ATC • AdvancedTechnologyConsortium
Providing support in quality assurance and data management for radiation therapy clinical trials

IMRT BENCHMARK

This document represents work in progress within the Advanced Technology QA Consortium (ATC). Comments are welcome and should be directed to Marcia Urie, PhD or David Followill, PhD, co-chairs of the ATC Credentialing and QA Committee.

This IMRT benchmark has been accepted by many of the NCI funded cooperative groups and Quality Assurance Offices as a minimum standard for an institution to be credentialed for use of IMRT in clinical trials. The benchmark is not site specific, i.e. it applies to IMRT treatment of all disease sites. Some Cooperative Groups may require a phantom measurement for an institution to be credentialed to use IMRT in specific protocols. This benchmark does not need to be completed if there is successful completion of the phantom measurement. This benchmark is not applicable to Cyberknife units; those must complete the phantom irradiation. When completed, this benchmark should be submitted to the appropriate Quality Assurance office, i.e. Quality Assurance Review Center (http://www.QARC.org), or Radiological Physics Center (http://rpc.mdanderson.org) for review (see table 1).

	Submit Benchmark to QARC	Submit Benchmark to RPC
Group members	COG ECOG SWOG ACOSOG CALGB PBTC	RTOG NSABP NCCTG GOG

Table 1. Benchmark submission route by members from each of the cooperative study groups

BENCHMARK CASE:

An institution may become credentialed to use IMRT in clinical trials by either successfully completing the IMRT benchmark or completing the IMRT phantom irradiation test. Unless a phantom measurement credentialing process is required by a specific protocol or by NCI, the successful completion of the IMRT benchmark will satisfy the requirements to use IMRT in clinical trials. Should an institution successfully irradiate the IMRT Head and Neck phantom, this successful irradiation will satisfy the IMRT benchmark requirement. Guidelines for the RPC phantom can be obtained from the RPC website (http://rpc.mdanderson.org).

Whichever credentialing pathway an institution chooses, i.e. the RPC phantom irradiation or this benchmark, the institution must complete the credentialing process following the chosen pathway. Institutions unable to pass the RPC phantom test will not be considered for credentialing using the benchmark; likewise institutions unable to pass the benchmark test will not be considered for credentialing with the RPC phantom. Once you have successfully been credentialed for IMRT, your institution will not need to repeat the credentialing steps for subsequent IMRT protocols unless there is a change in IMRT planning system or delivery technique (see note below). If there is any question about

your credentialing status the institution should contact the appropriate quality assurance office. See Table 1.

BENCHMARK GUIDELINES

Patient Data Selection:

For the IMRT benchmark case, a planning CT scan in the head region or in the pelvic region from your institution shall be used. The image data set shall extend at least 10 cm superiorly/inferiorly with slice thickness no greater than 3 mm. The geometry of the target volume (PTV), the organ at risk (OAR), and the "surrounding tissue" to be included is described below and shown in figure 1. The benchmark case must be planned with a planning system that is capable of transferring a patient's beams to a QA phantom. In addition to the treatment planning exercise, measurements with the QA phantom are required. If your planning system does not have this capability, contact the appropriate QA office for guidance (see Table 1).

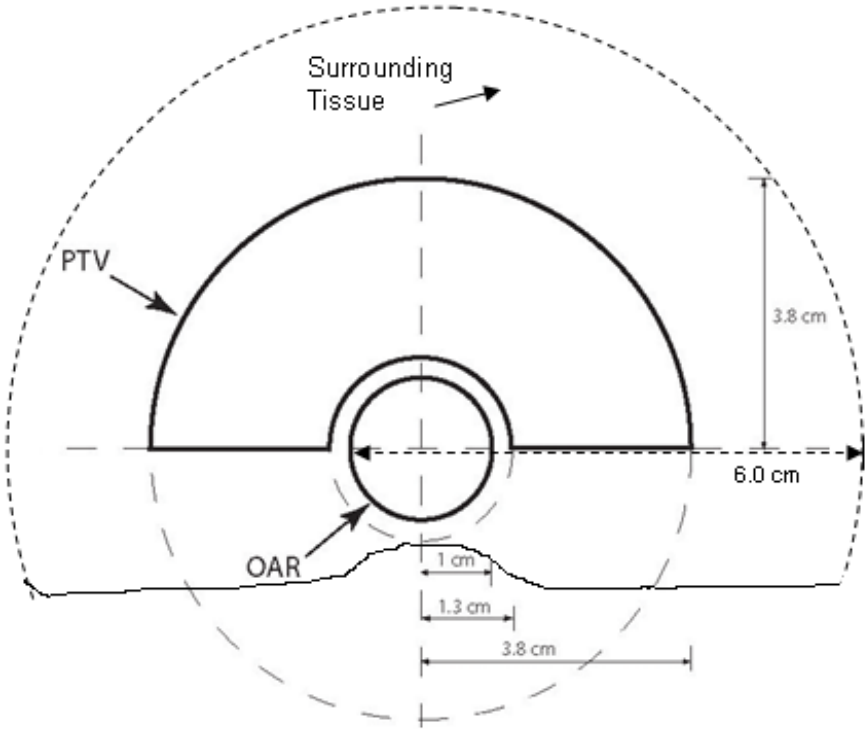

Figure 1. The geometry of the target volume (PTV), surrounding tissue and organ at risk (OAR).

The primary organ at risk (OAR) is a central (midplane) cylinder 2.0 cm in diameter which extends 5 cm caudad/cephalad. The planning target volume (PTV) to be treated is a half annulus 2.5 cm wide that has the same center as the OAR and surrounds the cylinder by 180 degrees. It too shall extend 5 cm caudad/cephalad. There shall be a 3 mm separation of the PTV and OAR. In other words, the annulus has an inner radius of 1.3 cm and an outer radius of 3.8 cm. The "Surrounding tissue" is a structure around the PTV that is 2 cm wide, but extends superiorly/inferiorly only as far as the PTV and OAR. With most planning systems, this can be created by expanding the PTV by 2 cm, subtracting the PTV and eliminating any extensions above or below the PTV.

For "step and shoot" and "sliding window" techniques the treatment plan shall consist of beams from at least 4 and not more than 9 gantry angles. Tomotherapy and other dynamic arc treatments (e.g. RapidArc and VMAT) shall be delivered in the usual clinical manner. All beams shall be coplanar in the plane of the axial slices; i.e. the patient's longitudinal axis must be parallel to the gantry's rotational axis.

Desired Dose Distributions

The aim of the plan is to deliver the prescribed dose of 200 cGy per fraction to 100% of the PTV and not more than 120 cGy (60% of the prescribed dose) to 5% of the organ at risk (OAR). The constraint on the organ at risk has priority over the target volume coverage. That is, the constraint of no more than 60% of the prescribed dose to 5% of the OAR *shall* be achieved. To accomplish the OAR constraint, target volume (PTV) coverage may be sacrificed slightly if necessary. The maximum dose to any point within the irradiated volume should be no more than 120% of the prescribed dose. The constraint on maximum dose is also of lower priority than the constraint on the organ at risk and so may be sacrificed slightly if necessary provided that the point of maximum dose is within the PTV.

An IMRT benchmark will be judged to be acceptable if it satisfies the following criteria:

1. 95% of the PTV must receive at least 95% of the prescribed dose (i.e.190 cGy).
2. No more than 5% of the PTV will receive a dose greater than 115% (230 cGy) of the prescribed dose.
3. No more than 5% of the OAR shall receive greater than 60% (120 cGy) of the prescribed dose.
4. No more than 10% of the surrounding tissue shall receive greater than the prescribed dose (200 cGy), none shall receive greater than 115 % (230 cGy), and no more than 50% shall receive greater than 75% (150 cGy)of the prescribed dose.

Dose Calculations

Dose distributions shall be calculated on every axial slice through the PTV, surrounding tissue and OAR. Isodose distributions shall be in absolute dose Dose volume histograms for the PTV, surrounding tissue and OAR shall be calculated. In addition, a DVH for "unspecified tissue" shall be calculated. Unspecified tissue is defined as tissue contained within the skin, but which is not otherwise contained within delineated structures.

Dose Verification:

The calculated dose distribution shall be transferred to the institution's QA phantom. The absolute dose shall be verified by the institution in the same manner as it normally performs clinically for its IMRT patients.

The dose distribution in the QA phantom shall be measured in at least one plane. The measured plane(s) shall correspond to plane(s) calculated in the planning software and the beams shall be delivered in the geometry of the treatment. That is, couch, gantry, and collimator angles shall be as for the patient. In cases where the institution routinely verifies the dose in any other geometry other than the true geometry of the patient, this verification shall be performed according to the institutions typical procedure, analyzed, and submitted to the appropriate QA office along with details regarding the institution's acceptance criteria for this dose verification.

Material to be Submitted:

Institutions are strongly encouraged to submit the IMRT plan electronically, by sFTP or on CD. For QARC submissions, instructions can be found on the QARC website (www.QARC.org). For RPC submissions, instructions may be found on the ATC website (http://atc.wustl.edu/). If digital submission is not possible, then the following data must be submitted:

1. Copies of representative axial CT slices of the patient through the target, surrounding tissue and OAR shall be submitted. The PTV, OAR, and Surrounding Tissue shall be shown. The dose distribution shall be superimposed.

2. Copies of the dose distribution calculated in the QA phantom at the plane(s) which is (are) measured.

3. Dose volume histograms for the PTV, OAR, and surrounding tissue.

4. Printouts with a description of all beam parameters.

Verification Dosimetry

1. Isodose distributions on the same scale and values as the dose distributions in #2 above, preferably overlaid, shall be provided from the measurement dosimetry. Identification of and correspondence of the QA phantom plane and dose distribution and patient plane (and dose distribution) must be explicit.

2. A complete description of the equipment used to measure the dose (e.g. diode array, ion chamber array, film) and the method, including software, used to compare the calculated with the measured isodose distributions must be included.

3. If the beam geometry other than the patient treatment geometry is routinely used for your verification, these results, including analysis, shall be submitted as well.

4. A detailed description of your verification procedures for absolute dose including your acceptance criteria. Measurements performed with an absolute dosimeter shall be described in detail and the results for this case reported.

Please return completed forms and supporting documents to the appropriate QA office:

Quality Assurance Review Center
Physics Division
272 West Exchange Street, Suite 101
Providence, RI 02903-1025
Phone: (401) 454-4301
FAX: (401) 454-4683
Email: Physics@QARC.org

Radiological Physics Center
1515 Holcombe Blvd.
Unit 547
Houston, TX 77030
Phone: (713)745-8989
FAX: (713) 794-1364
Email: RPC@mdanderson.org

NOTE: A change in IMRT planning system (but not version number) from that listed here or a change in IMRT delivery technique (i.e. step and shoot, sliding window, tomotherapy) requires resubmission of a new IMRT benchmark. The institution may also satisfy this requirement by re-irradiating the H&N IMRT phantom.