Improving Efficiencies in Quality Control of Radiotherapy Equipment

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Introduction

One of the major pieces of equipment in a radiotherapy department that is used for treatment of cancer is a linear accelerator (figure 1), which costs a minimum of £1m. The Christie has 16 accelerators across a network of 3 centres, each needing to be maintained within acceptable performance standards. The performance required is determined by the accuracy needed to achieve optimum treatment outcomes. The performance standards are maintained by designing a suitable quality control (QC) programme. The type and frequency of checks established within the QC program are influenced by the probability of, (1) an error occurring in the parameter being checked, (2) clinical impact of error, and (3) time taken to perform a check. At the Christie, the QC program is broken down into daily checks and infrequent checks (monthly/annually). Each accelerator requires approximately 1 hour of QC checks on a daily basis before it can be used for clinical treatments with an additional 4-5 hours of checks on a monthly basis. In order to maximise the number of patients that can be treated these checks need to be conducted in the evenings and weekends, which impacts on staff morale. The aim of this project was to find efficiencies in the QC program for linear accelerators such that the time required for staff to carry out QC outside core hours is minimised.

Phase 1 – Alignment with International Recommendations

The first phase of the project was to align the quality control checks carried out on linear accelerators at the Christie to various international recommendations. The recommendations from the following professional bodies were referred to during this review:
- Swiss Society of Radiobiology and Medical Physics (SSRMP 2003, SSRMP 2010).
- Canadian Association of Provincial Cancer Agencies (CAPCA 2005a, CAPCA 2003b, CAPCA 2005c).
- American Association of Physicists in Medicine (AAPM 2009).

See figure 2 for an example of changes proposed for QC checks carried out on electron beams. Part of this phase also involved a discussion session with all staff who carry out QC to feedback and seek views on the changes. This phase was successfully completed and changes implemented from January 2012. Changes included a reduction in frequency of some checks and therefore an overall reduction in time taken to carry out QC. The new QC program was in place for one year so that all checks within the program could be carried out before moving onto the next phase.

Phase 2 – Further Streamlining

The second phase of the project was to further reduce the number of QC checks carried out without impacting on safety of patient treatments. Two brainstorming sessions were organised with a wide group of individuals invited including engineers, dosimetrists and physicists; one to discuss daily QC and another to discuss infrequent checks.

Both meetings resulted in many ideas being put forward. These were then discussed between a core group to decide on an implementation/prioritisation strategy.

The reduced daily QC is currently being piloted on one of the linear accelerators for a period of four weeks with no issues found. This will then rolled out to all sixteen accelerators from May 2013 and will lead to a reduction in the time taken for daily checks by 15 minutes for each accelerator.

The reduction in infrequent checks are currently being implemented and should all be in place by August 2013.

Figure 1: Photo showing a clinical linear accelerator

Figure 2: Table showing current and proposed frequency of QC checks carried out for electron beams

Phase 3 – Future Work

3a. Reduction in Treatment Modalities at Oldham

A review of previous patient treatments at the Christie @ Oldham site is to be carried out to ascertain whether it is possible to decommission a number of electron energies and/or a physical wedge from clinical use. A dramatic reduction would be seen in the amount of QC checks to be carried out by removing either treatment modality from clinical use.

3b. Implementation of Electronic Portal Imaging QC (EPiQC)

The department has previously written and tested a software tool that enabled automatic linear accelerator QC using daily images taken with an amorphous silicon electronic portal imaging devices (Budgell et al 2007, Beck et al 2009). However, due to this project being reliant on a software engineer and other constraints the department has been unable to implement the use of this software.

The aim is to revive this project and implement the software, which would enable the reduction of more infrequent QC checks, due to parameters being monitored by the software on a daily basis.

Conclusions

The first phase of the project has been completed and implemented. This has led to the alignment of linear accelerator QC at Christie with international recommendations. The second phase is nearing completion and will enable a reduction in the time taken to carry out daily QC by up to 15 minutes per accelerator (16 in total).

Further changes are being implemented to streamline QC carried out on a more infrequent basis. These changes as well as the proposed future work should lead to an improvement in efficiency of QC carried out, therefore improving staff morale.

References

CAPCA  2005c  Physics Aspects of Quality Control in Radiotherapy. IPEM report no. 81
IPEM  1999  Physics Aspects of Quality Control in Radiotherapy. IPEM report no. 71 (IPEM, Fairmount House, 230 Tadcaster Road, York YO24 1ES)
IPEM  2005  Recommended Standards for Routine Performance Testing of Diagnostic X-ray Imaging Systems. IPEM report no. 71 (IPEM, Fairmount House, 230 Tadcaster Road, York YO24 1ES)
SSRMP  2003  Quality Control of Medical Electron Accelerators: Recommendations no. 11
IPEM  1999  Physics Aspects of Quality Control in Radiotherapy. IPEM report no. 71 (IPEM, Fairmount House, 230 Tadcaster Road, York YO24 1ES)
IPEM  2005  Recommended Standards for Routine Performance Testing of Diagnostic X-ray Imaging Systems. IPEM report no. 71 (IPEM, Fairmount House, 230 Tadcaster Road, York YO24 1ES)
SSRMP  2003  Quality Control of Medical Electron Accelerators: Recommendations no. 11 http://www.sgsmp.ch/r16igr-e.pdf