RADIATION SAFETY PROGRAM IN A HIGH DOSE RATE BRACHYTHERAPY FACILITY

L.V. Rodriguez
Department of Radiotherapy, Jose R. Reyes Memorial Medical Center, Manila, Philippines
R.C. Solis
Division of Radiation Oncology, St. Luke's Medical Center, Manila, Philippines
T.M. Hermoso
Department of Radiotherapy, Jose R. Reyes Memorial Medical Center, Manila, Philippines

Abstract

The use of remote afterloading equipment has been developed to improve radiation safety in the delivery of treatment in brachytherapy. Several accidents however, have been reported involving high dose-rate brachytherapy system. These events, together with the desire to address the concerns of radiation workers, and the anticipated adoption of the International Basic Safety Standards for Protection Against Ionizing Radiation (IAEA, 1996), led to the development of the radiation safety program at the Department of Radiotherapy, Jose R. Reyes Memorial Medical Center and at the Division of Radiation Oncology, St. Luke's Medical Center. The radiation safety program covers five major aspects: quality control/quality assurance, radiation monitoring, preventive maintenance, administrative measures and quality audit. Measures for evaluation of effectiveness of the program include decreased unnecessary exposures of patients and staff, improved accuracy in treatment delivery and increased department efficiency due to the development of staff vigilance and decreased anxiety. The success in the implementation required the participation and cooperation of all the personnel involved in the procedures and strong management support. This paper will discuss the radiation safety program for a high dose rate brachytherapy facility developed at these two institutes which may serve as a guideline for other hospitals intending to install a similar facility.

1. Introduction

The use of radiation in treatment of patients involves both benefits and risks. Experiences have shown that patients treated using radiation develop and manifest symptoms of side effects depending on the amount of dose received and target area. Likewise, it has been reported that early radiation workers had developed radiation-induced cancers. These knowledge lead to the continuous work for the improvement of radiation safety of patients and personnel. One of these developments is the use of remote afterloading equipment to improve radiation safety in the delivery of brachytherapy. Several accidents however, have been reported involving high dose-rate brachytherapy system [1].

The Department of Radiotherapy of Jose R. Reyes Memorial Medical Center and the Radiation Oncology Division of St. Luke's Medical Center are two of the hospitals in the Philippines to first acquire remote afterloading systems. The development of a radiation safety program in these hospitals has been started prior to the acquisition of the equipment. The foremost aim of the program is to improve the safety measures in the application of high dose rate brachytherapy, which will be of greatest benefits to patients and staff, and at the same time, satisfy requirements of regulatory agencies.

An effective radiation safety program will produce results such as decreased radiation exposures of patient and staff, improved accuracy in the treatment and increased department efficiency, which will eventually lead to reduced overall operating costs. A well observed radiation safety program develops vigilance of staff as well as decreased personnel and management anxiety.

The guiding document in the preparation of the radiation safety program at the above mentioned hospitals has been the International Basic Safety Standards for Protection Against Ionizing Radiation (IBSS) [2].

This paper will discuss the radiation safety program for a high dose rate brachytherapy facility developed at the Department of Radiotherapy, Jose R. Reyes Memorial Medical Center and at St. Luke's Medical Center which may serve as an example for other hospitals intending to install a similar facility.

2. Radiation safety program

The radiation safety program developed includes the following aspects: quality control and quality assurance, radiation monitoring, preventive maintenance, administrative measures, and quality audit.

2.1. Quality control/quality assurance program

The quality control/quality assurance (QC/QA) program [3] is conducted daily, monthly, and every source exchange. It consists of a set of mandated redundant performance checks, physical measurement, and guidelines for the development of performance procedures that are designed to minimize the frequency of human errors, miscommunication, and equipment malfunction. The quality control program is shown in Table 1.

Table 1. Brachytherapy quality assurance program

Daily	Monthly	Quarterly
Keys/power switch	Source position accuracy	Source calibration
Printer operation	Test run for all channels	Indexer checks
Computer Display (date, time, decay factor)	Source calibration	Dummy and source drive checks
Treatment Indicators	Review of daily checks	Radiation survey
Door Interlocks	Radiation survey	Computer hardware tests
Emergency/Interrupt buttons		Check of safety features
Acoustic and light warning signals		
Stored source position check		
Patient monitoring system		
Survey meters		
Emergency safety containers		

The success of patient treatment in brachytherapy depends on accurate treatment delivery. Accurate delivery means that the intended radiation sources are delivered to their intended positions within the correct applicator and remain there for the correct time. The results of QC/QA tests have shown source position accuracy achievable to within 0.2 mm, and source calibration reproducible to within 3% of specified activity.

The daily quality control includes computer operation checks, date/time and decay factor check, and verification of safety aspects such as warning signs, door interlocks, emergency buttons and patient monitor. These tests ensure that the patient is treated properly and that no person will be unnecessarily exposed to radiation by accident. The monthly checks include source position accuracy, source calibration, and applicator integrity. A graph of the %

difference between the manufacturer-quoted value and the clinically measured source activity for the last four installations is shown in Figure 1.

Quarterly checks are made to coincide with the source change and the preventive maintenance schedule.

Quality control checks are also conducted during treatment delivery process from the entry of the treatment parameters into the remote afterloader to the delivery of treatment. These checks are carried out to validate the entered data, to document the delivered treatment, and to immediately respond to unexpected machine malfunction and emergencies.

2.2. Preventive maintenance program

The preventive maintenance program is based on the checks submitted by the service engineers of the supplier of the company. For every source change, extensive mechanical checks, hardware tests as well as checks on the cycle counter, battery and electronic boards are performed. Values obtained should fall within the specifications and tolerance limits that are followed during the installation and commissioning process.

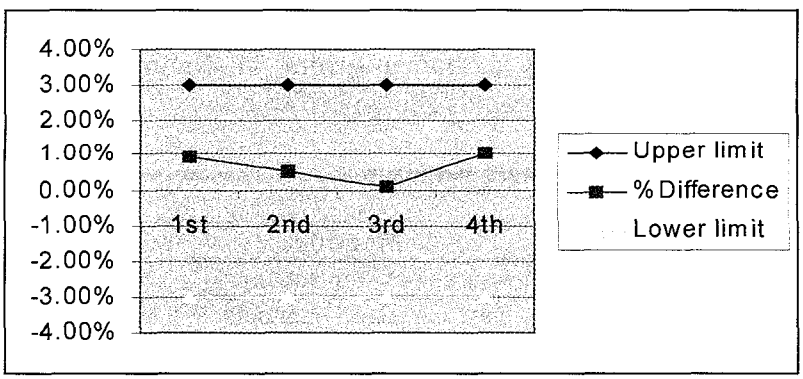

Figure 1. Source calibration accuracy

A list of parts to be replaced on regular basis such as battery and motor drives is provided by the manufacturer and is being followed.

2.3. Administrative measures

The head of the department is responsible for the overall departmental policy relating to quality matters and radiation safety program. He sees to it that his personnel are properly and adequately trained and that the radiation safety program is strictly observed. A medical radiation safety committee, having representatives from the different staff groups aside from the radiation health safety officer and management representative was formed to oversee this task. A forum is held quarterly where members of the committee study and discuss the radiation safety program in the department.

2.4. Radiation monitoring

Radiation monitoring has been used loosely to include activities referring to the source location, survey, and source inventory. Regular area surveys are conducted as part of the radiation monitoring program. Personnel exposures are monitored using film badges and pocket dosimeters.

Calibration of survey instruments is performed is done before first used, semi-annually and following repair [4]. The cylindrical ion chamber, well chamber, together with their respective electrometer are calibrated annually unless repair has been done in which case calibration must be performed prior to operation. Constancy checks is done on the dosemeter every month to confirm that results fall within 2%.

2.5. Quality audit

The quality audit, involves internal and external aspects. The internal aspect includes medical, technical, and procedural checks. The medical audit is performed by one of the consultants of the department through chart rounds, whereby charts of patients being treated are reviewed. The technical checks are conducted by the chief physicist to verify accuracy of source data and treatment plans. Procedural audit is conducted by the supervising radiologic technologist where spot checks are conducted to ensure that the treatment protocol is carried out.

The external audit is conducted by the regulatory agencies and includes checks on the list of qualified users, inventory of sources and records and documentation of procedures.

It is recommended that an IAEA Postal Dose Inter-comparison be performed to be part of an external audit for brachytherapy since it has been shown to be effective in highlighting problem areas and in improving quality for external beam radiotherapy worldwide.

3. Receipt and transport of radioactive source

Brachytherapy sources should be received by trained personnel and should be kept in a controlled and secured area. The type of radioactive source and the strength should agree with what was ordered. When opening the source packaging, it should be determined that there is no contamination present and that proper documents, including return documents, are inside the shipping container. The spent source must be properly secured in the same way that it was received and all documents necessary for its transport back to manufacturer must be complete. The record for receipt and shipping out must be kept and maintained.

4. Records and documentation

Records of the radiation safety procedures and the quality control test results are necessary. Records of equipment performance are kept throughout equipment life to enable reconstruction of events in the future if required.

References

[1] Lessons Learned From Accidental Exposures in Radiotherapy, Safety Reports Series No. 17, International Atomic Energy Agency, Vienna Austria (February, 2000).

[2] International Basic Safety Standards for Protection Against Ionizing Radiation, Safety Series 115, International Atomic Energy Agency, Vienna Austria (1996).

[3] Rodriguez, L. et. al., Micro-Selectron HDR installation and quality assurance: Philippine experience, Selectron Brachytherapy Journal **7** (1993), pp. 16-18.

[4] CPR Part 14 Licenses for Brachytherapy Sources for Medical Use, Philippine Nuclear Research Institute, Diliman, Quezon City.