Case Report

Fatal Radiation Exposure due to Careless Disposal of Cobalt-60 from a University Lab

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Abstract
Many radioactive materials are also used in laboratories for experimental works. The methods of disposal of these residual radioactive materials are always a concern, as it can adversely affect the environment as well as the health of the exposed persons. Eight persons including a scrap dealer were accidentally exposed to radiation by a Cobalt-60 irradiator in a scrap shop at Mayapuri, New Delhi, India. The source of irradiator was traced back to Chemistry department laboratory of Delhi University, where it was used for experimental analysis of effect of gamma rays on chemicals. It was sold to the scrap dealer without following proper guidelines. All persons suffered acute radiation syndrome, but the laborer who had dismantled the irradiator and touched the pencils suffered the maximum exposure. He later died during treatment at All India Institute of Medical Sciences (AIIMS) Hospital, New Delhi. The clinical course, autopsy findings of the deceased and legal aspects of this incident are discussed in this paper.

Key Words: Cobalt-60; Radiation; Death; Autopsy; Legal

Introduction:
In this modern age, many radioactive materials are used in hospitals as well as laboratories of teaching institutions. In hospitals, it is used for both diagnostic and therapeutic purposes. Many radioactive materials are also used in laboratories for experimental works.

The methods of disposal of these residual radioactive materials are always a concern, as it can adversely affect the environment as well as the health of the exposed persons. The population exposed to such events not only suffer acute radiation syndrome, but also bear the brunt of its long term sequel like malignancies. We are reporting a case, where one person died and seven others suffered acute radiation syndrome due to the residual radioactivity from a Cobalt-60 irradiator used in laboratory of a University.

Case History:
A scrap dealer purchased an irradiator. This was not in use, since past 25 years, in the chemistry laboratory of Delhi University, India.

The irradiator was dismantled by the dealer in late March, 2010 and was kept in his shop at Mayapuri, New Delhi. Within a week, he observed skin hyper-pigmentation of the hands and forearm, loss of scalp hair, nausea and fatigue. He came to emergency Department of AIIMS, New Delhi for treatment.

With these clinical signs, symptoms and history, he case was diagnosed as a case of suspected radiation injury. The National Disaster Management Authority (NDMA) was informed.

One emergency team from NDMA rushed to the suspected area and cordoned off the whole area. Subsequently teams from Bhaba Atomic Research Center (BARC), Mumbai and Narora atomic power plant, Narora, reached the spot and the article emitting harmful radiation was detected. The article was identified as a Gamma irradiator & the radioactive material as Cobalt-60. The Gamma irradiator was purchased by the Delhi University from Canada in 1968 and was condemned in 1985.

It was since then lying unused in their store and was sold to the scrap dealer without measuring its residual activity. Meanwhile, the patient who had presented with the symptoms, opted to shift to a private hospital, where he was treated and discharged afterwards.

This incident attracted huge media attention in India. Seven other persons working in that shop during that period were also traced, who had already developed similar skin manifestations and fatigue. They were initially
treated in a private hospital, out of which five were shifted to AIIMS hospital. All five were diagnosed and treated for Acute Radiation Syndrome out of which one died, during the course of treatment. Two other exposed sufferers were treated at a different hospital and were discharged too.

**Clinical Course of Patient Who Died:**

The patient was admitted to AIIMS hospital on 9th April 2010. The patient had history of exposure to radiation of about 2 weeks. He revealed that, he had broken the protective lead of the irradiator and had touched the cobalt-60 ‘pencils’. He used to work in that shop for 12-14 hours per day, where the pencils were kept.

He also gave history of gum bleeding, 2-3 episodes/day and epistaxis, 10-15 episodes/day for the past 5 days before admission. He had blackish discoloration of fingers and toes for 7 days and black spot over forearm and left shoulder since the past 2-3 days. The patient’s vitals were stable at the time of admission.

The haemogram profile at the time of admission was Hemoglobin (Hb) 9.4 gm%, Total Leukocyte Count (TLC)-600/cmm, platelets -10,000/cmm. On second day the Hb, TLC and Platelet count decreased further and he was labeled as a case of pancytopenia. As the condition started deteriorating, transfusion of packed RBC and platelets were started.

On fourth day, the patient developed signs and symptoms of pneumonia. The etiology was established to be fungal by High Resolution Computer Tomography (HRCT) & Broncho-alveolar Lavage (BAL) microscopy. This fungal etiology was further confirmed by culture.

Despite repeated transfusion of platelets and packed RBC the haemogram profile did not improve. Bone marrow biopsy was also done which confirmed bone marrow suppression.

Bone marrow transplantation was planned, for which HLA typing of blood relatives were carried out. Despite vigorous treatment with antibiotics, febrile neutropaenia regimen, systemic antifungal, repeated transfusion of packed RBCs, platelets, fluids etc, the patient’s condition kept deteriorating. Gradually he developed Acute Renal Failure, Acute Respiratory Distress Syndrome (ARDS) along with paralytic ileus, pyelonephritis and pulmonary Aspergillosis.

The patient was shifted to ICU on 15th day of admission, intubated and was kept on total parental nutrition. Despite round the clock close monitoring in ICU and treatment, he died on 26/04/2010.

The cause of death was mentioned by the treating physicians as “Septic shock with sepsis” (disease or condition directly leading to death) and “multi organ dysfunction with bilateral pneumonia with ARDS with pancytopenia with radiation exposure” (antecedent cause) in the International Form of Medical Certificate of cause of death.

The total radiation dose was calculated in patient during the course of treatment was 3.1Gy by BARC scientists. The body was declared safe for handling. Then body was transferred to morgue and the postmortem examination was carried out on the next day.

**Autopsy Findings:**

The body was that of a 26 year old male, average built.

**External Examination:**

A blackish patch of size (6x3) cm was present on right hand. Multiple hyper-pigmented areas were present on the body. (Fig.1) Sclera and nails showed yellowish discoloration.

**Internal Examination:**

Pleural cavities showed straw-coloured colored effusion, of about 300ml. Both lungs were heavy, edematous and showed diffuse consolidation with purulent exudates coming out of cut section. (Fig.2) Histopathology of lungs revealed dilated alveoli filled with fluid as well as fibrin deposits (Fig.3).

Peritoneal cavity showed effusion of fluid about 600ml. External examination of stomach wall showed a reddish-black discoloration of size (2x2) cm on fundal surface. (Fig.4) Stomach mucosa showed diffuse congestion and minute ulcerations. All other organs were congested.

Histopathological examination of coronaries and myocardium revealed no abnormality. Histopathological examination of kidney revealed congestion of glomeruli, peritubular capillaries and medulla. Patchy tubular atrophy was observed. (Fig.5) Liver architecture was maintained. Portal tracts were within normal histological limits. Sinusoids were dilated and congested. Hepatocytes were within normal limits. Few areas showed signs of autolysis. (Fig.6)

After perusal of treatment records, inquest papers, and autopsy, with histopathological examination, the cause of death was concluded to be shock due to septicemia consequent to acute radiation exposure.
Discussion:

In the last century, numerous radioactive accidents were reported from different parts of the globe, in various set-ups like power plants; hospitals etc. [2] However radiation exposure from Cobalt-60 in civilian set-up is rarely reported. An accident involving Cobalt-60 (tele-therapy heads) was reported in Thailand during year 2000, in which total 10 persons were affected and 3 died, due to acute radiation sickness. [3]. Very few cases of radiation accidents were reported from India; however no fatalities were reported till date. [4-7]

Death due to such radioactive exposure is hence unique and first of its kind in India. The victim in our case was a laborer, who had broken the protective lead covering of the irradiator and separated the pencils to individual one. He had directly touched the radioactive material Cobalt-60 which resulted in maximum exposure.

In our case the radiation dose (3.1 Gy) was detected in the victim. He presented with gingival bleeding, epistaxis and hyper-pigmentation on the right forearm. During the course of treatment pancytopenia, fungal pneumonia and bone marrow suppression was diagnosed. During treatment he developed paralytic ileus, ARDS, acute renal failure.

By postmortem and histopathology of organs sepsis, pneumonia, ARDS, gastric ulcerations and acute renal failure were confirmed. These findings further strengthened the clinical diagnosis. The explanation to the clinical course is that, the exposure caused hematopoietic depression due to bone marrow suppression. He developed infections and bleeding, secondary to low leukocyte and platelet counts, respectively.

In this case gastro-Intestinal syndrome accompanied the hematopoietic manifestations, further worsened the patient's condition, by compromising the absorptive layer of the gut altering absorption of fluids, electrolytes, and nutrients. GI injury had led to GI bleeding, sepsis, electrolyte and fluid imbalance in our patient, whose blood counts were compromised for a period of weeks, leading to death. [8]

There are statutory bodies in India who safeguard different aspects of radiation and its related events like Atomic Energy Regulatory Board (AERB), Safety Review Committee for Application of Radiation (SARCAR), but incidents like our case, raises concern on handling hazardous radio-isotopes in a civilian setup. [9] The authorities had effectively decontaminated the vicinity where the scrap dealer's shop was located.

Following the incident, AERB had banned the use of the radioactive isotope of Cobalt in the University. [10] After investigation by Delhi Police, six Professors of Chemistry Faculty of Delhi University were charged with criminal negligence under sections 337 (causing hurt by act endangering life or personal safety of others) and 338 (causing grievous hurt by act endangering life or personal safety of others), and 304A (causing death by negligence) of the Indian Penal Code. [11]

A Task Force for radiation accidents was constituted by The Ministry of Health and Family Welfare, for framing protocol for the medical fraternity to respond to emergencies, arising out of radiation exposure in the future. Though the victims exposed to the radiation, were efficiently traced and treated, one of them was unfortunate and died.

We highlight the undue negligence on the part of the authorities who had carelessly disposed off the hazardous radioactive materials. The authors stress the importance of following the protocols in handling such materials as per the existing guidelines, in order to avoid repetitions of such incidents in the future.

References:

Fig. 1: Body showing Hyperpigmentation

Fig. 2: Both lungs are Voluminous and Heavy

Fig. 3: Histopathology of Lungs Showing Dilated Alveoli Filled With Fibrin & Edema Fluid

Fig. 4: Stomach Outer Wall Showing Reddish-Black Patch

Fig. 5: Histopathology of Kidney Showing Patchy Tubular Atrophy and Glomerular Congestion

Fig. 6: Histopathology of Liver Showing Dilated Sinusoids