QUALITY ASSURANCE IN RADIOTHERAPY

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Abstract A common feature of the Radiotherapy Centres where there have been major accidents involving incorrect radiotherapy treatment is that they did not operate good Quality Assurance systems. A Quality Assurance system is sometimes called a Quality Management system, and it is designed to give assurance that quality standards are being met. One of the “spin offs” from operating a Quality Management system is that it reduces the likelihood of a radiotherapy accident. A detailed account of how to set up a quality system in radiotherapy has been given in an ESTRO booklet.2

Keywords: Quality Assurance systems; Quality Control; protocols; target delineation; introduction of a Quality System; organisation of a Quality System; control of a Quality System

1. Introduction

Among the quality standards that must be met in a Radiotherapy Centre are dosimetry standards and geometric standards. Meeting these standards is a necessary (but not complete) condition for good radiotherapy. It is widely accepted that dose discrepancies in the order of 6% or less will not be clinically detectable in individual patients. If this limit is not to be exceeded in more than one patient in 20, this represents two standard deviations, which means that the dosimetry standard should aim to deliver dose with an uncertainty not exceeding 3%. There is a chain of calibrations and calculations that lead to the final delivery of dose in a patient. The uncertainties in the component links in that chain (primary standard calibration, field chamber intercomparison, calculation of dose in a patient etc.) are each of the order 1–2%, so that the quadrature sum representing the overall uncertainty is close to the required 3%, or at least does not significantly exceed it. The Quality System is designed to ensure that the activities of each link in the chain are performed to the required tolerance.
Sometimes standards are required to ensure that target volumes are covered by radiation beams as accurately as practicable, with minimal risk to normal organs and tissues. Margins are drawn around target volumes which are supposed to be large enough to account for the principal sources of uncertainty: target delineation, set-up uncertainty, physical accuracy of radiotherapy equipment including “machine geometry” and motion of the target volume within the patient. Uncertainties in target delineation is generally the largest of these uncertainties, but the aim should be to minimise the set-up and machine geometry uncertainties over which there is potentially more control.

Most machine parameters, such as light and X-ray field size, laser alignment etc. drift slowly over time and, in practice, the discrepancies are not adjusted back to zero until an action level is reached, which is typically 2 mm. The likelihood of finding any given discrepancy is therefore approximately constant for all deviations up to the action level so that the probability density function may be represented by a “top hat” distribution. The standard deviation of such a distribution (with an action level of 2 mm) is \(2/\sqrt{3}\) mm which is approximately 1 mm. This is acceptably small compared with the standard deviations of set-up, delineation and organ motion and is therefore a suitable geometric standard for this Quality System.

It is important to differentiate between the terms “Quality Assurance” and “Quality Control”. Quality Control refers to the actions required to ensure that particular standards are being met, and this includes measuring output to check that it is within 2% of the standard, or checking that the lasers are accurate to within 2 mm. Quality Assurance refers to use of the actions that are necessary to give assurance that such quality control procedures take place. So Quality Assurance is a management system and Quality Control is a sub-set of the system. Other sub-sets include, for example:

- Writing protocols for the QC checks
- Managing these protocols to ensure that everyone has an up-to-date copy
- Ensuring that personnel are trained to carry out the QC procedures
- Analysing the training needs of the personnel and keeping training records
- Arranging systems to identify out-of-date conditions
- Drawing up timetables of machine QC
- Managing absence so that assurance can be given that there will always be personnel available to carry out the checks
- Drawing up a programme (organisations charts of personnel) so that responsibilities of individuals are clearly defined
- Making provision for resources to fund the equipment and personnel required to meet the quality standards etc.