Implementing SBRT Protocols: A NRG CIRO Perspective

Ying Xiao, Ph.D.

What is NRG Oncology?

- One of five new NCI-supported National Clinical Trials Network (NCTN) groups.
- NCTN officially started March 1, 2014.
- Founded as a group by NSAPB, RTOG, & GOG.
- The NSABP, RTOG, & GOG Foundations will conduct clinical trials independent of NCI.
- NRG Oncology has largest trial portfolio & highest projected enrollment of all 5 groups.
Group Enrollment 2006-2010

- 3,100 Institutions
- 14,000 Investigators
- About 25,000 pts enrolled on tx trials annually

<table>
<thead>
<tr>
<th>Trials</th>
<th>FY2006</th>
<th>FY2007</th>
<th>FY2008</th>
<th>FY2009</th>
<th>FY2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Phases:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment Trials</td>
<td>27,667</td>
<td>24,715</td>
<td>25,784</td>
<td>29,285</td>
<td>23,468</td>
</tr>
</tbody>
</table>

Accrual Distribution:
- Phase 3: 83.4%
- Phase 2: 15.1%
- Phase 1/Pilot: 1.5%
Improve the lives of adult patients with localized or locally advanced cancers through the conduct of high quality NCI-supported multi-institutional clinical trials;
NRG Oncology Specific Aims

Conduct practice-defining research for the major gender-specific malignancies (breast & gynecologic cancers & prostate cancer) while capitalizing on common biologic features and interactive research opportunities among these diseases;

NRG Oncology Specific Aims

Investigate new developments in medical technology, including radiation oncology, imaging, surgical technology, & IT, for opportunities to advance the care of patients with localized / locally advanced cancers;
5 NRG Oncology Specific Aims

Integrate and expand the legacy groups’ translational science programs to better inform biomarker- and biologic pathway-defined approaches to risk stratification, investigational therapy assignment, & clinical trial decision-making;

5 NRG Oncology Specific Aims

Selectively expand GOG’s developmental therapeutics program to NRG’s other six cancer disease site committees to further strengthen the selection of investigational approaches for phase II & III trials.
NRG Oncology
Center for Innovation in Radiation Oncology (CIRO)

NRG Committee Structure

Research Strategy Committee
- Disease Site Committees
  - Breast
  - Brain
  - Gastrointestinal
  - Colonrectal
  - Non-colonrectal
  - Gynecologic
  - Ovarian
  - Cervix
  - Uterine Corpus
  - GYN Rare Tumors
  - Head & Neck
  - Lung

- Non-Disease Site Scientific Committees
  - Developmental Therapeutics (DT)
  - Cancer Prevention & Control (CPC)
  - Patient-Centered Outcomes Research (PCOR)
  - Translational Science

Scientific Core Committees
- Medical Oncology
- Pathology
- Radiation Oncology
- Medical Physics
- Surgical Oncology
- Protocol Support
- Clinical Research Associates
- Nursing
- Patient Advocates
- Special Populations

Concept Prioritization Advisory Committee (CPAC)

- Protocol Generating Committees
- Scientific Interactions

Center for Innovation in Radiation Oncology (CIRO)

Administrative Committees
- Audit/Quality Control
- Communications
- Membership
- Investigator Training
- Publications
**Aims of CIRO**

- Promote innovative RT research within all NCTN
- Accelerate testing new rad onc innovations in NCTN
- Facilitate innovation in all appropriate protocols
- Foster intergroup & protocol harmonization
- Reduce timelines for development of new protocols
- Improve the clarity of NCTN protocols

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**NRG/RTOG 0617: Survival by RT Dose**

![Graph showing survival rates and data for Standard (60 Gy) and High dose (74 Gy)]

- **18-Month Survival Rate**
  - Standard: 66.9%
  - High dose: 53.9%

- **Median Survival Time**
  - Standard: 28.7 months
  - High dose: 19.5 months

- **Patients at Risk**
  - Standard: 213
  - High dose: 206

- **HR = 1.56 (1.19, 2.06)**
  - **p = 0.0007**
NRG/RTOG 1106 tests the efficacy of during-RT PET-MTV based individualized radiation dose escalation.

NRG/RTOG 1106-Adaptive RT for Stage III NSCLC Pts

1: Conc. chem-RT to a total of 60 Gy ED2/37 fxs or MLD of 20 Gy
2: Concurrent chem-RT to ED2≈50 Gy in 17-21 fxs

Inoperable or unresectable Stage III NSCLC (FDG-PET/CT staged)

FDG PET/CT based RT plan to 74 Gy ED2

FDG-PET/CT at 40-50 Gy ED2 for all pts

F-Miso-PET for Selected Institutions

1: Continue conc. chem-RT to a total of 60 Gy ED2/37 fxs or MLD of 20 Gy
2: During-RT FDG-PET/CT adaptive chem-RT to MLD 20 Gy in 2.4-3.5 Gy/fx for 9-13 fxs to a total of 86 Gy (100 Gy ED2 lung)/30 fxs

RTOG 0617 Uniform RT dose prescription

Experimental arm: Individualized adaptive RT
PET-Adapted Radiation Therapy

Initial PET/CT  Mid-Tx PET/CT

NRG/RTOG 1106
~3 wks

Proton Beamline
NRG/RTOG 1308: Phase III Randomized Trial Comparing Overall Survival after Photon vs Proton Chemo-RT for Stage II-IIIB NSCLC

Stratify
- Stage
  1. IIA
  2. IIB
- GTV
  1. $\leq 130$ cc
  2. $> 130$ cc
- Histology
  1. Squamous
  2. Non-Squamous

Randomization

Arm 1
- Photon: Highest achievable dose between 60-70 Gy at 2 Gy, once daily plus platinum-based doublet chemotherapy

Arm 2
- Protons: Highest achievable dose between 60-70 Gy (RBE) at 2 Gy (RBE) once daily plus platinum-based doublet chemotherapy

Arms 1 and 2: Consolidation Chemotherapy x 2 is allowed

Plan must meet dose and volume constraints of all OARs (very different from other trials)

Heart Dose: Protons vs IMRT

NRG/RTOG 1308: Phase III Randomized Trial Comparing Overall Survival after Photon vs Proton Chemo-RT for Stage II-IIIB NSCLC
3D vs Proton for NSCLC

NRG Oncology Summary

- Amazing Adaptation of NRG Oncology Members to New System!
- Trials in NCTN Limited by Available Resources
- What are Unintended Consequences of Transition?
- Great Need for Resources in Project Development
- CIRO will be a Critical Resource for NRG and NCTN
SBRT Protocols—Past & Present

Examples

NIH Public Access
Author Manuscript
Published in final edited form as:

Stereotactic Body Radiation Therapy for Inoperable Early Stage Lung Cancer

Robert Timmerman, M.D., Rebecca Paulus, B.S., James Galvin, Ph.D., Jeffrey Michalski, M.D., William Straube, Ph.D., Jeffrey Bradley, M.D., Achilles Fakiris, M.D., Andrea Bucjak, M.D., Gregory Videtic, M.D., David Johnstone, M.D., Jack Fowler, Ph.D., Elizabeth Gore, M.D., and Hak Choy, M.D.

Abstract

Context—Patients with early stage but medically inoperable lung cancer patients have a poor rate of primary tumor control (30–40%) and a high rate of mortality (3-year survival 20–35%) with current management.

Objective—To evaluate the toxicity and efficacy of stereotactic body radiation therapy in a high risk population of patients with early stage but medically inoperable lung cancer.

NRG ONCOLOGY

NRG-003
ClinicalTrials.gov NCT02065334

A Phase 1 Study of Stereotactic Body Radiotherapy (SBRT) for the Treatment of Multiple Metastases

This trial is sponsored by the National Cancer Institute (NCI) and will be led by NRG Oncology.

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Senior Statistician
Kathryn Winter, MS

NRG ONCOLOGY™
NRG BR001 Schema

SCHEMA

Patients with metastatic breast, adenocarcinoma of the prostate or non-small cell lung cancer with ≤ 4 metastases; all metastases not resected must be amenable to SBRT
See Section 3.0 for details

REGISTER

SBRT (in 3 or 5 fractions) to all existing metastases in 1-3 weeks
See Table 6-1 in Section 6.1 for dose levels and Table 13-1 in Section 13.3 for Dose Limiting Toxicities (DLTs)

See Section 5.0 for pre-registration requirements and Section 6.0 for details of radiation therapy planning and delivery

Legacy RTOG Protocol TOC

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The Process – SBRT template

Radiation Therapy Section Template for NRG SBRT Protocols

Last Update: 5/6/15 by Martha Matuszak and Indrin Chetty

Note: The goal of this new table format for SBRT protocols is to simplify and streamline protocol development as well as make it easier for sites to find relevant information in the protocol. This template was designed for lung SBRT, as part of the mission from lung and SBRT work group, NRG medical physics committee, Center for Innovation in Radiation Oncology (CIRI).

Instructions for Protocol Pl: Yellow highlighted text should be edited to be protocol specific.

5.2 Radiation Therapy

Radiation Therapy Schema

**INSERT PROTOCOL SPECIFIC FIGURE DETAILING THE SCHEMA WITH RELEVANT RT INFORMATION AND TIMELINE**
5.2.1 Treatment Technology Requirements

General treatment technology requirements for SBRT are given in Table 5.2.1A. Questions regarding appropriate technology for this protocol can be directed to the protocol PI or medical physics co-chair.

<table>
<thead>
<tr>
<th>Technology</th>
<th>Requirement</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Modality</td>
<td>MV Photons</td>
<td>Cobalt-60 &amp; Lutetium allowed, Charged particle beams (including electrons, protons, and heavier ions) are not allowed</td>
</tr>
<tr>
<td>Beam Energy</td>
<td>1 to 18 MV</td>
<td>Minimize use of high energy in lung. 6 MV or lower energies should be predominately used in low-density tissue.</td>
</tr>
<tr>
<td>Treatment Technique</td>
<td>3DCRT (static, arc) or intensity modulated techniques (IMRT, VMAT)</td>
<td>Tomographic and robotic techniques allowed.</td>
</tr>
<tr>
<td>Image Guidance</td>
<td>Treatment Machine must be equipped to provide daily image guidance. The minimum required image guidance techniques as a function of treatment techniques are given in Section 5.2.11</td>
<td>Non-ionizing guidance is allowed, but secondary image verification is required</td>
</tr>
</tbody>
</table>

5.2.2 Immobilization and Simulation

<table>
<thead>
<tr>
<th>Topic/Parameter</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immobilization</td>
<td>Proper immobilization with appropriate clinical devices to ensure reproducibility is required. Patient discomfort should be minimized.</td>
</tr>
<tr>
<td>Motion Control</td>
<td>Recommended in cases where the extent of motion and patient geometry may result in a violation of dosimetric constraints to normal tissues. Institutions should use their clinical judgment when determining which patients are appropriate for a motion management technique.</td>
</tr>
<tr>
<td>CT Slice Thickness</td>
<td>2 mm or less is recommended. No more than 3 mm shall be used in the vicinity of the target. PTV size should be taken into consideration when choosing the slice thickness. Slices of 1-2 mm should be used for tumors that are 1 cm or less in the largest dimension.</td>
</tr>
<tr>
<td>Use of Contrast</td>
<td>IV and/or oral contrast can be used at the clinical discretion of the treating institution. It is recommended to perform a non-contrast enhanced CT for planning. For how to handle treatment planning on a contrast CT, please see the treatment planning section.</td>
</tr>
</tbody>
</table>

To simplify the simulation and planning process, Table 5.2.2B highlights the recommended and minimum requirement for motion assessment, treatment planning imaging, and PTV margins for all SBRT protocols.
5.2.3 Imaging for Structure Definition, Image Registration/Fusion and Follow-up

Free-Breathing, MIP or AVE?

Table 5.2.2B Motion Assessment Guidelines for Simulation

<table>
<thead>
<tr>
<th>Treatment Technique</th>
<th>Recommended Method for Motion Assessment During Simulation</th>
<th>Minimum Method for Motion Assessment During Simulation</th>
<th>Scan(s) Required for Treatment Planning</th>
<th>Additional Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free breathing treatment using an ITV approach, including abdominal compression</td>
<td>CT scan at normal inhale and exhale positions</td>
<td>Average/Unweighted scan from 4DCT if dose calculations. MIP may be desirable to aid ITV definition; if 4DCT not available, planning scan should be at normal exhale</td>
<td>A free breathing non-4DCT scan is not appropriate</td>
<td></td>
</tr>
<tr>
<td>Gating with a gating window</td>
<td>Exhale CT plus phases (free-breathing - therefore strongly discouraged due to baseline shifts)</td>
<td>Reconstructed average of gating window scans if 4DCT or normal exhale scan</td>
<td>Exhale recommended since it gives the most conservative margins of lung dose</td>
<td></td>
</tr>
<tr>
<td>Gating with breath hold (i.e., ABC)</td>
<td>Reproducibility of breath hold confirmed (example: multiple low dose scans over tumor, repeat fluoroscopy or scout images)</td>
<td>N/A</td>
<td>Scan in breath hold position</td>
<td>Inhale recommended since it maximizes lung volume</td>
</tr>
<tr>
<td>Tracking</td>
<td>4DCT or breath hold CT</td>
<td>N/A</td>
<td>4DCT or breath hold CT</td>
<td>Need to know tumor trajectory</td>
</tr>
</tbody>
</table>

5.2.4 Definition of Target Volumes and Margins

Note: All structures must be named for digital RT data submission as listed in the table below. The structures marked as “Required” in the table must be contoured and submitted with the treatment plan. Structures marked as “Required when applicable” must be contoured and submitted when applicable. Resubmission of data may be required if labeling of structures does not conform to the standard DICOM name listed. Capital letters, spacing and use of underscores must be applied exactly as indicated.

Entries in the first column of the list below will be entered and edited by the QA Staff. The PIs are required to specify the information in the second, third columns. The detailed specifications have to include crucial items such as boundary definitions and margins.

<table>
<thead>
<tr>
<th>Standard Name</th>
<th>Description</th>
<th>Validation Required when applicable/Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTV_XXXX</td>
<td>GTV to receive XXXX cGy</td>
<td>Required when applicable</td>
</tr>
<tr>
<td>IGTV_XXXX</td>
<td>Volume enveloping GTV motion over the course of a respiratory cycle</td>
<td>Required when applicable</td>
</tr>
<tr>
<td>PTV_XXXX</td>
<td>PTV to receive XXXX cGy</td>
<td>Required</td>
</tr>
<tr>
<td>PTV_2cm</td>
<td>Volume defined to control intermediate dose spillage</td>
<td>Required</td>
</tr>
</tbody>
</table>
# 5.2.6 Treatment Planning Guidelines

<table>
<thead>
<tr>
<th>Topic/Parameter</th>
<th>Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning Technique</strong></td>
<td>3DCRT, conformal arc, and intensity-modulated techniques (IMRT, VMAT) allowed. Tomographic and robotic techniques also allowed.</td>
</tr>
<tr>
<td><strong>Number of Beams</strong></td>
<td>As planning dictates although ≥7 beams are recommended for static beam plans due to skin toxicity considerations. Similarly, arcs should cover an appropriate range so as to deliver a safe dose to the skin.</td>
</tr>
<tr>
<td><strong>Beam Arrangement</strong></td>
<td>Coplanar or non-planar, non-overlapping, non-opposing beams or arc therapy (non-coplanar arcs allowed). Combination of static and arc beams allowed.</td>
</tr>
<tr>
<td><strong>Beam Energy</strong></td>
<td>As planning dictates although lower energies preferred for lung</td>
</tr>
<tr>
<td><strong>Block Margin (for 3DCRT)</strong></td>
<td>0.5 mm</td>
</tr>
<tr>
<td><strong>Minimum Field Size</strong></td>
<td>As planning dictates although only the smallest field size accurately commissioned (e.g. small field output factors are within 5% of published standards or values) at the institution should be used. Because of concerns with small field dosimetry, field sizes above 2 cm x 2 cm are preferable.</td>
</tr>
</tbody>
</table>
| **Dataset for Dose Calculation** | ITV Approach – Average from 4DCT or normal exhale if 4DCT not available (Free breathing CT is not appropriate)  
Breath Hold – CT taken at treatment breath hold  
Gated – Average from gating window phases from 4DCT or the median phase in the gating window  
Tracking – 4DCT or breath hold CT  
Contrast Scans are not recommended for dose calculations. Recommend obtaining a non-contrast scan during simulation for dose calculation. If a contrast scan is used for dose calculation, density/material overrides are recommended when dose calculation accuracy may be affected. |
| **Dose Calculation Algorithm**   | Modern algorithms that accurately handle tissue heterogeneity and scatter should be used. IROC maintains an updated list of approved algorithms. Density corrections must be applied. Density overrides of the ITV are not recommended for photon treatment. All doses should be reported in terms of dose-to-water and not in terms of dose-to-medium. |
| **Dose Grid Resolution**         | 2 mm x 2 mm dose grid resolution or smaller is strongly recommended |
Planning Margin

Table 2. Lung tumor MDPD, PTV, and cm² of non-PTV lung tissue contained in the 100, 90, 80, 70, and 20% isodose volumes for different block margins.

<table>
<thead>
<tr>
<th>Margin (mm)</th>
<th>MDPD</th>
<th>PTV 100%</th>
<th>90%</th>
<th>80%</th>
<th>50%</th>
<th>25%</th>
<th>MDPD</th>
<th>PTV 100%</th>
<th>90%</th>
<th>80%</th>
<th>50%</th>
<th>25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.3</td>
<td>2.2</td>
<td>27</td>
<td>58</td>
<td>86</td>
<td>205</td>
<td>525</td>
<td>1.3</td>
<td>2.2</td>
<td>28</td>
<td>6</td>
<td>91</td>
</tr>
<tr>
<td>5</td>
<td>1.6</td>
<td>1.6</td>
<td>14</td>
<td>32</td>
<td>49</td>
<td>140</td>
<td>426</td>
<td>1.4</td>
<td>1.7</td>
<td>16</td>
<td>34</td>
<td>53</td>
</tr>
<tr>
<td>2.5</td>
<td>1.3</td>
<td>1.6</td>
<td>13</td>
<td>25</td>
<td>40</td>
<td>123</td>
<td>400</td>
<td>1.5</td>
<td>1.6</td>
<td>13</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>0.0</td>
<td>1.6</td>
<td>1.4</td>
<td>9</td>
<td>18</td>
<td>29</td>
<td>105</td>
<td>387</td>
<td>1.6</td>
<td>1.4</td>
<td>10</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>-2.5</td>
<td>1.9</td>
<td>1.4</td>
<td>10</td>
<td>18</td>
<td>21</td>
<td>113</td>
<td>444</td>
<td>1.9</td>
<td>1.5</td>
<td>11</td>
<td>19</td>
<td>32</td>
</tr>
</tbody>
</table>

Dose Calculation Algorithm

Table 1. PTV D95 and MLD for EPL-3D, AAA, CCC, and MC algorithms in three field size groups relative to the EPL-1D (100%) method.

<table>
<thead>
<tr>
<th>FS (cm)</th>
<th>N</th>
<th>PTV D95 (%)</th>
<th>AAA</th>
<th>CCC</th>
<th>MC</th>
<th>EPL-3D</th>
<th>AAA</th>
<th>CCC</th>
<th>MC</th>
<th>EPL-3D</th>
<th>AAA</th>
<th>CCC</th>
<th>MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&lt;Fs&lt;5</td>
<td>50</td>
<td>95±3±9</td>
<td>82±4±5.1</td>
<td>82±6±2.2</td>
<td>82±5±6.0</td>
<td>94±4±7.4</td>
<td>90±7±5.6</td>
<td>91±8±6.1</td>
<td>90±9±5.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5&lt;Fs&lt;7</td>
<td>62</td>
<td>95±4±2.1</td>
<td>85±3±5.2</td>
<td>85±7±6.1</td>
<td>85±6±5.8</td>
<td>100±5±2.5</td>
<td>95±3±2.7</td>
<td>96±1±2.4</td>
<td>96±1±1.8</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7&lt;Fs&lt;10</td>
<td>21</td>
<td>95±9±1.7</td>
<td>90±4±3.7</td>
<td>90±6±3.8</td>
<td>90±8±3.8</td>
<td>102±2±2.8</td>
<td>96±1±2.1</td>
<td>95±0±2.4</td>
<td>97±3±3.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. PTV D95 and MLD for EPL-3D, AAA, CCC, and MC algorithms for lung-island, lung-wall and lung-central tumors relative to the EPL-1D (100%) method.

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>PTV D95 (%)</th>
<th>AAA</th>
<th>CCC</th>
<th>MC</th>
<th>EPL-3D</th>
<th>AAA</th>
<th>CCC</th>
<th>MC</th>
<th>EPL-3D</th>
<th>AAA</th>
<th>CCC</th>
<th>MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung-island</td>
<td>39</td>
<td>95±2±2.0</td>
<td>81±6±4.4</td>
<td>81±4±5.8</td>
<td>81±4±5.8</td>
<td>97±2±6.1</td>
<td>92±1±5.1</td>
<td>92±9±5.6</td>
<td>92±9±5.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung-wall</td>
<td>44</td>
<td>96±5±1.8</td>
<td>86±8±4.9</td>
<td>87±4±5.6</td>
<td>86±9±5.7</td>
<td>98±6±6.7</td>
<td>94±3±4.8</td>
<td>94±4±4.3</td>
<td>94±9±4.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung-central</td>
<td>50</td>
<td>95±2±1.8</td>
<td>80±2±5.9</td>
<td>86±5±6.3</td>
<td>80±7±6.0</td>
<td>99±3±4.8</td>
<td>94±5±3.7</td>
<td>95±4±3.8</td>
<td>95±0±3.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2.7 Compliance criteria

Table 5.2.7A Target Volume Constraints and Compliance Criteria

<table>
<thead>
<tr>
<th>Name of Structure</th>
<th>Dosimetric parameter</th>
<th>Priority</th>
<th>Per Protocol</th>
<th>Variation Acceptable</th>
<th>Notes (if needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITV lesion</td>
<td>Dose(D0)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITV lesion</td>
<td>Dose(D50)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITV lesion</td>
<td>Dose(D95)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2.7B Normal Structure Constraints and Compliance Criteria

<table>
<thead>
<tr>
<th>Name of Structure</th>
<th>Dosimetric parameter</th>
<th>Priority</th>
<th>Per Protocol</th>
<th>Variation Acceptable</th>
<th>Endpoints/Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Vane(C2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target</td>
<td>Vane(C5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target</td>
<td>Dose(C60)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2.7C Additional Target and Normal Structure Recommendations – Not to be used in plan scoring or acceptability

5.2.8 Treatment Planning Priorities and Instructions

Table 5.2.8A Treatment Planning Priorities

<table>
<thead>
<tr>
<th>Planning Priority</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Respect all Priority 1 OAR criteria in Table 5.2.7A to at least Variation Acceptable levels.</td>
</tr>
<tr>
<td>2</td>
<td>Achieve Priority 2 PTV coverage criteria in Table 5.2.7B while minimizing conformity and gradient indices (i.e., achieve conformity and compactness of the dose distribution). In cases of overlap with Priority 3 OAR criteria, it is recommended to achieve variation acceptable levels of target coverage and minimize hotspots in OAR overlap areas. Intensity-modulated techniques may be desirable.</td>
</tr>
<tr>
<td>3</td>
<td>Meet Priority 3 OAR criteria in Table 5.2.7A.</td>
</tr>
<tr>
<td>4</td>
<td>Meet recommended criteria in Table 5.2.7C.</td>
</tr>
</tbody>
</table>
### 5.2.9 Patient specific QA

Any patient-specific QA that needs to be acquired should follow institutional guidelines. For intensity modulated techniques, patient specific QA is highly recommended.

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#### 5.2.10 Daily Treatment Localization/IGRT

<table>
<thead>
<tr>
<th>Treatment Technique</th>
<th>Acceptable Methods for Daily Image Guidance</th>
<th>Matching Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITV/free breathing (includes abdominal compression)</td>
<td>Volumetric Imaging (i.e. CBCT or CT on rails) is strongly recommended</td>
<td>Initial rigid alignment to bony anatomy; Repeat imaging to ensure tumor surrogate is within ITV; Repeat imaging at each treatment port to ensure tumor surrogate remains within the ITV is very strongly recommended</td>
</tr>
<tr>
<td>Planar Imaging</td>
<td>Volumetric imaging is not available, then an appropriate tumor surrogate (i.e. implanted fiducials) must be able to be accurately imaged in the treatment position with 2D imaging. The patient surface is not an appropriate surrogate for tumor setup although surface based imaging may be used during treatment to assess unexpected patient motion. Note that when orthogonal 2D imaging (with or without implanted fiducials) is employed for sites where respiratory motion is expected and not controlled via motion management techniques, care must be taken to ensure accurate targeting of the ITV within the treatment. For example, static kV imaging at an undetermined breath hold position would not be adequate IGRT for treating a free-breathing lung tumor. Repeat imaging during treatment is recommended to verify that the tumor is in the ITV if any significant baseline shifts are noted, resimulation should be strongly considered.</td>
<td></td>
</tr>
<tr>
<td>Volumetric Imaging (i.e. CBCT or CT on rails) is strongly recommended for the initial localization to verify isocenter and tumor trajectory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gating with a gating window</td>
<td>Volumetric imaging (i.e. CBCT or CT on rails) is strongly recommended for the initial localization to verify isocenter and tumor trajectory</td>
<td>Initial rigid alignment followed by soft tissue match for baseline gating position; Repeat imaging to ensure tumor surrogate is within ITV; Repeat imaging at each treatment port to ensure tumor surrogate remains within the ITV is very strongly recommended</td>
</tr>
<tr>
<td>Gating with breath hold (i.e. ABC)</td>
<td>Volumetric imaging recommended; planar at breath hold position acceptable; repeated imaging recommended to ensure reproducibility of breath hold. All imaging should be done at breath hold treatment position</td>
<td>Initial rigid alignment followed by soft tissue match of tumor or surrogate</td>
</tr>
<tr>
<td>Tracking</td>
<td>Volumetric imaging or real-time fluoroscopic imaging of tumor surrogate required based on treatment machine capabilities.</td>
<td>Initial rigid alignment followed by soft tissue match of tumor or surrogate in baseline position</td>
</tr>
</tbody>
</table>
IGRT Investigations

Table 4. Mean, systematic, and random residual setup error for five imaging protocols

<table>
<thead>
<tr>
<th>Imaging protocol</th>
<th>ML (mm)</th>
<th>CC (mm)</th>
<th>AP (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No IG</td>
<td>-0.20</td>
<td>1.5</td>
<td>2.9</td>
</tr>
<tr>
<td>First 5-day IG</td>
<td>-0.25</td>
<td>2.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Weekly IG</td>
<td>-0.20</td>
<td>1.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Alternate IG</td>
<td>-0.23</td>
<td>1.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Daily IG</td>
<td>-0.20</td>
<td>0.9</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Abbreviations: ML = mediolateral; CC = craniocaudal; AP = anteroposterior; M = mean; Σ = systematic error; σ = random residual setup error; IG = image-guidance.


Summary

- CIRO – the Resource for Implementation of Advanced Radiation Therapy in Clinical Trials
- SBRT Guidelines from Radiation Oncology Community Studies
- NRG Protocol Radiation Therapy Sections Follows Clinical Processes
- We appreciate feedback to improve
THANK YOU!