Prescribing, Recording and Reporting Photon Beam Therapy

Supplement to ICRU Report 50
ICRU Report 62

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Executive Summary

Relation to ICRU Report 50

The present report is a Supplement to ICRU Report 50, *Prescribing, Recording, and Reporting Photon Beam Therapy,* published in 1993. Report 50 contained recommendations on how to report a treatment in external photon beam therapy. These recommendations were formulated in such a way that they can generally be followed in all centers worldwide.

Publication of Report 50 and its application to clinical situations stimulated broad interest, raised new questions, and sometimes triggered vigorous discussions and debates.

In the intervening years since Report 50 was published, irradiation techniques have advanced with many new procedures introduced. Driving this process are the considerable improvements in three-dimensional imaging which allow exquisite definition of target volumes, volumes of interest, as well as organs at risk. Naturally, treatment planning systems kept pace with these advances allowing improved radiation prescriptions.

Aim of Present Supplement

For these reasons, the ICRU decided to publish a supplementary document in order to formulate more accurately some of the definitions and concepts and to take into account the consequences of the technical and clinical progress. This new report complements the recommendations contained in the previous one and reflects these developments.

When delivering a radiotherapy treatment, the volumes and the doses must be specified for several purposes: prescribing, recording, and reporting. It is not the goal nor the task of the ICRU to recommend treatment techniques and absorbed dose levels. *Prescription* of a treatment is the responsibility of the radiation-oncology team in charge of the patient. *For reporting purposes,* it is important that clear, well-defined, unambiguous, and universally accepted concepts and terminology are used to ensure a common understanding. Only under these conditions can a useful exchange of information between different centers be achieved.

Volumes and Margins

The development of conformal therapy and the expected therapeutic gain, as well as the increased risk of missing some of the cancer cells, require a more accurate definition of the *margins around the target volumes.* The concepts of Gross Tumor Volume (GTV) and Clinical Target Volume (CTV) need not to be reconsidered, since they are oncological concepts independent of any technical development. However, the different factors to be taken into account when delineating the Planning Target Volume (PTV) and the corresponding margins deserve more accurate identification.

In the present Supplement, the Internal Margin (IM) is defined so as to take into account variations in size, shape, and position of the CTV in relation to anatomical reference points (*e.g.,* filling of stomach or bladder, movements due to respiration, etc.). The Set-up Margin is added to take into account all uncertainties in patient-beam positioning.

Segregating the Internal Margin and the Set-up Margin reflects the differences in the source of uncertainties. The Internal Margin is due mainly to physiologic processes which are difficult or impossible to control. In contrast, the Set-up Margin (SM) is added because of uncertainties related mainly to technical factors that can be reduced by more accurate set up and immobilization of the patient, as well as by improved mechanical stability of the machine.

The global concept and definition of the PTV as given in ICRU Report 50 is not changed. For each volume defined, a color code is proposed to assure clarity of interpretation.

Probability of Benefit versus Risk of Complications

Finally, this supplement recognizes that the linear addition of the margins for all types of uncertainties would generally lead to an excessively large PTV. This could result in exceeding the patient tolerance and fail to reflect the actual clinical consequences.

The risk of missing part of the cancer cell population must be balanced against the reduction of the risk of severe normal tissue complications. The balance between disease control and risk of complications often dictates acceptance of reduced probability of cure in order to avoid severe and serious treatment-related complications.

Therefore, the selection of a composite margin and the delineation of the border of the PTV involve a compromise that relies upon the experience and the judgment of the radiation-oncology team.

Organs at Risk

The compromise to be accepted when delineating the PTV is due to the presence of Organs at Risk. Such Organs at Risk are normal tissues whose radiation sensitivity and location in the vicinity of the PTV may significantly influence treatment planning and/or the absorbed dose level to be employed. The problems resulting from the presence of Organs

at Risk is discussed in more detail in this Supplement to Report 50.

The system of classifying Organs at Risk as "serial", "parallel", or "serial-parallel" is discussed, and the use of this system to interpret tolerance of various Organs at Risk is explained. A typical example of a tissue with a high "relative seriality" is the spinal cord, implying that a dose above the tolerance limit, even to a small volume, can totally impair the function of the organ (myelitis). In contrast, the lung has a low "relative seriality", implying that the main parameter for impairing pulmonary function is the proportion of the organ that receives a dose above the tolerance level. The heart can be considered as having a combined "serial" (coronary arteries) and "parallel" (myocardium) structure.

Planning Organs at Risk Volumes (PRV)

The present Supplement stresses the fact that for the Organs at Risk, as for the CTV, movements and changes in shape and/or size, as well as the set-up uncertainties, must be considered. A margin must be added to compensate for these variations and uncertainties, which leads to the concept of the *Planning Organ at Risk Volume (PRV).* Thus, for the Organs at Risk, the PRV is analogous to the PTV for the Clinical Target Volume. For reporting, the description of the PRV (like that of the PTV) should include the size of the margins in all directions. The PTV and the PRV may overlap, and often do so, which implies searching for a compromise as discussed above.

Conformity Index

The concept of a Conformity Index (CI) is introduced and defined as the quotient of the Treated Volume and the volume of the PTV. This definition of the CI implies that the Treated Volume totally encompasses the PTV. Note that the Treated Volume is the tissue volume that receives at least the dose selected and specified by the radiation oncology team as being appropriate to achieve the purpose of the treatment, tumor eradication or palliation.

Not surprisingly, optimization of the CI may result in deterioration of other desired parameters, such as the size of the Irradiated Volume or the absorbed dose homogeneity in the PTV. Again, to optimize the CI, some overall compromises may be required.

Dose Specification for Reporting

Recommendations contained in Report 50 for dose specification for reporting are maintained. First, the absorbed dose at the ICRU Reference Point should be reported. Then, the best estimates of the maximum and the minimum doses to the PTV should be reported. Furthermore, any additional relevant information should be given, when available, *e.g.,* Dose-Volume Histograms (DVHs). The absorbed doses to the Organs at Risk should also be given.

Reporting Doses in a Series of Patients

ICRU Report 50 dealt with dose reporting in an individual patient. Different issues are encountered when reporting treatments for a series of patients.

First, the treatment prescription or protocol should be described in detail, including the volumes, absorbed-dose levels, and fractionation. The treatments should be reported following the above recommendations, and the deviations from the prescription should be stated. In particular, the proportion of patients in whom the dose variation is less than $\pm 5\%$, ± 5–10%, and more than $\pm 10\%$ of the prescribed dose at the ICRU Reference Point should be reported.

When reporting the treatments in scientific journals, it is recommended that the prescribed CTV and PTV and corresponding doses be illustrated in an isodose distribution chart, giving the total absorbed doses in Gy.

The Three Levels for Reporting

The three levels of complexity for reporting the irradiations that were introduced in Report 50 are retained. However, since its publication in 1993, the limits between the three levels were modified due to the recent improvements in irradiation techniques and developments in imaging and in treatment planning.

Clinical Examples

Finally, the present Supplement to ICRU Report 50 contains an Appendix with three examples illustrating how the recommendations can be applied in clinical situations. The first example compares the irradiation of the internal mammary chain using a single electron beam or a combination of an electron beam and a photon beam. The second example deals with irradiation of prostatic adenocarcinoma. The third example illustrates how to report an irradiation of a bronchus carcinoma.

Conclusions

This Supplement to ICRU Report 50 provides updated recommendations that include the many advances in treatment techniques, treatment planning, and image based target definition. To assist the necessary decision-making process in therapy, the concept of a "Conformity Index" is defined and introduced. Finally, clear guidance is provided for reporting treatments of individuals and series of patients. Hence, this Supplement will guide and assist the process of modern radiation therapy.