An Accidental over Exposure in Mednif Tele-Cobalt Machine in Nepal

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ABSTRACT

A radiation incident took place during treatment on MEDNIF Tele cobalt-60 therapy machine in B.P.KOIRALA MEMORIAL CANCER HOSPITAL in Bharatpur, Nepal. This Chinese made machine has activity of 6240 Curies of cobalt -60. This machine has fulfilled safety requirements. ICRP recommendations, safety rules are followed and practiced. The source was struck up during treatment and a technician was exposed to equivalent dose of 13.75 mSv. recorded by Personal film badge. Risks of workers are comparable to other safe industries. All exposures shall be kept as low as reasonably possible. The higher level of safety is achieved only when every one is dedicated to common goal. A lesson is learnt for future. Good practice is essential but not sufficient. A high demand for tele Cobalt therapy convinced management to replace Mednif machine with a new efficient Elite Tele Cobalt theratron Machine.

1. INTRODUCTION

To cope with new challenges in cancer care the government of Nepal decided to establish the first cancer hospital B.P.Koirala Memorial Cancer Hospital (BPKMCH) in Bharatpur, Chitwan, Nepal. This hospital will be the nucleus for the radiological international standards, safety rules and regulation in future for Nepal. Radiotherapy service started here since July 1999 with MEDNIF FYC 2600H Tele cobalt and simulator machines. These machines are under grant from Chinese government to Nepal and made in Shanghai Medical Nuclear instrument factory in the people republic of China (PRC). Till date about one thousand patients has received radiation therapy here .The cobalt -60 source activity was 6240 Curies. A farmer type ionization chamber calibrated from secondary standard dosimetry laboratory IAEA/WHO ministry of health PRC is used for dosimetry. The source send device is a pneumatic system made of air compressor and circuit of air and source moves in linear in tube. Three indicating lamps on source head and on control panel indicate instantaneous position of the source such as shielded storage position when green light is active, on way leaving storage position and RAD red during treatment position. There is a circular hole in the center of the radioactive beacon (three lines chart). When the source is in the RAD state a red rod (named emergency push rod) will stretch from the circular hole used as mechanical identification beacon and for treating in emergency condition. A close circuit TV monitor is used for viewing patient and source position. An intercom is used to communicate to patient from control room. Other safety features such as if the door interlock is opened or in case of power failure during treatment the source goes back to safe position. After setting the patient treatment position and parameters the hand control is to be off position each time to start the treatment from control panel. Once the set treatment time is over an alarm sound is audible in control.

2. SAFETY STANDARD AND PRACTICES

Basic safety standard and guidelines resulting in publications of recent recommendations by International Commission on Radiological Protection (ICRP) and other nationals are used as reference guide lines and applied. A radiation safety program is designed to meet safety of patients, the radiation workers and public at large. Safety is a function of equipment design, room design and construction, staff training, working procedures and application of appropriate safety rules.

The following principles are followed. No practice shall be adopted unless its introduction produces net positive benefit.

All exposures shall be kept as low as reasonably achievable (ALARA) economic and social factors being taken into account.

Dose to individual shall not exceed recommended limits. The cobalt unit, which is housed in properly protected room, includes an entrance maze, functioning door interlock and the dose rate outside the room in areas occupied by staff is far below the current international dose limit for radiation workers of 25 micro Sv/ hr. Any technician working in a cobalt unit will receive most of his annual exposure inside treatment room whilst setting up patients. The routine survey is performed with Aloka calibrated survey meter. The average leakage radiation level in source off condition is 13 μSv /hr at 5 cm. from the surface of head and 4 μ Sv/hr from 1 meter. These values are average of seven readings noted at different points. A provision for gamma zone monitor is also there but it is out of order. The leakage radiation at one meter with source on can not exceed 0.1% of the useful beam at that distance except for the collimator zone.

3. DETAIL OF INCIDENT

Mr. A had entered the treatment room to remove a patient at the end of the treatment on seeing green light at the entrance door. He went near to the patient on the table to help him to release from the table and set another patient. As he wanted to rotate the gantry suddenly noticed the rod in beam on position. The source was struck up. He became away from head and called the patient also to come out from the room. He became psychologically Upset and panic about the apprehension of high dose. We discussed the whole situation with him and tried to convince that his possible dose will be less than Maximum Permissible Dose (MPD) values. His used film badge was urgently sent to BARC, Mumbai India for dose report.

4. SITUATION MANAGEMENT

The incident occurred in the following situations. The machine gantry angle 270°, field sizes 13x10 cm set treatment time 64 seconds and D_{max}. 125 cGy /min, SSD at 80cm, treatment table height 126 cm, Mr. A chest height 126 cm. He was inside the room for about one minute and got all the secondary scatter exposure and also crossed the exit exposure (exit primary from patient) about 5 seconds at 150 cm away from head. He was convinced with the calculations and demonstrations with pocket dosimeter that his dose would be approximately 15 mSv. A telegram was received from PMS/FBS on 30/03/2000 for urgent dose report of Mr. A that his equivalent dose was 13.75 mSv. And advised to discontinue his radiation work. The Performa for investigating overexposure and individual statements were sent as mentioned above. It was approved that the dose received was genuine and again he should resume radiation work in August 2000 after 180 days of exposure. The source was pushed back to the safe position by physicist. Graetz EDW150 pocket dosimeters and Film Badges were used. Following dose were recorded at pocket dosimeters

At chest level ----4μSv.
At pelvis level -----3 μSv.

No dose in the film badges used during the same period was recorded.

5. DISCUSSION

Low level radiation effects are difficult to perceive for a number of reasons. None of the deterministic effect can occur following chronic radiation exposure for decades. The late stochastic effects namely carcinogenesis which occurs years or decades after exposure and the genetic effects which express as increased frequency of genetic disorders in future generations of exposed individuals may occur even for low doses. These effects are probabilistic in the sense that they occur only in a very small fraction of those exposed, second if the effect did occur it is in no way distinguishable from those which occur spontaneously due to many known and unknown causes, third radiation is a weak carcinogen as compared to many chemicals and other environmental agents. On the basis of increased incidence of cancer seen (in many different organs) in human beings exposed to large doses, it is inferred that low level radiation may also be associated with an increased risk of cancer induction, albeit very small. However, the populations world over exposed occupationally within the specified limits (20 mSv /Y) do not show a statistically significant increasing incidence of cancers. Only the UK cohorts showed a small increase in the incidence of Leukemia. Besides the population living in many high radiation background areas (e.g. Kerala coast, Gondong province in China, Ramsar in Iran etc.) do not show a higher incidence of cancers or genetic disorders as compared to those living in the normal areas. Such value overexposure of 13.75mSv equivalent dose was recorded because mainly the technicians were exposed to primary exit exposure or few seconds. The dose volume is less than whole body irradiation. This dose is few times the dose of C.T scan . In normal condition there is not any chance of getting more than 3/10 of MPD values for occupational exposure. The risk to radiation workers is comparable to other workers of safe industries. The myth that radiation is poisonous however small the dose some times exaggerated radiation phobia make more panic and which are resulted from psychological stress due to fear of exposure, a fear of potential diseases. Studies showed that low level radiation is not measurably hazardous to the health of human body. Cancer mortality is lower in areas of high background radiation than in control areas. In this overexposure the technician was not fully alert, he did not visualize the source position *on TV monitor. The gamma zone monitor was also out of order. This situation can be avoided by calling the patient from outside and managing it in proper way. The green light system must indicate position of source not the timer. To push the source back to safe position the gantry was rotated to 80-90 degree and field size reduced to console during the operation the operator must be calm, quick and carry dosimeters and impact the pushing the emergency rod. Primary beam must be always avoided. To prevent accidents in future there is a requirement to go beyond the strict implementation of a good practice so that all duties related with safety are carried out correctly with alertness with due thought, with full knowledge, sound judgement and proper sense of accountability. The higher level of safety is achieved only when everyone is dedicated to the common goal. The person's psychological and emotional attitude about the accident changed in course of time. There has been time to reconsider problems connected with human factor and emotional reactions. In a radiation accident the victim is exposed to an extremely unusual situation. The great rush around him provides a sense of insecurity and even panic. Knowledge and competence conferred by training, instruction, and self-education commitment at senior management level motivation through leadership supervision including audits and review practices. Two technicians at a time during treatment are formally assigned. Safety culture involves all level policy level, commitment of management, response of individuals.Since the performance of Mednif Cobalt was comparatively poor so it was decided by management to commission a new tele cobalt Elite 1000 Theratron machine in the same room which is now safely in use treating about 70 patients daily.

CONCLUSION

The retrospective evaluation of the consequences of the accident provides data and lesson about the management of such situation and all necessary protection measures. To prevent accidents during repair and maintenance or treatment of radiation unit adequate technological and dosimetric equipment and clear-cut guidelines for use are indispensable. Since technical failure may occur and its corrections may entail the possibility of high dose rates. Through plans should be prepared for bringing the source under control and should include provision for the shielding of workers use of remote manipulation and monitoring operation. Good practice is essential but not sufficient. The decision by management to replace chinese cobalt machine with new Elite Theratron machine proves to be good here.

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