3.2 Gross Examination

The sample obtained after surgery was showed that one part of liver tissue with the volume 10 cm x 7.5 cm x 4.5 cm and the volume of gallbladder was 4.5 cm x 2 cm x 2 cm. The cut surface was gray and the Intrahepatic bile duct expanded. Several stones were found in the liver and gall bladder. The stone obstructed the lumen and the liver tissue was tough with no obvious mass observed.

### 3.3 Histological Findings

Morphologically, part of the lining of the epithelium in the dilated bile duct wall was absent in which fibrosis and inflammatory cell infiltration were accompanied. Stones were also seen in the lumen. The structure of hepatic lobule and manifold were not destroyed. The hepatic cords were normal and lymphocytes infiltrated in hepatic manifold (Figure 1B). Hepatocyte degeneration and cholestasis in cytoplasm were showed. The nucleuses were enlarged, the nuclear membrane was thickened and the nucleolus was visible. Active growth was evidenced by a large number of mitosis. Twelve nuclear fissions were found under high magnification even in some area where pathological nuclear fission could be observed (Figure 1C).

### 3.4 Immunohistochemical Staining

Immunohistochemical staining of Ki67 revealed that the hepatocyte proliferation index was approximately 20% (Figure 1D).

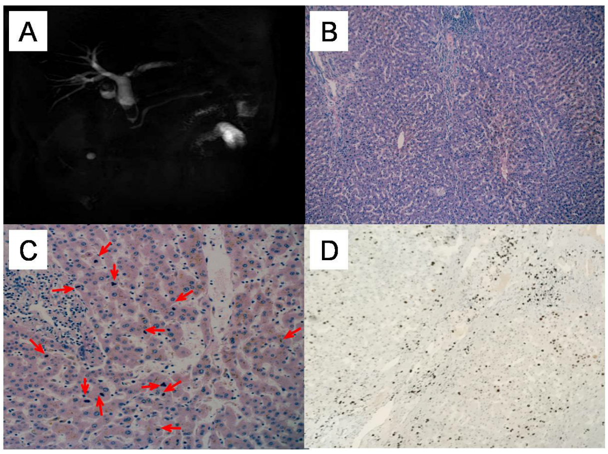


**Figure 1.** [A]Multiple stones were found in the gallbladder and left liver by Magnetic Resonance Cholangiopancreatography.[B] The hepatic cords were normal and lymphocytes infiltrated in portal area. Hepatocyte degeneration and cholestasis in cytoplasm were showed (4×). [C]The hepatocellular nucleus was enlarged and the nucleolus was visible. Twelve nuclear fission were observed under high magnificationin some area and pathological nuclear fission could also be found (showed by red arrows, 20×). [D] Immunohistochemical staining of Ki67 revealed that the proliferation index was about 20%.

## 4. Discussion

Hepatolithiasis is a common gallstone disease, but stones are segmentally distributed along the intrahepatic bile duct tree, resulting in many complications such as bile duct obstruction, local stricture or liver abscess, threatening the life and safety of patients. Hepatectomy is one of the main methods for clinical treatment of the disease, which can not only remove the focus, but also remove all the stones, relieve bile duct obstruction and improve the symptoms and condition of patients.Long operation time will not only enhance the stimulation of anesthesia to patients, but also prolong the time of wound infection and increase the incidence of incision infection, abdominal infection and biliary tract infection. It can also cause the attack of acute cholangitis, plus the second operation will increase the separation of wound, increase postoperative abdominal exudation and increase the risk of postoperative abdominal infection. In addition, most patients with secondary surgery will have residual stones or stricture of choledochojejunostomy, which will cause atrophy of the involved hepatic lobe, damage the structure of the hepatic hilum, affect postoperative recovery, cause inflammatory reaction, and lead to wound inflammation or infection. The abnormal blood supply of biliary tract in patients with a history of biliary surgery, coupled with the attack of cholangitis, can lead to scar formation and thickening of bile duct wall. After the second surgical treatment, it will affect the healing of biliary tract and increase the incidence of biliary leakage or biliary bleeding. Preoperative low albumin is easy to increase the nutritional risk of patients and reduce their postoperative immune ability, which will not only affect the prognosis of patients, but also not conducive to the recovery of liver function, but also increase the risk of postoperative infection and even increase mortality. For patients with hepatolithiasis, adequate surgical preparation should be made, and appropriate surgical procedures should be selected combined with the results of imaging examination. Before operation, we should pay attention to the nutritional intake of patients and guide their reasonable and healthy diet. At the same time, we can work with dietitians to formulate the corresponding diet. If the patient has diabetes, we can change the diet accordingly to ensure that the blood sugar of the patient is normal and supplement sufficient protein. The operation can only be carried out after the nutritional index reaches the standard. At the same time, nursing supervisors should strengthen the surgical training and assessment of nursing staff, organize them to participate in the study of surgical cooperation nursing in other colleges and universities, improve their nursing level of surgical cooperation, and at the same time, strengthen communication between doctors and nurses and cultivate tacit understanding. It is helpful to improve the efficiency of surgical cooperation and shorten the time of operation. In the course of the operation, the nursing staff should stop the bleeding in time to ensure the clear visual field of the operation, at the same time, strictly follow the principle of aseptic operation, remind the doctor to pay attention to the operation strength and reduce the unnecessary injury at any time. It can avoid the occurrence of infection to the maximum extent, prevent the use of antibiotics after operation, and reduce the infection rate of patients.

Mitosis is the process by which eukaryotic cells divide the chromosomes into two nuclei in their nucleus. After mitotic division, the cytoplasmic division is usually accompanied, and cell structures such as cytoplasm, organelle and cell membrane are equally distributed into daughter cells [13,14]. Mitosis and cytokinesis are defined as the cleavage phase of the cell cycle, or the M phase. This process produces two daughter cells that are identical to the parent cell gene [15-17]. This process typically accounts for about 10% of the entire cell cycle. The mitosis process is highly complex and regular. During mitosis, chromatin forms a pair of chromosomes and is pulled by the microtubules of the spindle, dragging the sister chromatids to the cell poles [18]. Mitotic spindle is an apparatus which forms during cell division and promotes sister chromatids segregation through the anaphase. The mitotic spindle is composed of a variety of proteins among which tubulins are predominant. The chromosomes attached to the tubulins via the kinetochore proteins actively monitor spindle formation and prevent premature anaphase onset. The cells then enter the cytoplasmic division, producing two cells with the same genetic makeup. Mistakes in mitosis could kill the cell by apoptosis or cause mutations that cause cancer [19-22].

Hepatocytes belong to completely regenerative cells but an increase in hepatic mitosis is unusually seen under pathological conditions except for acute viral hepatitis and drug-induced hepatitis, such as infectious mononucleosis and leptospirosis [23,24]. The nuclear material staining of normal mitotic hepatocytes is consistent with that of normal hepatocytes, and there is no specificity, and most of them are two closely adjacent and similar offspring hepatocytes. In abnormal division, the nuclear material of the liver was stained specifically, shining brightly, and the nuclear chromosomes were loose, fragmented, cord-like or fine-grained.Recent studies have shown that a boosted hepatocyte turnover occurring in a context of metabolic liver disease contributes to the induction of the chromosomal instability (CIN) that represents one of the key features of HCC tumorigenesis. CIN is sensed as DNA damage and induces a signaling pathway named DNA damage response (DDR) [25]. The DDR is involved in several aspects of DNA integrity because it affects several cellular processes such as mitosis, senescence, apoptosis. In other tumors, an increased rate of CIN generates diverse karyotypes within a tumor, the term chromosomal instability describes a rate of change i.e. a dynamic feature of chromosome pathophysiology [26]. This affects chromosome number and structure and is a characteristic of many cancer types including HCC. It is also associated with the formation of extranuclear bodies that contain damaged chromosome fragments or whole chromosomes [26,27]. By now, the appearance of abound hepatic mitosis in the patient who suffers from cholelithiasis has not been retrieved. The patient in our report had no history of hepatitis and taking medicine. After surgery there were about one and a half year and he survived very well at present. The proliferative index of normal hepatocytes is less than 1%. Increased number of hepatic mitosis might be due to the stimulation from stones, hepatic biliary or secondary inflammatory [28].

High index of proliferation should be prevented from the potential misdiagnosis of hepatic tumor. As far as differential diagnosis was concerned, the lesions showing much more mitosis in liver should be ruled out. (1) Acute hepatitis. Liver cells turbid and swollen, edema-like changes and balloon-like changes. Inflammatory cells infiltrated in the lobes, mainly lymphocytes, and scattered in the point of necrosis. Hepatocyte regeneration and repairing, manifested as nuclear division or increased nuclear phenomenon. The laboratory tests could detect the virus in the blood [29]. (2) Large cell changes in hepatocytes of nodular cirrhosis. The number of large cells increases with the age of the patients without P53 gene mutation, so this change is considered to be a cell proliferation disorder, rather than precancerous lesions. It is characterized by the increase of the volume of hepatocytes and nucleus to 2 to 3 times normal. At the same time, the nucleus is heteromorphic, showing enlarged nucleoli, multi-nuclear and nuclear chromatin staining. Mitosis could be observed in large cells [30]. (3) Liver neuroendocrine tumor. The tumor cells could be arranged as trabecular, banded, solid tumor nest, acinar or tubular. Tumor cells are small with abound cytoplasm. Nucleus is round or oval with deep staining. Mitotic figures are more common and Ki-67 index is significantly increased. Neuroendocrine granules are visible in the lesion and immunohistochemistry chromogranin (CgA), neuron specific enol (NSE), Syn are positive expression [31]. (4) Hepatocellular carcinoma. Carcinoma cells are arranged in a solid mass, surrounded by dilated sinusoids. The border of cancer cells is unclear. The nucleus usually has an abnormal shape and the mitotic figures are easy to be observed. Forming a clear mass, the disappearance of the liver plate and hepatic sinus is a distinguishing point from the normal liver in morphology [32].

## Conflict of Interest

The authors declare that there are no conflicts of interest.

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REVIEW

# Potential Phytochemicals for Cancer Treatment: A Review

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ABSTRACT

Today, cancer had been described as one of the deadliest diseases worldwide. It has been estimated that cancer causes about 9.9 million deaths in the year 2020. The conventional treatment for the disease involves single chemotherapy or a combination of mono-chemotherapy and or a combination of mono-chemotherapy and radiotherapy. However, there are negative sides to these approaches which have prompted the search for new therapeutic drugs. In view of this, scientific communities have started looking for innovative sources of anticancer compound of natural origin which include traditional plants. Nowadays, several studies have evaluated the anticancer properties of bioactive components (phytochemicals) derived from the plants both in vivo and in vitro. The phytochemicals are secondary metabolites or chemical compound produced during metabolic process in plants which are useful in the protection of plants. Most of these phytochemicals such as alkaloid, flavonoids, phenolic compounds, cyanidin, fisetin, genistein, gingerol kaempferol, quercetin, resveratrol possessed certain medicinal properties and found to have numerous applications in pharmaceutical industries for treatment of cancer. The paper was aimed to review some plants bioactive components (phytochemicals) used in cancer treatment.

## 1. Introduction

Today, cancer had been described as one of the deadliest diseases worldwide. It has been estimated that cancer causes about 9.9 million deaths in the year 2020 [1]. Cancer is a complex disease characterized by uncontrolled proliferation and development of cells in tissues forming a tumour that may potentially expand to a whole organ or systematically to other tissues called metastasis [2]. The severity of death due to cancer in the world every year indicated that the present standard of treatment with chemotherapeutic drugs is not enough. According to the World Health Organization (WHO), the global cancer rate could increase by half by 2020 in which majority

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of the affected population will be from medium and low income countries, with lack of chemotherapeutic drugs as well as other resources [3]. As result, there is need for alternative anticancer therapeutic drugs. This has pushed researchers and scientist to search for innovative alternate source of anticancer drugs from natural source including plants [4]. Initially, plants have been used in all cultures for healing wide ranges of diseases and as well to improve well-being [5,6]. Further studies demonstrated that medicinal plants contain secondary metabolites called phytochemicals, which have a positive effect on health due to their medicinal properties. These effects of the phytochemicals are attributed to the biological properties such as anti-inflammatory, antioxidant, antimicrobial and anticancer they possessed. Today, the potential of plants as a source of anticancer agents is recorded well both in experimental findings and traditional medicine [7]. In most cases, phytochemicals have been applied directly or modified chemically to develop chemical compounds used in modern medicine which include anticancer drugs. Food and Drug Administration (FDA) inform that over 60% of the drugs used in treatment of cancer are sourced from natural resources [5].

Therefore, plant-anticancer compound has been considered as a possible option for the development of new chemotherapeutics and also to improve the affectivity of the conventional drugs [8-10]. However, these plants derived compounds present many drawbacks, such as negative side effect (toxicity), low stability and difficulties in extraction from natural source [11]. Hence, the application of phytochemicals still faces challenges and need for further research is vital. Phytochemicals are largely distributed in different parts of plants with the potential of reducing the risk of different types of diseases including cancer [12].

## 2. Cancer

Today, cancer had been described as one of the deadliest diseases worldwide. It has been estimated that cancer causes about 9.9 million deaths in the year 2020 [1]. Cancer is a complex disease characterized by uncontrolled proliferation and development of cells in tissues forming a tumour that may potentially expand to a whole organ or systematically to other tissues called metastasis [2]. The abnormal cell behavior due to cancer may be as a result of heredity genetics or alteration of oncogens related to cell cycle and regulation of cell death (apostasis) [13]. According to World Health Organization, the main causes behind the development of cancer include; ionization radiation, reactive oxidative species (ROS), random somatic mutation, chemical agents such as alkylating agents, and biological agents [14]. The ionization radiations such as x-rays are able to disrupt the hydrogen bond between nucleic acid thereby altering its chemical structure, which may lead to alteration in normal DNA expression regulation [15]. Infectious caused by microorganisms such as bacteria, virus and fungi have also been significantly correlated with developing cancer [16]. Virus that integrate their genetic materials into the host tissue or organ may alter normal genetic expression related to cell division or even induce oncogens that could derive into cancer development [17-19]. Conversely, bacterial infection may evoke the release of toxins with cytotoxic effect and the disruption of the tissue cell matrix. Some common examples of bacterial toxins are enteric toxins from *Salmonella typhi* or CagA and vacuolating toxins of *Helicobacter pylori*, which may induce formation of new tissue (neoplasia), cell death, and alteration in the normal cell metabolism [20,21]. Other infectious pathogens such as parasitic helminths and fungi that produce direct or toxin-mediated tisular damage are also considered as oncogenic agents [22]. Apart from genetic alteration, the main recognized tumor-inducing mechanism of biological agents is tissue inflammation as a result of cell damage and subsequent neoplasia which, if unchecked, can result in potential chronic inflammation of the affected tissues (e.g., hepatic cirrhosis by Hepatitis virus) [17,23].

Reactive oxygen species (ROS) such as hydroxyl radical or hydrogen peroxide are believed to provoke the alteration and damage of the cell membrane, DNA and lipids [24]. They are also been identified to increase in tumor cells enhancing their survivability and proliferation [25]. Nonetheless, the common factor besides possible genetic alterations by oxidative stress, infections and ultraviolet radiation is the associated inflammatory response [22,24]. On this matter, chronic inflammation is considered both cause and symptom of other ailments, but particularly of cancer, as tumorous cells secrete several pro-inflammatory molecules [26]. For example, it is well known that the pro-inflammatory mediator cyclooxygenase-2 (COX-2) is over-expressed in several types of cancer. As such, pro-inflammatory mediators are markers of cancer and could be also a possible target for anticancer therapies [27,28]. Considering chemical carcinogens aside from potentially hazardous substances, the main carcinogens originate in diet. Major chemical carcinogens include polycyclic aromatic hydrocarbons (PAHs), N-nitroso compounds, heterocyclic amines (HCAs) and alcohol. PAHs like anthracene appear in combustion reactions, and are reported in grilled or smoked foods, as well as being part of urban air pollution. They are linked to lung and digestive tract cancer [29,30]. Closely related in their effects and occurrence, HCAs like 2-Amino-1-methyl-6-phenylimidazo [4,5-b] pyridine are the result of pyrolysis of proteins and amino acids in meat or fish foods [31,32]. It is worth mentioning that tobacco is reported to contain high levels of PAHs and HCAs, linking them to the pro-carcinogen effects of tobacco consumption [33]. N-nitroso compounds are additives in processed meats and include nitrites and nitrosamines like N-nitrosedimethylamine that have been correlated to gastric cancer development [34]. Ethanol as well as other alcohols present in beverages and spirits induce many metabolic and endocrine disorders along with being highly cytotoxic chemicals and attributed to cause many types of cancers [35]. Altogether, it should be considered that a variety of exogenous carcinogens from different sources can heavily prompt cancer development

## 3. Phytochemicals

The phytochemicals are secondary metabolites or chemical compound produced during metabolic process in plants which are useful in the protection of plants [37]. Many of these secondary metabolites possess vital medicinal properties which have many applications in pharmaceutical industries. Phytochemicals such as alkaloids, tannin, quinones, flavonoids, vitamins and amines are free radical-scavenging molecules and possess antimicrobial, anti-inflammatory, antioxidant and anticancer activities [38]. In general, most plants bioactive components possess antioxidant property which protects human cells against oxidative damage. Phytochemical from such plants are used for reducing the intensity of inflammation related diseases and as well provide protective effect by countering reactive oxygen species (ROS) [39].

## 4. Some Phytochemicals Used as Anticancer Agents

### 4.1 Cyanidin

Cyanidin is an extract of pigment from red berries such as blackberry, apples, red onion, red cabbage, plums, raspberry, cranberry and grapes. The extract possesses radical scavenging and antioxidant effect which may reduce cancer risk. It is reported that cyanidin inhibits cell proliferation and gene expression in colon cancer cell [40]. Another research demonstrated that Cyanidin-3-glucoside (C3G) attenuated the benzo[a]pyrene-7,8-diol-9,10-epoxide-induced activation of AP-1 and NF-κB and phosphorylation of MEK, MKK4, Akt, and MAPKs and blocked the activation of the Fyn kinase signaling pathway, which may contribute to its chemo-preventive potential [41]. Cyanidin-3-glucoside inhibit ethanol-induced activation of ErbB2/cSrc/FAK pathway in breast cancer cells and may reduce ethanol-induced breast cancer metastasis [42], inhibition of growth and induction of apostasis in tumorigenic rat esophagus cell line [43], and inhibition of UVB-induced COX-2 expression and PGE2 secretion in the epidermal skin cell line by suppressing NF-κB and AP-1 which are regulated by MAPK [44-46].

### 4.2 Fisetin

Fisetin is the flanone found in several plants such as Eurasian smoke tree, apple, grape, onion, *Acacia*, cucumber, strawberries, and persimmon [47]. The compound has been found to reduce aging effect in fruit fly or yeast [48] and exert anti-inflammatory effect in LPS-induced acute pulmonary inflammation and anticarcinogenic effects in HCT-116 human colon cancer cells [49]. Fisetin is also a potent antioxidant and modulates lipid and protein kinase pathways. Along with other flavonoids such as luteolin, galangin, quercetin and EGCG, induced the expression of Nrf2 and the phase II gene product HO-1 in retinal pigment epithelial cells which could retinal pigment epithelial cells from death due to oxidative stress with high degree of potency and low toxicity and reduced hydrogen peroxide induced cell death. A study conducted by Khan et al. [50] found dual inhibition of PI3K/Akt and mTOR signaling in human non-small cell lung cancer cells by fisetin.

### 4.3 Genistein

Genistein is the isoflavane that originate from a number of plants such as fava beans, lupine, soy beans, coffee, *Flemingia vestita* and kudzu. Genistein functions as anthelmintic, antioxidant and as well found to have antiangiogenic effect i.e. blocking of blood vessels formation. It also found to block the uncontrolled cell growth associated with cancer most likely by inhibiting the enzyme that regulate cell survival (growth factor) and cell division. The genistein activity was actively functions as tyrosine inhibitor by inhibiting DNA topoisomerase II [51]. *In vivo* and *in vitro* studies show that genistein is important in treating leukemia [52].

### 4.4 Gingerol

Gingerol is an active component of fresh ginger with characteristics spiciness. It is known for its anticancer activity against cancer in the colon [53], ovary, breast [54], and pancrease [55]. A review recently conducted by Oyagbemi et al. [56] summed up the mechanisms in the medicinal effect of gingerol. In summary, gingerol has demonstrated anti-inflammatory, antioxidant and antitumor promoting properties and decreases iNOS and TNF-alpha expression via suppression of IκBα phosphorylation and NF-κB nuclear translocation [56]. Treating MOLT4 and K562 with gingerol, the ROS level was significantly higher than the control, including apoptosis of leukemia cells by mitochondrial pathway.

### 4.5 Kaempferol

Kaempferol is a natural flavonol isolated from grape fruit, apples, tea, witch hazel, Brussels sprout brococoli etc. it has been studied for pancreatic cancer [57] and lung cancer [58]. Kaempferol has also been investigated for its radical scavenging effect, antiangiogenic and anticancer [59]. The compound displayed moderate cytostatic activity of 24.8 - 64.7μM in the cell line of PC3, HeLa, and K562 human cancer cell. Kaempferol has been studied as aryl hydrocarbon receptor antagonist showing inhibition of ABCG2upregulation, thereby reversing the ABCG2-mediated multidrug resistance and this can be useful for treatment of esophageal cancer.

### 4.6 Lycopene

Lycopene as phytochemical is a bright red pigment from fruits such as watermelons, tomato, red papayas and red carrot. It shows antioxidant activity and chemo-preventive effect in prostate cancer. The anticancer property of lycopene is largely attributed to activating cancer preventing enzymes such as phase II detoxification enzymes [60]. Lycopene was found inhibiting human cancer cell proliferation and suppressing insulin like growth factor-I-stimulated growth. This may open new avenue for its study on the role of the treatment and prevention of endometrial cancer and other forms of tumors. The Lycopene also possessed inhibitory effects on endometrial and breast cancer cell [61], prostate and colon cancer cells [60].

### 4.7 Quercetin

Quercetin is a flavonoid compound mostly found in leafy vegetables, berries and onions, to which the anticancer property is attributed [62]. In this sense, numerous studies *in vivo* and *in vitro* pre-clinical studies have shown positive results. Regarding its action mechanisms, quercetin has been demonstrated to induce cell cycle arrest by regulating cyclin D1 and p53-related pathways; apoptosis trough the induction of pro-apoptotic factors and the decrease of anti-apoptotic ones; induces autophagy and inhibits proliferation, angiogenesis and metastasis [63]. These effects have been observed in different in vitro cell lines, including breast, ovarian, lung and colon cancer cells, among many others [63], and also in different in vivo mice models [64]. Furthermore, quercetin has been reported to enhance the efficacy of chemotherapeutic drugs [65]. Regarding clinical trials, several have evaluated the suitability of quercetin as anticancer drug. For example, a study conducted on humans reported that a high intake of quercetin in the diet is inversely related to the risk of gastric adenocarcinoma [66]. Another study evaluated the use of quercetin to prevent and treat oral mucositis induced by chemotherapy. The results showed a significant reduction of oral mucositis incidence in the quercetin treated group, which may suggest that this compound could be used to palliate chemotherapy side-effects [67].

### 4.8 Resveratrol

Resveratrol is a phenolic compound present in some fruits, such as grapes, peanuts, blueberries and blackberries. Numerous studies have evaluated the anticancer properties of this compound. Several action mechanisms of resveratrol have been described: positive regulation of p53 and BAX proteins (related with pro-apoptotic pathways) and negative regulation of NF-_ B, AP-1, hypoxia-inducible factor 1-alpha (HIF-1_), matrix metalloproteases, Bcl-2 protein, COX-2, cytokines and CDK [68]. Some pre-clinical studies performed in vitro demonstrated that resveratrol was able to suppress the cell proliferation through cell cycle arrest, induce apoptosis and modulate autophagy in different cancer cell lines, including ovarian cancer cell line, resistant human leukemia cells, non-small-cell lung cancer and human lung adenocarcinoma [69]. Regarding in vivo studies, the anticancer properties of these compounds were also significant. For example, in an in vivo study, resveratrol was administered to mice, leading to a 60% reduction in the appearance of sporadic colorectal cancer. Similarly, resveratrol inhibited cell proliferation, induced the apoptosis and suppressed the angiogenesis and metastasis in bladder cancer mice models [70]. Resveratrol has been also reported to enhance the efficacy of traditional chemotherapeutic drugs, including temozolomide, doxorubicin and paclitaxel in mice models [71].

## 5. Conclusions

Cancer is a complex disease that every year costs several millions of human lives. The uncontrolled proliferation of cells causes the incorrect functioning of the body, with a long list of symptoms and finally, death. So, given the health and social importance of this disease, but also its economic impact on the health system, new therapeutic alternatives are being continuously investigated. Traditional plants have been historically considered as an endless source of new compounds for the development of new pharmaceuticals and drugs. Therefore, nowadays researchers have at their complete disposal, plenty of ethnomedicinal and ethnopharmacological information of very different plant species which is a tool for selecting candidates and lead the research to those plants more promising. In this context, a variety of phytochemicals obtained from plants have been discovered and are currently used in cancer therapies such as cyanidin, fisetin, genistein, gingerol kaempferol, quercetin, resveratrol.

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CASE REPORT

# High Grade Muscle-Invasive Urinary Bladder Cancer in A 36 Year Old Male Patient: A Case Report & Review of Literature

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ABSTRACT

We are reporting a case of urothelial bladder cancer in a 36 year old male patient with no history or exposure to any risk factors. The incidence of urothelial bladder cancer is very low in young individuals i.e. below 40 years of age with reported rate of incidence around 0.1-0.4 %. Most of the times, these young individuals present with non-muscle invasive bladder cancer with low grade and low stage. As the age increases, the incidence of high grade bladder cancer increases along with it. The index case presented with high grade muscle invasive bladder cancer at the time of diagnosis without any known risk factors. The 5-year survival of urothelial bladder cancer is better in young patients (93.8 %) as compared to older people(85.1 %). Cigarette smoking is responsible for development of bladder cancer in majority of patients followed by exposure to occupational carcinogens. Role of genetic alterations in development of bladder cancer is still under research and process of urothelial bladder carcinogenesis is unanswered in young individuals.

## 1. Introduction

Urothelial bladder cancer is a rare presentation in young individuals, preferably below 40 years of age with reported incidence rate of around 0.1% to 0.4% in the first two decades of life and majority of patients are above 60 years of age at the time of diagnosis [1]. Worldwide, bladder cancer ranks at 11th position with incidence 3%, mortality around 2.1% and 5-year prevalence around 22.07% [2]. In India, bladder cancer ranks at 17th position with incidence 1.6%, mortality 1.3% and 5-year prevalence around 3.57% [3]. In developed countries, Squamous cell carcinoma of the bladder is a rare cause of bladder cancer with accountability of 2.7% of all bladder cancer cases [4]. Around 59% of bladder cancer cases are caused by schistosomiasis where it is endemic [5]. The sub-classification of squamous cell carcinoma of the bladder is bilharzial and nonbilharzial which depends upon the

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causative agent, Schistosomiasis hematobium [6,7]. About 30% of newly diagnosed bladder cancer patients present with muscle invasive bladder cancer (MIBC) or later they progress to MIBC [8]. It is extremely rare below 30 years of age and only limited case studies are reported where bladder cancer was diagnosed in young adult and paediatric patients [9,10]. Various chemical carcinogens have been identified which are responsible for bladder cancer, out of which cigarette smoking is responsible for near about 50% of cases and 20% of cases are caused by occupational exposure [11].

## 2. Case Report

A 36 year old gentleman with no co-morbidty with Eastern Cooperative Oncology Group Performance Status 1 (ECOG PS - I) presented to our clinic with post [TURBT] Trans Urethral Resection of Bladder Tumor procedure. He had a history of occasional hematuria for the last 15 days. His home town is located in a remote village which is far away from the city. He is a farmer by occupation and his 3 generations were involved in farming business. No relevant family, past, surgical and medical history. He had no addiction. He consulted a nearby local general practitioner for hematuria and he had been advised ultrasound of abdomen with pelvis. Ultrasound was suggestive of bladder tumor of size 3x2 cm at postero-lateral wall of urinary bladder. With this report, he had been referred to urologist. Urologist advised him to do Contrast Enhanced Computed Tomography [CECT] of thorax, abdomen and pelvis. CECT picked up a lesion of size 2.8x2.2 cm located at left postero-lateral wall of urinary bladder with extension at left vesico-uretric junction with no uretric obstruction. No pelvic or retroperitoneal lymphadenopathy with no distant metastasis. He had been advised TURBT and he underwent the procedure. Post TURBT histopathology demonstrated a high grade muscle invasive urothelial carcinoma with carcinoma in situ component at fundus of bladder and prostatic urethra.

Patient was visited to our clinic with the report. Systemic examination was unremarkable. Case was discussed in our Institutional Multidisciplinary Tumor Board and plan was decided to go ahead with upfront surgery. Board advised him a surgical procedure of Radical Cysto-prostatectomy with bilateral pelvic lymph node dissection with ileal conduit or neo bladder. Patient had opted for ileal conduit. He underwent the surgical procedure (Figures 1, 2). Prostate was also removed along with the specimen as prostatic urethra had focus of carcinoma. Ileal conduit was prepared for urinary diversion (Figure 3). From 3rd postoperative day, oral feeding was started. Post operative course was uneventful and he was discharged on 8th postoperative day. Final histopathology was suggestive of high grade residual urothelia carcinoma of size 2x2 cm with thickness 1 cm located at left postero-lateral wall with invasion into the serosal fat. Prostate, seminal vesicles, bilateral uretric and urethral cut margins were free from tumor and bilateral pelvic lymph nodes (right -0/6, left 0/11) were free from metastasis. Case was re-discussed in the tumor board and adjuvant chemotherapy had been advised to him. He had completed chemotherapy without any major adverse effects. Now he is in follow up with us as per our institutional follow up protocol and after 1 year of completion of treatment, he is still disease free.

**Figure 1.** Radical Cystectomy specimen (Dorsal View)

**Figure 2.** Radical Cystectomy specimen (Ventral View)

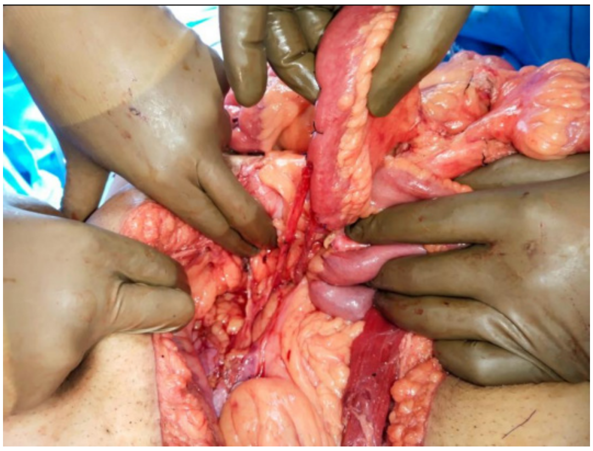

**Figure 3.** Ileal Conduit with uretric transposition

## 3. Discussion

The incidence of urothelial bladder cancer (UBC) is 15-20 times higher in people with age above 70 years as compared to people with age range between 30-50 years [12]. The incidence is 15-20 times more in males as compared to females [13]. The higher prevalence in males is because of smoking habits and higher occupational exposure to risk factors [14]. Most of the time, patients with UBC present with hematuria which may be painless and macroscopic [10]. Hence, there will be a diagnostic delay for a period of 6-12 months. Utrasound imaging is reliable and most sensitive tool for detecting UBC. Urine cytology has very low sensitivity and it carries less important role in diagnosing UBC. Computed Tomography is useful in assessing upper urinary tract and distant metastatic foci. Several case studies reported that UBC below 20 years of age has different clinical and pathological features as compared to others [11]. As the age increases, the incidence of high grade UBC increases along with it and in young patients it is low stage and low grade. According to Wang, the 5-year survival of UBC is better in young patients (93.8%) as compared to older people (85.1%) [15]. The index case presented with occasional painless hematuria. However, he reported immediately to the treating medical team after noticing it and underwent the investigations and procedure as suggested.

Several studies were conducted to find out the genetic alterations responsible for development of UBC in young patients who does not have any risk factors and presented with lower stage and low grade tumors. Wild et al [16] and Owen et al [17] reported that genetic alterations are extremely rare under 20 years of age. The recurrence rate of UBC is less in younger individuals as compared to elderly people. Na et al. [18] reported the recurrence rate of 7.1% in patients below 40 years of age as compared to 38% in patients with age above 60 years. Most of the young patients present with UBC with non-muscle invasive disease with lower progression, low grade and lower recurrence rate. Paner et al. demonstrated in his review of younger patients with UBC with age below 30 years, only 3.0% had muscle-invasive disease and only 1.7% had high-grade tumor [19]. However, aggressive bladder cancer has been reported in children - a 31-month-old and a 14-year-old [20,21]. The index case had no known risk factors and he had been diagnosed with high grade disease at the time of initial diagnosis.

Cigarette smoking is by far the most prevalent risk factor for developing UBC. Polycyclic Aromatic Hydrocarbon (PAH) exposure is responsible for 15-20% of bladder cancer cases. In rest of the cases, other occupational carcinogens and genetic alterations are the causative agents. Radical cystectomy is the definitive curative treatment option for patients with muscle invasive bladder cancer, recurrent high grade superficial bladder cancer and high-grade T1 disease. In the postoperative period, young patients may suffer from infertility and impotence. Nerve sparing surgery along with preservation of prostate and seminal vesicle should be an option in young patients. Neobladder urinary diversion is the preferred surgical option which helps in maintaining body image and quality of life. In the index case, prostatic urethra was involved by the disease, so he underwent prostatectomy and he does not have issue of impotency in the postoperative period. Thus, it is a rare presentation of high grade muscle invasive bladder cancer without any known risk factors in a 36 year old gentleman.

## 4. Conclusions

Bladder cancer oncogenesis is still unclear in young adults due to lack of precise research studies. High grade muscle invasive bladder cancer is rare below 40 years of age and preservation of fertility with maintenance of quality of life are prime important factors while doing radical cystectomy in young patients.

## Disclosures

**Human subject**

Informed consent was obtained from the patient for being included in the study.

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ARTICLE

# Assessment on Radiation Hazard Indices from Selected Dumpsites in Lafia Metropolis, Nasarawa State, Nigeria

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ABSTRACT

This research reports an assessment of ionizing radiation in some chosen Dumpsites in Lafia Local government area of Nasarawa State. Ionizing radiation measurement was conducted at four Dump sites. The survey was done using a radiation survey meter (Radex one Outdoor 55130719 NA). Radiation exposure rate in micro sievert per hour ($\mu Svhr^{-1}$) was measured. Readings were taken by placing the detector at gonad level about 1 meter above the ground. Result showed that the average annual effective dose rate in the selected dumpsites were 0.22 mSv/yr for Lafia modern market, 0.17 mSv/yr for dumpsite opposite governor Isa house, 0.15 mSv/yr for Timber shade Lafia and 0.20 mSv/yrfor Science School Lafia respectively with a mean value of 0.19 mSv/yr for all location, while the mean calculated excess life cancer risk (ELCR) is 0.65 x $10^{-3}$.Dumpsites yearly absorbed dose rate and their corresponding ELCR values did not exceed the 1.0 mSv/y Basic Safety Standard set for the masses by International Council on Radiation Protection (ICRP, 1999) and mean world average ECLR value of 1.16 x $10^{-3}$. Based on these results there are no radiation consequence to the scavengers, dumpsite workers and residents living around the dumpsites.

## 1. Introduction

Radiations are categorized into two types, which are, the ionizing and non-ionizing radiation. Ionizing radiation is the type of radiation which has the energy that is sufficient enough to strike an electron out of its orbits around atom, altering the electron/proton ratio and making the atom positively charged. Molecules and atoms which are electrically charged are called ions. Ionizing radiation includes those radiations which come from both natural and artificial radioactive materials [1]. Examples of ionizing radiations are alpha particles and beta. Alpha particles are made up of two protons and two neutrons each and that carry a double positive charge. Beta particle consists of charged particles that are ejected from an atom's nucleus and that are physically identical to

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electrons. Non-ionizing radiation is the type of radiation which does not possess sufficient energy compared to ionizing radiation; the energy it possesses is not sufficient enough to liberate an electron from an atom. It can only excite the atom. Background radiation is radiations that could occur as a result of natural sources of radiation such as cosmic radiations (sun), terrestrial radiation (soil) and internal radiation (potassium – 40 and carbon – 40 inside the body) [2,3].

Naturally-occurring background radiation is the major source of getting exposed to radiation for most of the population. The Basic Safety Standard for workers has been recommended to be 20 mSv/yr, while that of public is about 1 mSv/yr [4].

Ionizing radiation can also be generated as a result of medical, commercial and industrial activities. The most familiar and, in national terms, the largest of these sources of exposure is medical X-rays. Literature has it that natural radiation contributes almost about 88% of the annual dose to the population and medical procedures most of the remaining 12%. Natural and most of the artificial radiations are not different in kind or effect [5].

Most of the differences in getting exposed to natural background radiation are as a result of inhalation, ingestion and direct contact of radioactive gases such as Radon which are produced by radioactive minerals found in soil and bedrock. Radon is an odorless and colorless radioactive gas that is produced from the decay of Radium. Radium is a radioactive gas produced from the decay of Thorium. Thorium is a radioactive gas produced from the decay of Uranium. Radon and Thorium levels are varying considerably by location depending on the composition of soil and bedrock [6-8].

Once these gases are released into the air, they always get diluted to their harmless levels in the atmosphere even though, most times they become trapped and accumulate in our buildings and later inhaled by occupants of those buildings [9]. Radon gas causes some health risks not only to illegal miners, but also to home owners if it is allowed to enter into our various homes. On average, it is the largest source of natural radiation exposure [10,11].

Exposure to radiation carries a lot of health risks and Understanding the risks helps the CNSC and other regulatory bodies establish dose limits and regulations that keep exposure at an acceptable or tolerable risk level, where it is unlikely to cause harm [12-15].

Waste can be defined as unwanted and unusable materials and is considered as a substance that cannot be used any longer. Dump sites are piece of land where waste materials are dumped like dry waste, e-waste, plastics, scraps metals, broken glasses among others. Waste is generally classified as Industrial waste, commercial waste, domestic waste, and agricultural sources of waste. In dumpsites, waste is commonly classified as biodegradable that is those that can decompose (organic waste) and non- biodegradable waste that is those that do not decompose (in organic waste). Based on IAEA categorization of radioactive waste, wastes from dump sites can be classified as very low-level waste (VLLW) called naturally occurring radioactive material (NORM) waste though they may not be harmful to humans or the environment but studying the level of background radiation in dumpsites could provide essential radiological information in an environment [16].

Wastes made up an environmental and public health nuisance in major cities all over the world. Thus, governments regard waste management as vital social service whose budgetary provision is made in line with population projections [17]. Hazards caused by such dumpsite are not only in term of odor and presence of disease causing microorganism, but can arise from the radiation emanating from such dumpsite [18]. Various radioactivity measurements have shown the existence of traces of radionuclide in books [19] and in the staple food consume in Nigeria [20]. It has also been established that vegetation and environmental fields in Nigeria contain traces of radioisotopes. All these, are contained in the domestic waste which are indiscriminately dumped on open fields, farms soils, Quarry sites, rivers, well and boreholes, industries and even on road sides and mechanic workshops [21]. In addition, industrial wastes that are liable to contain traces of radionuclide are also dumped indiscriminately. Consequently, the radioisotope content in the waste dumpsite, if not properly managed emits mixed radiation to the environment [22]. Emission of radiation categorization of waste dumpsites [23] and measurement of background radiation in refuse dumps [24] shows the level and long term effects of these radiations if not properly monitored. The 2011 Fukushima Daiichi nuclear disaster displaced thousands of people and its effects is still being felt even in places far from the site [25].

The regulatory bodies that are saddled with providing limits on background radiations includes the National Council on Radiation Protection and management (NCRM), United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR) Nigeria Nuclear Regulatory Authority (NNRA), Radiation Protection Regulation, (RPR) and international commission on Radiation Protection (ICRP) among others. According to ICRP recommendations, the limit of exposure to the public should not be more than 1mSv/yr [26].

Waste disposal and its successful management is a global challenge, with the continuous increase in population in Nasarawa State due to increase in commercial businesses, educational institutions, industries amongst other, Lafia and its environ is not left out of this growing concern as waste disposal has also increased which could lead to increase in background radiation and invariably leading to increase in human radiation exposure because of the concentrations of $^{40}K$, $^{226}Ra$ and $^{232}Th$ in the soil and waste materials or because of internal inhalation of radon and its progenies in dust and fumes from waste disposal sites [27-29].

There are four major dumpsites in Lafia which contains the biodegradable and non- biodegradable wastes. Although, the waste according to IAEA are classified as NORM and may not be harmful to human or environment, the level of background radiation could be more than that stipulated by ICRP. The literature reviewed showed no data on the level of background radiation in the selected sites, therefore the aim of this study is to assess the background radiation level from some selected dump sites located in Lafia Metropolis, Nasarawa State through the following objectives by measuring the absorbed dose rate in micro sievert per hour from the selected dumpsites in Lafia metropolis and using the measured result to compute the annual effective dose rate from the chosen dumpsites in Lafia metropolis and the associated excess lifetime cancer risk as a result of the exposure.

Therefore, proper time to time checking and estimation of the radiation level emanating from dumpsites in order to give accurate data as part of environmental monitoring research for effective assessment of radiation exposure rate of the metropolis motivated this study.

The results obtained from this work will allow for the estimation of excess life cancer risk of persons living close to the dumpsites. Data obtained from this work could be used as a reference baseline radiometric data for future research on background radiations in the selected areas. This could be used as a yard stick for evaluating the extent of any pollution in the environment due to any accidental release of radionuclide. The result gotten from this work could also be a sort of guide to the Lafia waste management body in setting up safety waste management protocols.

## 2. Materials and Method

### 2.1 Materials

The materials used in this research include;

i. Inspector alert Nuclear Radiation Monitor RADEX ONE Outdoor (Radioactivity indicator) with the serial number 55130719 NA (manufactured by OOO Quarto-Rad) used to measure ambient ionized radiation types of beta, Gamma and products, as well as the accumulated radiation dose received.

ii. Global Positioning System (GPS): The GPS (Global positioning system) mobile application was used to take all location data.

### 2.2 Method

#### 2.2.1 Sample Location

The study was carried out in Lafia the capital of Nasarawa state, the area for which study was carried out is a Cosmo-political, heavily populated area of Lafia. The dumpsites are located in the communities with a various number of scavenger's sources for the daily recycling of waste. The site, location of dumpsites, waste found in the dumpsites as well as their respective GPS coordinate are tabulated below:

**Table 1.** Description of Dumpsite

| S/N | Site Name | Location of the Dumpsite | Waste Found | GPS Coordinate | |
|---|---|---|---|---|---|
| | | | | North | East |
| 1 | Lafia modern Market) | The dump site is situated close to the exit gate of the market site | Rotten food, vegetables, nylon, glasses, and irons | $8^0$29'31 | $8^0$31'44 |
| 2 | Opposite governor Isa house Tudun kauri | The dump site is located along Markurdi road | Irons, food waste, glasses, nylons and electronics waste | $8^0$29'8 | $8^0$31'53 |
| 3 | Timber shade Lafia | The dump site is located along U.A.C road inside Lafia timber processing factory | Timber waste | $8^0$29'51 | $8^0$30'49 |
| 4 | Science School Lafia | The dump site is located behind the fence of science school Lafia. | Nylons, food waste, irons, electronics waste, and rotten vegetables | $8^0$30'11 | $8^0$30'45 |

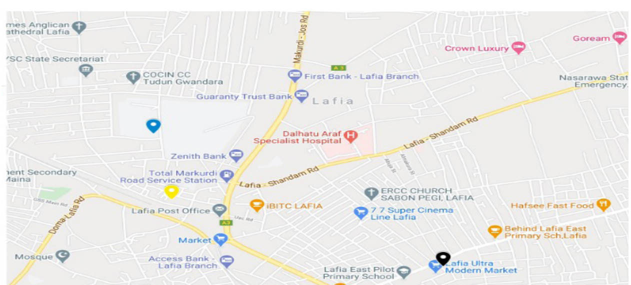


**Figure 1.** Map of Sample Locations

### 2.2.2 Method Data Analysis

The detector that was used to measure the exposure level in the field was a well calibrated, sensitive and portable radiation survey meter with serial number 55130719 NA having a Geiger Muller tube that has the ability of detecting Alpha, Beta, Gamma and X-rays. Readings were taken from ten (10) different locations in each of the four dumpsites to spatially reflect the sites, while a global positioning system (GPS) was used to take the coordinates of sample points. Data were collected three times in a week in each of the dumpsites for four weeks (1 month, March/April 2020) and the average values were obtained. Data were obtained between the hours of 11.00 am and 4:00 pm each day. The tube of the radiation meter was placed at a height of 1 m above the ground with its window facing first the Dumpsites and then vertically downward. The detector was switched on to absorb radiation for a few seconds and the highest stable point was recorded. This was converted to annual effective dose rate in milli Sievert per year ($mSvyr^{-1}$). The result obtained was used to calculate the ELCR using Equations 1 to 3.

Absorbed dose in air, D (nGy/hr) = Exposure in air, E (µSv/hr) x 1000 (1)

AEDR (mSv/yr) = absorbed dose in air (D) (nGy/hr) x 8760hr/yr x O.F x C.C (2)

ECLR = AEDE(mSv/yr) x DL x RF (3)

Where

8760hr/yr = the total hours per year.

0.2 = outdoor occupancy factor (OF) for outdoor radiation.

0.7 = the conversion coefficient (CC) (Sv/yr).

D= Annual absorbed dose rate in micro sievert per year.

ELCR- excess lifetime cancer risk

AEDR- annual effective dose rate

DL- average duration of life (70 years)

RF- risk factor (0.05 $Sv^{-1}$)

## 3. Results and Discussion

### 3.1 Results

The aim of this study was to assess the level of background radiation from some selected dump sites located in Lafia Metropolis, Nasarawa State. Tables 2 to 5 show the average values of absorbed dose rate in µSv/hr for morning and evening readings in the selected locations. While Table 6 shows the summary of radiological hazard indices that is the annual effective dose rate in mSv/yr and Excess Life Cancer Risk in the selected dumpsites. These values were calculated from the average values of absorbed dose rate in µSv/hr.

**Table 2.** Absorbed Dose Rate in µSv/hr in Lafia Modern Market

| Lafia Modern Market | | | | |
|---|---|---|---|---|
| **Week** | **GPS Coordinate** | | **Absorbed Dose (µSv/hr)** | |
| | North | East | Morning | Afternoon |
| 1 | $8^0$29’31.383 | $8^0$31’44.474 | 0.20 | 0.21 |
| 2 | $8^0$29’31.439 | $8^0$31’44.330 | 0.21 | 0.18 |
| 3 | $8^0$29’31.490 | $8^0$31’44.446 | 0.16 | 0.17 |
| 4 | $8^0$29’31.507 | $8^0$31’44.488 | 0.14 | 0.14 |
| **Average** | | | 0.18 | 0.18 |

**Table 3.** Absorbed Dose Rate in µSv/hr at Dumpsite Opposite Governor Isa House, Tudun Kauri, Lafia.

| Opposite Governor Isa House | | | | |
|---|---|---|---|---|
| **Weeks** | **GPS Coordinate** | | **Absorbed Dose (µSv/hr)** | |
| | North | East | Morning | Afternoon |
| 1 | $8^0$29’8.532 | $8^0$31’52.327 | 0.17 | 0.10 |
| 2 | $8^0$29’8.690 | $8^0$31’52.801 | 0.16 | 0.12 |
| 3 | $8^0$29’8.843 | $8^0$31’52.403 | 0.15 | 0.14 |
| 4 | $8^0$29’8.620 | $8^0$31’52.300 | 0.11 | 0.17 |
| **Average** | | | 0.15 | 0.13 |

**Table 4.** Absorbed Dose Rate in µSv/hr at Dumpsite in Timber Shade, Lafia.

| Timber Shade Lafia | | | | |
|---|---|---|---|---|
| **Weeks** | **GPS Location** | | **Absorbed Dose (µSv/hr)** | |
| | North | East | Morning | Afternoon |
| 1 | $8^0$29’51.329 | $8^0$30’49.239 | 0.10 | 0.13 |
| 2 | $8^0$29’8.391 | $8^0$31’52.233 | 0.12 | 0.10 |
| 3 | $8^0$29’51.321 | $8^0$31’52.975 | 0.14 | 0.12 |
| 4 | $8^0$29’51.425 | $8^0$31’52.874 | 0.13 | 0.14 |
| **Average** | | | 0.12 | 0.12 |

**Table 5.** Absorbed Dose Rate in µSv/hr at Dumpsite in Science School Lafia.

| Science School Lafia | | | | |
|---|---|---|---|---|
| **Weeks** | **GPS Location** | | **Absorbed Dose (µSv/hr)** | |
| | North | East | Morning | Afternoon |
| 1 | $8^0$30’11.481 | $8^0$30’45.344 | 0.20 | 0.16 |
| 2 | $8^0$30’11.765 | $8^0$30’45.543 | 0.18 | 0.15 |
| 3 | $8^0$30’11.590 | $8^0$30’45.216 | 0.15 | 0.14 |
| 4 | $8^0$30’11.763 | $8^0$30’45.195 | 0.14 | 0.16 |
| **Average** | | | 0.17 | 0.15 |

**Table 6.** Radiological Hazard Indices for the Four Selected Dumpsites in Lafia Metropolis.

| S/N | Location | Average dose rate (μSv/hr) | Mean dose rate. D (nGy/hr) | Annual effective dose rate (mSv/yr) | ELCR x 10-3 |
|---|---|---|---|---|---|
| 1 | Lafia modern market | 0.18 | 180 | 0.22 | 0.77 |
| 2 | Opposite governor Isa house | 0.14 | 140 | 0.17 | 0.59 |
| 3 | Timber shade Lafia | 0.12 | 120 | 0.15 | 0.53 |
| 4 | Science School Lafia | 0.16 | 160 | 0.20 | 0.70 |
| | **Average** | 0.14 | 150 | 0.19 | 0.65 |

## 3.2 Result Analysis

The collected data were analyzed using excel spread sheet. Graphs were plotted using origin 5.0 to enable vivid comparison of results with other works and that of standard organizations.

Figure 2 shows a plot of average values of radiological hazard indices from the selected Dumpsites compared with the values of related works of other authors and that of international regulation UNSCEAR.

From Figure 2, the annual effective dose rate and Excess Life Cancer Risk (ELCR) values of this work when compared with other authors work shows that the values were higher than the work of [9] while the AEDR and ELCR values were lower when compared with the work of [30].

However, from the values of radiological hazard indices obtained in this work and related works; the annual effective dose rate (AEDR) was below the world standard of 1mSv/yr (ICRP) and excess life cancer risk (ELCR) was also below the world standard of 1.16 x $10^{-3}$ except Avwiri and Esi, whose values were higher than the world standard.

## 3.3 Discussion

In this work, the minimum value of absorbed dose rate from the four selected dumpsites is 0.12 μSv/hr in Timbre Shade, while the maximum value is 0.18 μSv/hr in Lafia Modern Market. These values were calculated using the average values from Table 2 to Table 5. The total average value of the absorbed dose rate for the four selected site was found to be 0.14 μSv/hr.

The annual effective dose rate was calculated using Equation (2) and an average value of 0.19mSv/yr was found for all the selected dump sites with a minimum average value of 0.15 mSv/yr in Timbre Shade and an average maximum value of 0.22 mSv/yr in Lafia Modern Market. The Excess Life Cancer Risk (ELCR) which is the possibility of getting cancer resulting from life time exposure to background radiation was calculated from the average value of AEDR using Equation 3 The ELCR values ranges from 0.53 x $10^{-3}$ to 0.77 x $10^{-3}$ with a total average value of 0.65 x $10^{-3}$ as shown in Table 6.

## 4. Conclusions

The estimation of ionization radiation in four dumpsites

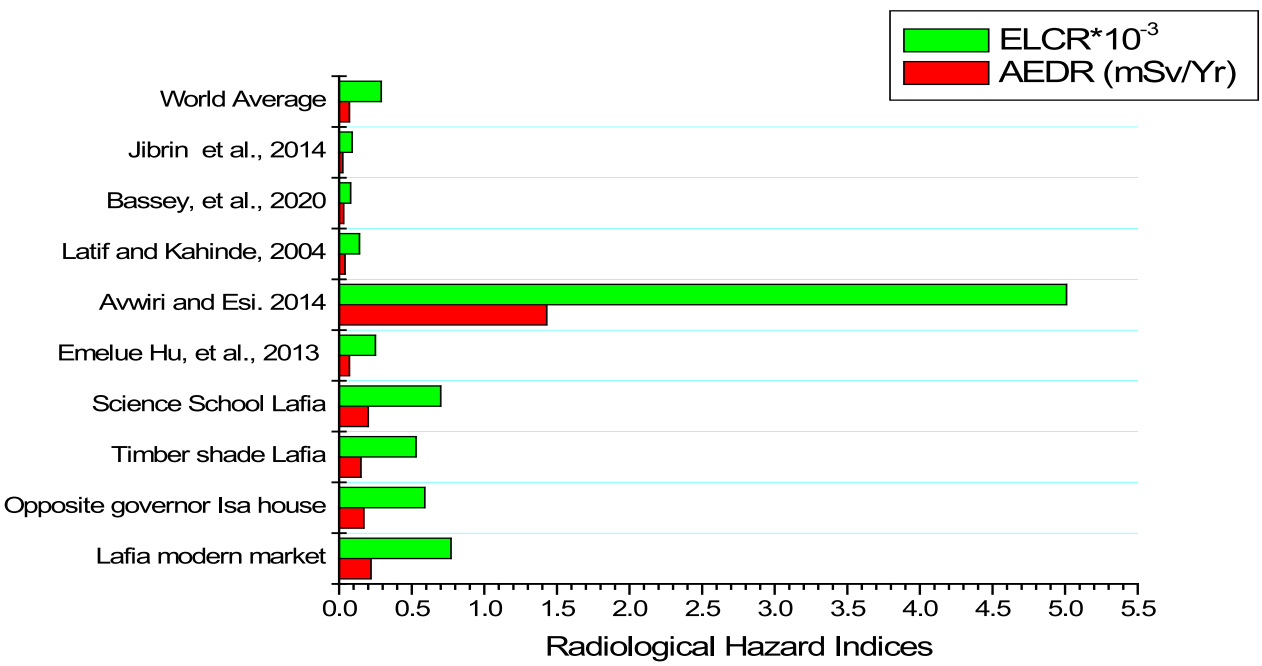


**Figure 2.** Values of radiological hazard indices in this work, related works and world average.

in Lafia Local government area of Nasarawa State, Nigeria was carried out. The mean average background radiation exposures in the selected dumpsites were lower than the normal background standard of 0.39μSv/hr. The computed annual absorbed dose rate obtained results are also lower than the ICRP dose limit of 1.0mSv/yr for the general public (ICRP, 1999). The corresponding estimated average ELCR of 0.65 x $10^{-3}$ were also lower than the normal background standard of 1.16 x $10^{-3}$.

### 4.1 Recommendations

It is recommended that waste material should be adequately sorted out before disposing into the dumpsites. There should be regular monitoring/inspection of radiation levels in these environments by the government. More so, dumpsite workers should operate shift system, and lastly Environmental Health Officer should also assist to ensure that all activities within the selected areas are within environmental standard.

### 4.2 Suggestion for Further Studies

Further research should be carried out on soil sample analysis at the same location to know the specific radionuclide elements contributing to the background radiation in the area and their degree of contribution.

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ARTICLE

# Identification of Medical and Industrial Used Radioisotopes in Mining Sites of Nasarawa, Nasarawa State, Nigeria

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ABSTRACT

This research intends to unveil the presence of radioisotopes in the soil of some mining sites in Nasarawa of Nasarawa state using thermos-scientific interceptor (IdentiFINDER). The work aimed at detecting the presence, types and trust level of radioisotopes. The result showed that, $^{103}Pd$ and $^{125}I$ were found in 57% of the total points and the percentage abundance of the detector reached 50-65% indicating that, those radioisotopes are likely found in the area, $^{109}Cd$ was found in 15% of the total areas. The percentage abundance of the detector for $^{109}Cd$ shows 50% indicating that, those radioisotopes are likely to be found in the area, $^{241}Am$ was found in 7% of the total areas. The percentage abundance of the detector for $^{241}Am$ shows 81% indicating that, those radioisotopes are likely found in the area, $^{235}U$ was found in 7% of the total points. The percentage abundance of the detector for $^{235}U$ reaches 57% indicating that, those radioisotopes are likely found in the area, $^{75}Se$ was found in 7% of the total points. The percentage abundance of the detector for $^{75}Se$ was in abundance up to 57% indicating that, those radioisotopes are likely gotten in the area and $^{57}Co$ was gotten in 7% of the total areas. The percentage abundance of the detector for $^{57}Co$ was 54% indicating that, those radioisotopes are likely to be gotten in the area. Based on this high percentage abundance of the detector for these radioisotopes, they can be harnessed and applied appropriately in medicine and industry.

## 1. Introduction

Nuclear medicine is one of the specializations in medicine that uses the nuclear properties of radioisotopes in diagnostic, therapeutic and researches to evaluate metabolic, physiological and pathological situations of human parts. As an integral part of patient care, nuclear physics in medicine is currently applied to diagnose, treat and prevent many of serious problems in medicine [1]. In the present days, nuclear physics in medicine provides procedures which are vitally important over a wide range

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of medical sciences starting from oncology to cardiology up to psychiatry. Today physicists are equipped with a broad spectrum of nuclear imaging procedures and these differently supplies information about the working of virtually every major organ/tissue of the human parts. Nuclear medicine imaging procedures most times identify abnormalities at the initial stage of the growth of the disease, long before other alternative diagnostic modalities could detect them and this allows the disease to be arrested in its early course. However, the main strength of nuclear medicine depends on its ability to control both anatomical and physiological work in-vivo, which is impossible by the other contemporary imaging methods, like, computed tomography (CT) scanning, magnetic resonance imaging (MRI) and ultrasound imaging [1]. Though, these imaging techniques are able to depict anatomical features with a much quality resolution. Even though the field of nuclear medicine is filled with the diagnostic procedures, it also has valuable therapeutic applications, such as treatment of hyperthyroidism, rheumatoid arthritis, Hodgkin's disease and a wider range of cancers, such as breast cancers, ovary cancer, prostate cancer, liver cancer, colon cancer, lung cancer and endocrine glands cancer. Nuclear medicine has also been completely used to treat various heart problems, leukemia and for providing pain relief to the patients suffering from metastatic bone cancer. Nuclear medicine has always been maybe the most exciting area of investigation in medicine. Now-a-days, it is considered as one of the good diagnostic and therapeutic specialization in the armamentarium of medical sciences in spite of its modest beginning few centuries ago [2].

Nuclides with fixed atomic number but different mass number are known as isotopes. Almost 2500 known isotopes exist; even though, only 280 of them are stable. The remaining ones are not stable. The unstable ones are called Radioisotopes, because they emit some kinds of energetic rays and/or particles when they are trying to attain more stability [3].

Thus, radioisotopes used in nuclear medicine are vastly artificial and are originated from the soil. In most of our farm lands, the radioisotopes are embedded and whenever there is mining activities going on in these farm lands, the radioisotopes get excavated from beneath the soil surface to the top of the soil surface, and then when it rains, the water flushes it to our rivers or our farms where we consume them either through water or through crops [4].

These radioisotopes can be used in our various hospitals and our various industries for so many purposes if properly harnessed, instead of living these them after been excavated from beneath the soil to the soil surface to be flushed by rain water and later become harmful to us [5].

Applications of radioisotopes in human health care are extensively wide-spread and cover both the diagnostic and therapeutic domains. The diagnostic procedures could be performed either by in-vivo use of radiopharmaceuticals or by in-vitro use of radioimmunoassay. On the other hand, therapeutic procedures could be affected either by using the sealed sources or by the systematic administration of radiopharmaceuticals [6].

Even though there are few naturally occurring radioisotopes such as $^{131}I$, $^{125}I$, $^{123}I$ which are all isotopes of the same element. Their chemical and biological properties are expected to be the same [6]. The little variation in the weights, that they have, is because of the variation in the number of particles that they hold inside their nucleus. Some isotopes are disturbed by this kind of changes in their nuclear structure. They become not stable, and give out radiation till they reach their stable state. These elements are called radioisotopes [7]. Importance of radioisotopes in medicine is because they possessed two unique characteristics, which include the fact that their biological behavior is identical to their stable counterparts, and also because they are radioactive, so their emissions can be detected by suitable machines. Finding the percentage abundance of radioisotope spreading in our surroundings gives vital information on radiological sciences. Natural radioactivity originates from extraterrestrial sources as well as from radioactive elements in the earth crust [7]. About 340 nuclides have been found in nature, and more than 60 of these are radioactive [8]. All elements having an atomic number greater than 80 possess radioactive isotopes, and all isotopes of elements heavier than number 83 are radioactive [8]. The natural radio activities of the earth are categorized into primordial, secondary and Cosmo genic radioisotopes [9]. The primordial nuclides which now exist are those that have half-life at least comparable to the age of the universe. Radioisotopes with half-life greater than 1010 years have decayed very little up to the present time [10]. All isotopes of iodine will behave in the same way and will concentrate in the thyroid gland. There is no way of detecting the stable, natural iodine in the thyroid gland, but the presence of radioactive iodine can be detected externally in vivo by a detector. Thus, the radioactive iodine becomes a tracer, a sort of a spy, which mimics the behavior of natural iodine and relays information to a detector [10]. The radioactive tracers are popular because of the ease with which they can be detected in vivo and the fact that the measurement of their presence in the body can be in quantitative terms. The measurement can be very accurate and sensitive [11]. The radioisotopes are physical entities and their radiations and measurements are characterized by laws of physics. Hence, the knowledge of nuclear physics is needed for practicing Nuclear Medicine [12]. Radioisotopes are also used in 'Radiation joint lining removal' or 'Radio-surgery', where the radio labeled preparations are used to control and counteract immoderate propagation of synovial membrane in arthritis affected joints. This methodology has the advantage over other treatment modalities such as, chemical surgery and surgical intervention in terms of cost, side effects and need for hospitalization. Targeted radioisotope therapy in addition with other treatment techniques like, chemotherapy and surgical intervention have now become an integral part in the management of a wider variety of cancers such as, prostate cancer, colon cancer, breast cancer, ovary cancer and so on [13]. Nuclear Medicine is usually defined as a "clinical specialty devoted to diagnostic, therapeutic and research applications of internally administered radioisotopes." Diagnostic implies both in vivo and in vitro uses [13]. In modern times, there is hardly any medical research, where a radioactive tracer is not used in some form or other. Normally basic medical research is not considered as nuclear medicine, but clinical research applications of radioisotopes are considered as an integral part of this specialty. Same thing holds true for nuclear physics in relation to the practice of nuclear medicine. The approach in this work is also to give few salient facts, which one needs to know in actual day-to-day practice of nuclear medicine [14]. When we detect radioactivity, there is some component of it, which is arising from the background radiation. Most of these come from naturally occurring radioactivity in the soil. Procedures designed to answer these questions with the use of radioisotopes form the basis of Nuclear Medicine [15]. Radiation discovered more than a century ago has found many vital applications in medical and industrial spheres. Radiotracer technology has become an integrated part of multi-disciplinary investigation in oil fields for oil reservoir evaluation [16].

In medicine, $^{57}$Co is used as marker to estimate organ size also used as a tracer to diagnose pernicious anemia [17], $^{75}$Se is a radiotracer used in brain studies scinti graphy scanning study of the production of digestive enzymes [18], $^{103}$Pd is used in brachy therapy for early prostate cancer [19], $^{109}$Cd is used in cancer detection and pediatric imaging [20], $^{125}$I is used in cancer brachy therapy (prostate and brain) filtration rate of kidneys, can also be used as a major diagnostic tool applied in clinical tests and to diagnose thyroid disorders [21]. Also used in biomedical research and $^{241}$Am is used in osteoporosis detection and heart imaging [21]. While in industry, $^{57}$Co is used to locate pipeline blockages in petroleum industries [22], $^{241}$Am is applied in many smoke detectors for homes and businesses, to measure levels of toxic lead in dried paint samples, to ensure uniform thickness in rolling processes like steel and paper production and to help determine where oil wells should be drilled [23], $^{109}$Cd is used to analyze metal alloys for checking stock and scrap sorting [24], $^{75}$Se is used in protein studies in life science research [25] and $^{235}$U is used a fuel for nuclear power plants and naval nuclear propulsion systems and used to produce fluorescent glassware, a variety of colored glazes and wall tiles in industries [26].Studies of the same kind have been conducted in different parts of Nigeria to assess the radioisotope spreading and their respective percentage abundance but there were never been any proof of such a kind of research to assess the radioisotope spreading and their respective percentage abundance in Lafia dumpsites. Therefore, this research unveils the presence of the above stated radioisotopes in soil from some mining sites as well as their trust level (which indicates their availability in the study area) in Nasarawa of Nasarawa State, using thermos-scientific interceptor (identiFINDER) obtained from Nigerian Nuclear Regulatory Authority (NNRA).

## 2. Materials and Methods

### 2.1 Materials

The materials which have been applied in the study area for the Identification of Medical and Industrial Used Radioisotopes in Mining Sites in Nasarawa, Nasarawa State, Nigeria can be shown in Table 1.

### 2.2 Method

To achieve the aim of this study, the stratified random data collection method was employed in which a grid was defined for the study area. The grids for the area under study have been defined within the area of meters. After defining the grid of the area under study, in each data point, the type of radioisotopes and their respective percentage abundance are obtained. The process have been made according to the recommendations of technical documents of some Regulatory authorities like International Atomic Energy Agency and Nigerian Nuclear Regulatory Authority that covers almost if not all the aspects of the uranium mining industry, from exploration to exploitation, decommissioning and the application of modalities in other non-uranium resource areas[27-29]. The data were taken using a portable hand held detector (i.e. thermo scientific interceptor), which is the most suitable detector for qualitative and quantitative analysis of gamma radiation that uses a Cadmium Zinc

Telluride (CZT) detector.

This research work centered on Nasarawa of Nasarawa State. The coordinates of the study area are tabulated in Table 2. Map of the study area is presented in Figure 1.

**Table 1.** Materials, their Specifications and uses

| Materials | Specifications | (i) Uses |
|---|---|---|
| Thermo Scientific Interceptor (radiation identiFINDER) | (ii) A High-efficiency Cadmium Zinc Telluride (CZT) finder Detector, with dimension 122mm x 68mm x 30mm, resolution of 7mm x 7mm x 3.5mm (0.3in x 0.3in x 0.15in) CZT identification detector, with $^{3}$He Neutron detection at 8atm., 13-mm diameter x 66m (0.5in dia x 2.6in) at 1.2 cps/nv. It has dose rate of High performance, 1024-channel DSP-based MCA with energy compensation dose rate algorithm on finder detectors and operating temperature range of -20$^{0}$C to +50$^{0}$C (-4$^{0}$F to +122$^{0}$F) at up to 95%RH at 95$^{0}$F with energy range of 25KeV to 3MeV and sensitivity of 1.5cps/μR/h, 1.2cps/nv. | (iii) This is used to detect the radioisotopes as well as their trust level |
| Map of the study area | Google map | This gives the names and locations of the area. |
| Tape Measure | Steel type | This is for measuring grid size. |
| Global Positioning System (GPS) | 15m horizontal (50 ft) | Used to take coordinatesof sample points. |

**Table 2.** Sample Points and their Locations

| PointCode | Sample Coordinates | |
|---|---|---|
| | North | East |
| OP A | $08^{0}21'24.9''$ | $007^{0}54'29.6''$ |
| OP B | $08^{0}21'19.8''$ | $007^{0}54'24.5''$ |
| OP C | $08^{0}21'15.5''$ | $007^{0}54'20.2''$ |
| OK A | $08^{0}24'04.1''$ | $007^{0}52'10.6''$ |
| OK B | $08^{0}24'01.2''$ | $007^{0}52'07.7''$ |
| OK C | $08^{0}23'99.8''$ | $007^{0}52'04.8''$ |
| EY A | $08^{0}24'38.2''$ | $007^{0}52'59.2''$ |
| EY B | $08^{0}24'33.1''$ | $007^{0}52'54.1''$ |
| EY C | $08^{0}24'28.0''$ | $007^{0}52'49.0''$ |
| UM A | $08^{0}25'56.3''$ | $007^{0}53'49.3''$ |
| UM B | $08^{0}25'51.2''$ | $007^{0}53'44.2''$ |
| UM C | $08^{0}25'46.9''$ | $007^{0}53'39.9''$ |

## 3. Results and Discussion

In this section, the results for both medical and industrial used radioisotopes as well as their respective trust level obtained from the field was presented and further discussion was made on the radioisotopes distribution in the study area.

### 3.1 Results

The results gotten from different mining areas like radioisotopes with their respective percentage abundance are presented in Table 3.

**Table 3.** Radioisotopes and Trust Level from the Study Area

| Point Code | Radioisotope I | Trust Level (%) | Radioisotope II | Trust Level (%) |
|---|---|---|---|---|
| **OP A** | I-125 (Med) | 61 | Pd-103 (Med) | 54 |
| **OP B** | Pd-103 (Med) | 53 | Cd-109 (Ind) | 50 |
| **OP C** | U-235 (Med) | 57 | I-125 (Med) | 52 |
| **OK A** | I-125 (Med) | 49 | Pd-103 (Med) | 46 |
| **OK B** | Se-75 (Med) | 57 | Co-57 (Ind) | 54 |
| **OK C** | I-125 (Med) | 49 | Cd-109 (Ind) | 42 |
| **EY A** | Pd-103 (Med) | 63 | - | - |
| **EY B** | Am-241 (Ind) | 81 | - | - |
| **EY C** | I-125 (Med) | 62 | Pd-103 (Med) | 50 |
| **UM A** | I-125 (Med) | 53 | Pd-103 (Med) | 45 |
| **UM B** | I-125 (Med) | 64 | Pd-103 (Med) | 51 |
| **UM C** | I-125 (Med) | 56 | Pd-103 (Med) | 52 |

OP = Opanda; OK = Okereku; EY = Eyenu; UM = Udege = Mbeki; A = Mining Point; B = 100 meter away from Mining Point; C = Water Way within the Mining Point.

## Results Analysis

In this study, the results presented in Table 3 were used to plot chart in other to explain the radioisotopes percentage abundance per total area under investigation as presented in Figure 2.

### 3.2 Discussion

The results of the Identification of Medical and Industrial Used Radioisotopes in Mining Sites across Nasarawa Local Government using Thermo-Scientific Interceptor CTZ Radioisotope IdentiFINDER Detector were presented in Table 3. The analysis of the radioisotopes percentage abundance was done using a chart as presented in Figure 2. Seven (7) radioisotopes were found to be spread across the twelve points in the area under study. These radioisotopes and their respective atomic masses include Palladium-103, Iodine-125, Cadmium-109, Americium-241, Uranium-235, Selenium-75 and Cobalt-57. From the findings of this study as presented, it is possible to see that $^{103}$Pd (Palladium-103) and $^{125}$I (Iodine-125) were found to be in 57% of the areas in which the samples were taken and the percentage abundance of the detector reaches 50-65% which indicates that, those radioisotopes which may be used for either medical or industrial purpose are likely to be found in the area. Similarly, it is clearly seen that

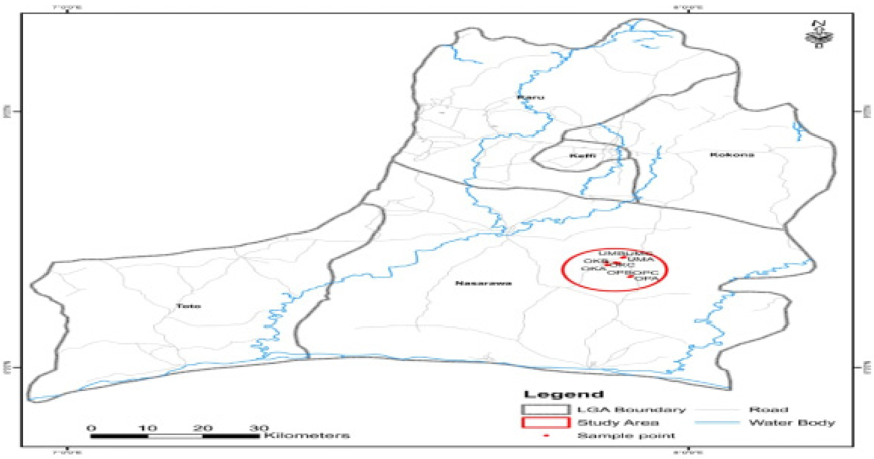


**Figure 1.** Map of the Sample Location in Nasarawa West

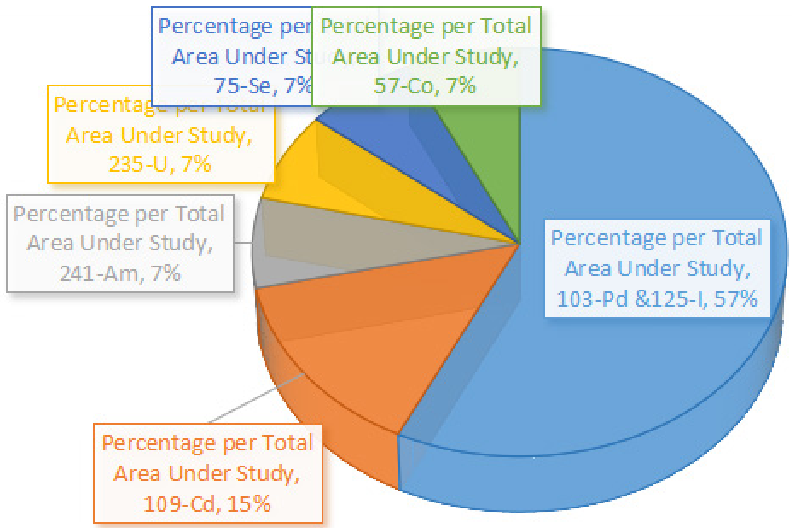


**Figure 2.** Radioisotopes and Percentage Abundance per Total Area under Study

$^{109}$Cd (Cadmium-109) was found to be in 15% of the total areas in which the samples were collected. The percentage abundance of the detector for $^{109}$Cd (Cadmium-109) shows 50% which indicates that, those radioisotopes which may be used for either medical or industrial purpose are likely to be found in the area. It is also obviously seen that $^{241}$Am (Americium-241) was found to be in 7% of the total areas in which the samples were taken. The percentage abundance of the detector for $^{241}$Am shows 81% which indicates that, those radioisotopes which may be used for either medical or industrial purpose are likely found in the area. It is similarly possible to notice that $^{235}$U (Uranium-235) was found to be in 7% of the total points in which the samples were collected. The percentage abundance of the detector for $^{235}$U (Uranium-235) reaches 57% which indicates that, those radioisotopes which may be used for either medical or industrial purpose are likely gotten in the area. It is also possible to see that $^{75}$Se (Selenium-75) was found to be in 7% of the total points in which the data were measured. The percentage abundance of the detector for $^{75}$Se (Selenium-75) was in abundance up to 57% which indicates that, those radioisotopes which may be used for either medical or industrial purpose are likely gotten in the area. And lastly, it is also possible to see that $^{57}$Co (Cobalt-57) was found to be in 7% of the total areas in which the data were taken. The percentage abundance of the detector for $^{57}$Co (Cobalt-57) was 54% which indicates that, those radioisotopes which may be used for either medical or industrial purpose are likely to be gotten in the area. Based on this high percentage abundance of the detector of these radioisotopes, they can be harnessed and applied appropriately in medicine and industry.

## 4. Conclusions

Identification of Medical and Industrial Used Radioisotopes in Mining Sites of Nasarawa in Nasarawa State, Nigeria using thermos-scientific interceptor (radiation identiFINDER) was carried out and the findings of the study show that, the trust level of the radioisotopes distributed across all the areas under investigation for both Medical and Industrial uses found in most of the areas under investigation are high. This high trust level indicates that these radioisotopes are embedded in those areas and can be harnessed and put to appropriate use in their area of usage as stated in Table 3 since they are highly demanded in our various hospitals and industries. It is therefore recommended that, the government should look for a way of sponsoring researchers to enable them to engage in researches on the possible ways to extract these radioisotopes for use in our various hospitals and industries instead of importing them from foreign countries. It is also suggested that researches of the same kind should be conducted in the remaining parts of the country.

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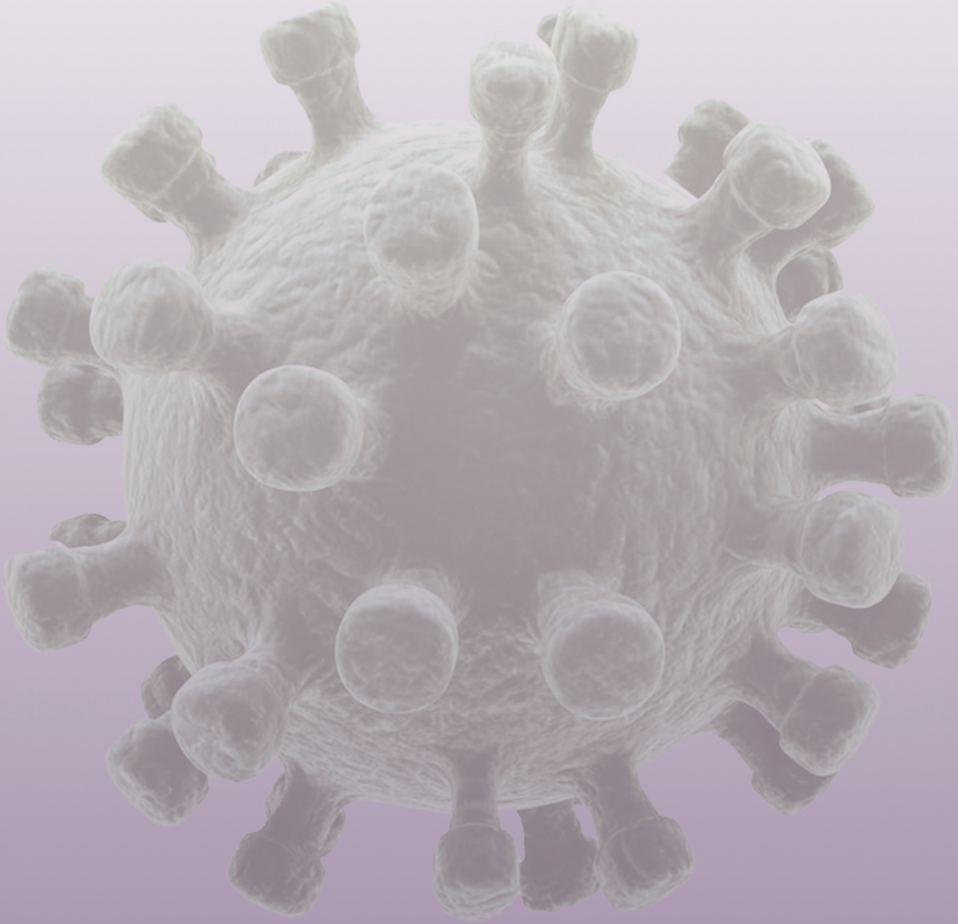

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