QUALITY ASSURANCE IMPLEMENTATION IN THE NATIONAL CANCER CENTRE

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ABSTRACT

The importance of accurate dose delivery in radiotherapy is well documented. Studies have shown that a mere 5% deviation of the prescribed dose can produce an undesirable treatment outcome.
Uncertainties in the dose delivery can arise at different stages of the radiotherapy process. Therefore, a good quality assurance programme will ensure the best possible results and consistency of the radiotherapeutic treatment.
Quality assurance in any radiotherapy department involves the responsibility of a multi-disciplinary team of radiation oncologists, medical physicists and radiation technologists. This paper will focus on the physical and technical aspects of QA.
The organizational structure and responsibility of the physics QA team is outlined and also included the types and frequencies of QA checks. For a QA program to be effective, action levels should be clearly defined and understood by all staff concerned.
Data of the Singapore National Cancer Centre's participation over the last ten years with the IAEA / WHO Postal TLD Dose Inter-comparison programme is presented. The data obtained were within the international criteria.
For a QA program to be successfully implemented, there must be a commitment by management to provide adequate staff, test equipment, machine time as well as continual training and education. This is in addition to the positive attitudes of all the staff. A quality audit is also necessary to serve as a check and balance to ensure that the QA is in order.

INTRODUCTION

There are now 4 operational radiotherapy centres in Singapore; each has its own quality assurance programme to ensure safe and efficacious use of radiation for the treatment of patients. The QA programme is also to fulfill the administrative requirement of the Medical Audits and Accreditation Unit of the Ministry of Health of Singapore for the application /or renewal of operation licenses. In addition, these radiotherapy centres are also required to comply with the Radiation Protection Regulations, 2000 under the Radiation Protection Acts. The dose limits are in-line with the ICRU 60 and IAEA Radiation Basic Safety Standard.
This presentation will focus on the physical and technical aspects of radiotherapy, in particular, on the Medical Linear Accelerators at the National Cancer Centre of Singapore.

NATIONAL CANCER CENTRE

The Radiotherapy Department of the National Cancer Centre is the oldest radiotherapy institution in Singapore. It has a total of eight high energies teletherapy units, 2 simulators, 2 CT and 2 high dose rate brachytherapy units. It also conducts IMRT, stereotactic radiosurgery and intravascular brachytherpy procedures.

PHYSICS QA PROGRAMME

Quality assurance has gradually evolved from simple radiation output checks to a more comprehensive regime. The comprehensive QA programme was initiated in 1900 when the hospital was restructured.
QA on the technical and physics aspects is part of the departmental QA programme. The Physics QA comes under the purview of the Chief Radiation Physicist who set out the QA policies and manages its implementation. He is held accountable to the Head of The Radiotherapy Department. The implementation of the programme involved radiation physicists, dosimetrists and radiation therapists.

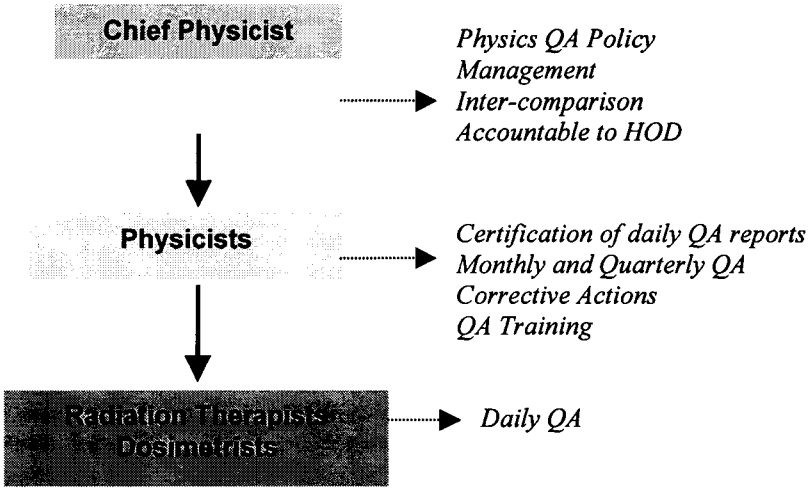


Fig. 1 Organizational Chart For Physics QA Program

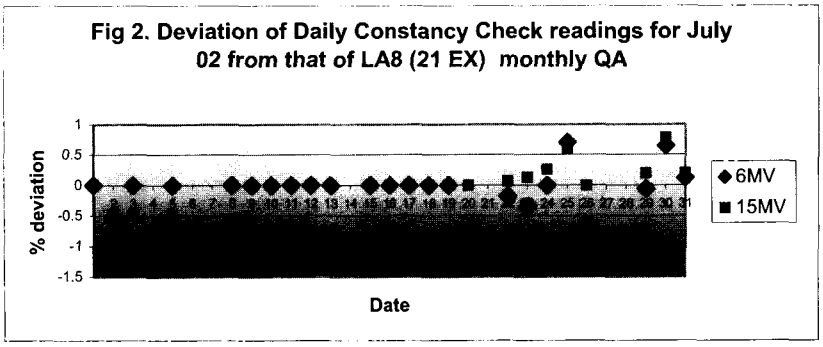
QA on the machines are performed on daily, weekly, monthly and quarterly basis. The quarterly QA includes semi-annually and annually QA[1,2]. The frequencies of check are shown in Table1.
QA checks are done with increasing details from daily to quarterly basis. Daily QA takes about 15 to 20 minutes whilst an annual QA may take up to 3 days.
The QA procedures are the tolerance levels as stated in the QA manuals. The QA results are recorded and documented in prescribed forms. These are ready for internal audits and external inspection.

	Equipment	On -treatment	Daily	Monthly	Quarterly	Semi-annually
1	Linear Accelerators		y	y	y	
2	CT Simulator		y	y	y	
3	Simulator		y	y		y
4	HDR Brachytherapy		y	y	y	
5	Stereostatic Radiosurgery	y		y	y	
6	IMRT	y		y	y	
7	Treatment Planning		y	y		
8	Intravascular Brachy	y			y	
9	Measuring equipment					y
		Physicists	Rad. Therapists	Physicists	Vendors/Phys	Vendors/Phys

Table 1: Frequencies of QA

DAILY QA

Daily QA is performed by the radiation therapists every morning prior to patient treatment, which takes about 15 to 20 minutes. It consists of some audio-visual checks on the water level, gas pressures, warning lights, and the general conditions of the machines, which includes checking of the laser light coincidence and the isocentre. Constancy-check devices such as the Vigilant or the LINACHECK are used. These are recorded in a prescribed form by a tick or by entry of observed parameters. The tolerance levels are included in the forms for comparison. The duty-physicist has to be countersigned the form before treatment can proceed. Any deviation from the norm will be noted by the physicist-on-duty who will discuss with the Chief Physicist for follow-up actions. A typical monthly constancy check tabulation is at Fig 2.



MONTHLY QA

This is performed by the physicists on a monthly basis. Additional items checked are as follows:

1. Radiation Light Field Coincidence checks
2. Symmetry and Flatness
3. Gantry rotation
4. Collimator Rotation
5. Couch Rotation
6. Beam Quality
7. Output Calibration

IAEA TRS398[3] in water beam calibration protocol is used for dose calibration. All monthly QA are done on Saturdays as there is no treatment scheduled. Thus minimize treatment disruption.

QUARTERLY QA

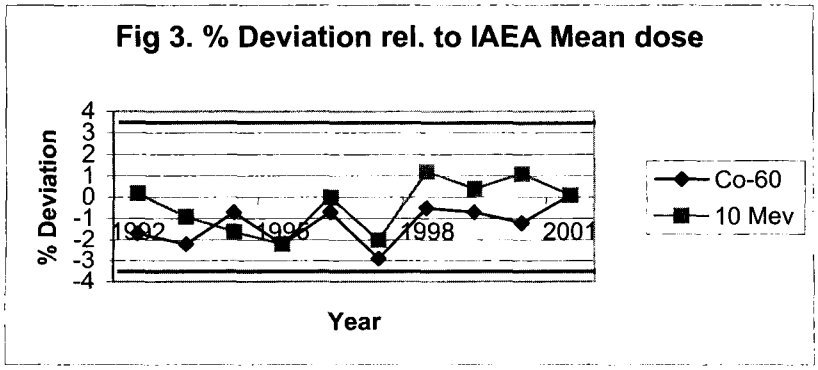
The quarterly service preventive maintenance is carried out in accordance to the vendor's protocol. This includes an annual beam scanning of the profiles and depth doses, stars shots, etc. Thus, to ensure that the machine's parameters are within the technical specifications. This is followed by a QA checks and calibration by the physicists before the machine is used for patient treatment.

EXTERNAL AUDIT: IAEA DOSE COMPARISON

The department has been designated as a Collaborating Centre for the IAEA\WHO Network of Secondary Standards Dosimetry Laboratory (SSDL)[4] since 1980. We participate regularly in the IAEA/WHO TLD Postal Quality Inter-comparison programs as a way of our external auditing procedure for our dose measurement. The advantage being that it provides us confidence on the adequacy of dose measurement and without incurring additional cost.

The inter-comparison involves the use of TLD of lithium fluoride power contained in polyethylene capsules. These capsules are prepared by the IAEA and distributed to participating member institutions. Each institute receives four capsules, of which three must be irradiated to a dose of 2 Gy in water under reference conditions. The fourth capsule serves a detector of any dose received during transit. These are sent back to IAEA for evaluation. The established acceptance limit between the user-stated dose and the IAEA measured dose is $\pm$3.5%. Should the measurement fall outside the tolerant limit, IAEA with the agreement of the participating institution will take follow-up action to resolve the discrepancy.

Results of the last 10 years for the CO-60 beams and 10 MeV photon beams are shown in Fig 3.



FUNCTIONAL PERFORMANCE & TOLERANCE LEVELS

One of the main purposes of QA check is to ensure that the equipment performs accordingly to its technical specifications. As a buyer from a small country, there is very little leeway to set own product's specifications, which differ from the vendors. Suppliers of radiotherapy equipment are only a handful. We have to accept what are provided in the vendor's product specifications. It is unlikely the supplier can cater for the individual needs. Fortunately, the functional performance of the Linacs complies with the IEC-977[5] recommendations.

It is of paramount importance for the user to check and confirm that the equipment delivered met the stated specifications during the commissioning and acceptance. These data can be used as a benchmark to determine the performance and tolerance levels of the equipment.

SPECIAL PROCEDURES

For some special treatment procedures such as for radiosurgery, intravascular brachytherapy and IMRT, there is a need to undertake additional QA procedural checks.

A typical QA procedure is illustrated for IMRT. After an IMRT treatment plan is prepared, a verification check of the dose distribution is undertaken using a phantom. For this, the IMRT fields are applied to a solid water phantom on the treatment planning system to compute the isodoses of three-transverse planes. Hardcopies are produced and compared with isodose measured using films. Treatment will proceed only after the verification is within acceptable limits. The two sets of isodoses generally agree to within 3% or 2 mm. Limits.

The optical density of the films is calibrated for every instance using a known depth-dose curve against the optical density of the depth of a film. This is to ensure consistency of the film dosimetry due to difference in processing density and chemical concentration. We are using our existing physics equipment for the verification.

KEY INGREDIENTS TO A SUCCESSFUL QA PROGRAM

The implementation of a QA program requires the commitment of staff.

The performance tests and acceptance criteria and action levels should be clearly disseminated and understood. Further, the staff must be adequately trained to do the job.

Management should provide the necessary funding for the procurement of necessary QA tools to undertake the QA checks\ and spare parts replacement.

Where corrective action is required, the machine should be made available for rectification and not use for treatment until the problem is resolved.

In so far as physics QA is concerned, in the event that QA check showed parameters are outside the tolerant limits, it would be useful that the order for suspension of the usage of machine for treatment be given or delegated to staff a personnel who is overall in-charge of physics QA. The aim is to expedite corrective actions.

CONCLUSION

It is unquestionable that a good QA program contributes to quality and consistent treatment. The extent and scope of QA to be undertaken will be dependent on the resource allocation of the institution and the commitment of staff and management.

There is still plenty of room to further QA improvement and harmonization. AFOMP as a regional organization, perhaps the latter can take a lead in formulation some policy and guidelines in this area to further upgrade QA programs in the region.

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