Full Automation in Radiotherapy

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# Project Team

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- Peter Balter, PhD – radiation physics
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- Jinzhong Yang, PhD - atlas segmentation
- Rachel McCarroll – H&N algorithms
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- Peter Balter, PhD – radiation physics
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- Ann Klopp, MD/PhD – GYN planning
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  - Hannah Simonds, MD
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- University of the Free State
  - William Rae, PhD
  - William Shaw, PhD
  - Alicia Sherriff, MD
Increasing Need for Cancer Care in LMICs

“Cancer ‘tidal wave’ on horizon, warns WHO”

### Increasing Need for Cancer Care in LMICs

#### Table 1. Leading Causes of Death Worldwide by Income Level, 2012 (Thousands)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Worldwide Deaths</th>
<th>%</th>
<th>Low- and Middle-income Deaths</th>
<th>%</th>
<th>High-income Deaths</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17,513</td>
<td>31%</td>
<td>13,075</td>
<td>30%</td>
<td>4,438</td>
<td>38%</td>
</tr>
<tr>
<td>2</td>
<td>8,204</td>
<td>15%</td>
<td>5,310</td>
<td>12%</td>
<td>2,894</td>
<td>25%</td>
</tr>
<tr>
<td>3</td>
<td>6,431</td>
<td>12%</td>
<td>6,128</td>
<td>14%</td>
<td>303</td>
<td>3%</td>
</tr>
<tr>
<td>4</td>
<td>4,040</td>
<td>7%</td>
<td>3,395</td>
<td>8%</td>
<td>645</td>
<td>6%</td>
</tr>
<tr>
<td>5</td>
<td>3,716</td>
<td>7%</td>
<td>3,212</td>
<td>7%</td>
<td>504</td>
<td>4%</td>
</tr>
<tr>
<td>6</td>
<td>3,060</td>
<td>5%</td>
<td>2,664</td>
<td>6%</td>
<td>396</td>
<td>3%</td>
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<tr>
<td>7</td>
<td>2,263</td>
<td>4%</td>
<td>1,748</td>
<td>4%</td>
<td>515</td>
<td>4%</td>
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<tr>
<td>8</td>
<td>1,497</td>
<td>3%</td>
<td>1,243</td>
<td>3%</td>
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<tr>
<td>9</td>
<td>1,428</td>
<td>3%</td>
<td>1,185</td>
<td>3%</td>
<td>243</td>
<td>2%</td>
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<tr>
<td>10</td>
<td>1,195</td>
<td>2%</td>
<td>935</td>
<td>2%</td>
<td>260</td>
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<tr>
<td>11</td>
<td>559</td>
<td>1%</td>
<td>534</td>
<td>1%</td>
<td>25</td>
<td>0%</td>
</tr>
<tr>
<td>12</td>
<td>556</td>
<td>1%</td>
<td>515</td>
<td>1%</td>
<td>42</td>
<td>0%</td>
</tr>
<tr>
<td>13</td>
<td>296</td>
<td>1%</td>
<td>293</td>
<td>1%</td>
<td>3</td>
<td>0%</td>
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<td>14</td>
<td>216</td>
<td>0%</td>
<td>158</td>
<td>0%</td>
<td>58</td>
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<tr>
<td>15</td>
<td>193</td>
<td>0%</td>
<td>116</td>
<td>0%</td>
<td>77</td>
<td>1%</td>
</tr>
<tr>
<td>All causes</td>
<td>55,843</td>
<td>0%</td>
<td>44,172</td>
<td>0%</td>
<td>11,671</td>
<td>1%</td>
</tr>
</tbody>
</table>


Impact of Radiation Therapy (RT)

- RT is estimated to be needed in 45-55% of newly diagnosed cancers.

- In addition, RT provides durable palliation and pain control for patients with advanced stage disease.

- RT is a complex technologically advanced treatment, which requires training and quality assurance (QA) at multiple steps.

- Optimizing availability of RT equipment, and training, is crucial to providing quality therapy throughout the world.

*Datta NR et al. IJROBP 89:448-457 (2014).*
Estimated Radiation Therapy Availability

Figure 5. Estimated Radiotherapy Availability Worldwide, 2013

Countries with 100% of patients able to access radiotherapy may also include countries where radiotherapy supply is greater than demand, although disparities in access may still exist within these countries.

Challenges in Radiation Oncology Practice

- Complex, multi-step process involving:
  - Physicians
  - Physicists
  - Dosimetrists (treatment planners)
  - Radiation therapists (radiographers)
- Advanced machinery, evolving technology, complicated software and interfaces
  - Different techniques
  - Different technologies
  - Different hardware
  - Different software
  - Computer interfaces
  - Dependence on robust power supply
- Need for advanced training for optimal utilization and quality assurance
- Increasing pace of technological change
- Increased potential for errors
  - Side effects and toxicity may not manifest for years
Challenges in Radiation Oncology Practice
Predictability in Radiation Oncology Practice

- Diagnose and stage the cancer
- Establish radiation therapy as an integral part of treatment
- Ensure safety of radiation treatment for the patient
  - Prior radiation?
  - Pregnancy?
  - Pacemaker/defibrillator/electronic medical device?
- Determine applicability and goal of radiation therapy
  - Palliative or curative
  - Definitive or post-operative or pre-operative
- Obtain planning imaging/clinical set-up
  - Clinical or plain film or CT
- Delineate normal tissues to be used as avoidance structures
- Delineate fields or tumor volumes
- Create a treatment plan
- Review plan with physician
- Check plan by medical physicist
- QA planned treatment
Our Goal

Development of an automated treatment planning system for radiation therapy that:

1. Provides high quality treatment plans
2. Includes internal quality assurance
3. Can be used by a trained individual with a high school education
4. Can be deployed worldwide to radiation centers, regardless of hardware and software
Initial RPA Project Focus

1. Gynecologic cancer
   MDACC annual census
   400 patients (75 cervix)

2. Breast cancer
   1000 patients

3. Head & neck cancer
   850 patients

Primary Planning
- CT Table Removal
- Body Contour Definition
- Marked Isocenter Detection
- Atlas-Based Contouring
- Create fields
- Optimize dose
- Calculate dose

Secondary Verification
- CT Table Removal
- Body Contour Definition
- Marked Isocenter Detection
- Atlas-Based Contouring
- Create fields
- Optimize dose
- Calculate dose

Do primary and secondary methods agree?

Plan Documentation

Manual planning

Transfer Plan to Record and Verify

MD approves plan?

Yes

No
Dr. Court
Case Presentations

1. Current Practice
2. Case Presentations for Cervical Cancer
3. Case Presentations for Head and Neck Cancer
At my institution, we currently treat patients with cervical cancer (external beam) using:

a) No imaging (e.g. separation measurement)

b) 2D imaging techniques (e.g. conventional simulator)

c) CT planning: AP-PA or 4-field box techniques WITHOUT blocks

d) CT planning: AP-PA or 4-field box techniques WITH block

e) CT planning: 3D conformal radiotherapy (multiple beams, shaped to contoured targets)

f) CT planning: IMRT or VMAT
Current Practice

At my institution, we currently plan patients with breast cancer (intact breast) using:

a) No imaging (separation measurement)
b) 2D techniques (e.g. conventional simulator)
c) CT planning: Tangents, open fields only
d) CT planning: Tangents with wedges
e) CT planning: Opposed tangents with field-in-field
f) CT planning: IMRT or VMAT
Current Practice

At my institution, we currently plan patients with head/neck cancer using:

a) No imaging (separation measurement)
b) 2D techniques (e.g. conventional simulator)
c) CT planning: opposed lateral fields
d) CT planning: 3D conformal radiotherapy
e) CT planning: IMRT or VMAT
Case Presentations

For each case, please answer with:

1. The best choice offered
2. Assumption that you have the equipment to deliver your choice
RPA Test #1: Cervical Cancer
Case #1: Cervical Cancer

- 44 year old female who went to her gynecologist for routine screening
  - Pap smear: HPV-positive HSIL (high-grade squamous intraepithelial lesion)
  - Follow-up cervical biopsy and endocervical curettage: Moderately differentiated squamous cell carcinoma
  - Examination: 2 cm lesion at the anterior cervical lip
  - MRI and PET:
    - Stage IIA1 squamous carcinoma of the cervix
### Case #1: Planning Order

**Section 1: Demographics**
- **MRN:** [ ]
- **Name:** [ ]
- **Treatment Site:** Cervix
- **Comment:** [ ]

**Section 2: Treatment General**

**Sex/Pregnancy status:**
- [X] Female: Not pregnant (verified or not of child-bearing potential).
  - [ ] Male
  - [ ] Female: Pregnant; however, the benefits outweigh the risks, and the patient is aware of potential toxicity to the fetus.

**Prior radiation:**
- [X] The patient has not received prior radiation treatment to the same area.
  - [ ] The patient has received radiation treatment to the same area; however, the benefits outweigh the risk, and the patient has been consented for potential increased toxicity.

**Pacemaker/implanted electronic medical device presents?**
- [X] No
  - [ ] Yes; however, the benefits outweigh the risks, and appropriate monitoring of the device will be performed, and the patient has been consented for potential increased toxicity.

**Other implants (e.g. hip replacement):**
- [X] Patient has no known implants in the treatment area
  - [ ] Patient has implants in the treatment area

**Autoplan start:**
- [X] Automatically
  - [ ] Technician
**Section 3: Treatment Specific (Cervix)**

**Primary disease extent:**
- **X** Limited to cervix, no vaginal or lymph node involvement.
- ○ Extends beyond cervix (with vaginal or lymph node involvement).

**Patient positioning:**
- **X** Supine
- ○ Prone

**Treatment technique:**
- **X** 4 field box
- ○ AP-PA

**Treatment machine:**
- **X** LINAC A
- ○ LINAC B

**Field blocks:**
- **X** Use MLCs
- ○ Use conventional blocks

**Dose prescription:**
- Fractionation: 25 fractions
- **X** 4500 cGy (180 cGy/fraction)
- ○ Other
Case #1: Automated Field Design

AP     Rt
Lat
PA     Lt
Lat
Case #1: Comparison to Clinical Fields

Absolute difference in all jaws, averaged across all beams (cm) = 0.18
MAD in block aperture, averaged across all beams (cm) = 0.27
Case #1: Treatment Plan and Isodose
Case #1: Feedback Survey

a) I would treat this patient with the plan as presented
b) I would have made different choices in the PLAN ORDER, but otherwise the plan looks acceptable
c) These fields would require minor edits to be used to treat this patient
d) These fields would require significant edits to be used to treat this patient
e) I do not use fields like this, so would not use this planning technique
f) Other

More detailed feedback can be emailed to: bbeadle@stanford.edu
Case #2: Cervical Cancer

- 25 year old female who presented with irregular bleeding
  - Primary care examination: Cervical mass
  - Gynecologic examination: 5 cm friable tumor encompassing the entire posterior ectocervix
  - MRI and PET:
  - Stage IIA2 squamous carcinoma of the cervix
## Case #2: Planning Order

### Section 1: Demographics
- **MRN:**
- **Name:**
- **Treatment Site:** Cervix
- **Comment:**

### Section 2: Treatment General
- **Sex/Pregnancy status:**
  - X Female: Not pregnant (verified or not of child-bearing potential).
  - ○ Male.
  - ○ Female: Pregnant; however, the benefits outweigh the risks, and the patient is aware of potential toxicity to the fetus.

- **Prior radiation:**
  - X The patient has not received prior radiation treatment to the same area.
  - ○ The patient has received radiation treatment to the same area; however, the benefits outweigh the risk, and the patient has been consented for potential increased toxicity.

- **Pacemaker/implanted electronic medical device presents?**
  - X No
  - ○ Yes; however, the benefits outweigh the risks, and appropriate monitoring of the device will be performed, and the patient has been consented for potential increased toxicity.

- **Other implants (e.g. hip replacement):**
  - X Patient has no known implants in the treatment area
  - ○ Patient has implants in the treatment area

- **Autoplan start:**
  - X Automatically
  - ○ Technician
Case #2: Planning Order

**Section 3: Treatment Specific (Cervix)**

**Primary disease extent:**
- [X] Limited to cervix, no vaginal or lymph node involvement.
- [ ] Extends beyond cervix (with vaginal or lymph node involvement).

**Patient positioning:**
- [X] Supine
- [ ] Prone

**Treatment technique:**
- [X] 4 field box
- [ ] AP-PA

**Treatment machine:**
- [X] LINAC A
- [ ] LINAC B

**Field blocks:**
- [X] Use MLCs
- [ ] Use conventional blocks

**Dose prescription:**
- Fractionation: 25 fractions
- [X] 4500 cGy (180 cGy/fraction)
- [ ] Other
Case #2: Automated Field Design

AP

PA

Rt Lat

Lt Lat
Case #2: Comparison to Clinical Fields

Absolute difference in all jaws, averaged across all beams (cm) = 0.57
MAD in block aperture, averaged across all beams (cm) = 0.48
Case #2: Treatment Plan and Isodose
Case #2: Feedback Survey

a) I would treat this patient with the plan as presented
b) I would have made different choices in the PLAN ORDER, but otherwise the plan looks acceptable
c) These fields would require minor edits to be used to treat this patient
d) These fields would require significant edits to be used to treat this patient
e) I do not use fields like this, so would not use this planning technique
f) Other

More detailed feedback can be emailed to: bbeadle@stanford.edu
Case #1 & 2: RPA Impact

Based on these examples, would you use RPA for planning cervical cancer treatments?

a) Yes
b) I would like to, but we do not have the appropriate equipment (CT or MLCs)
c) No – we base our treatments on contoured targets and normal tissues
d) No – there is no benefit for us
e) No – other reason

More detailed feedback can be emailed to: bbeadle@stanford.edu
RPA Test #2: Head/Neck Cancer
Case #3: Head/Neck Cancer

• 47 year old male who presented with a left neck mass
  – FNA of left neck mass: squamous cell carcinoma
  – Exam under anesthesia and bilateral tonsillectomies
    • Left tonsil: 2.1 cm squamous cell carcinoma, p16-positive
    – CT with contrast:

  – AJCC 7: Tx (2) N2b M0 (Stage IVa)
  – AJCC 8: Tx (2) N1 M0 (Stage I)
# Case #3: Planning Order

## Section 1: Demographics

<table>
<thead>
<tr>
<th>MRN:</th>
<th>Name:</th>
<th>Treatment Site:</th>
<th>Comment:</th>
</tr>
</thead>
</table>

## Section 2: Treatment General

**Sex/Pregnancy status:**
- Female: Not pregnant (verified or not of child-bearing potential).
- Male
- Female: Pregnant; however, the benefits outweigh the risks, and the patient is aware of potential toxicity to the fetus.

**Prior radiation:**
- The patient has not received prior radiation treatment to the same area.
- The patient has received radiation treatment to the same area; however, the benefits outweigh the risk, and the patient has been consented for potential increased toxicity.

**Pacemaker/implanted electronic medical device presents?**
- No
- Yes; however, the benefits outweigh the risks, and appropriate monitoring of the device will be performed, and the patient has been consented for potential increased toxicity.

**Other implants (e.g. hip replacement):**
- Patient has no known implants in the treatment area
- Patient has implants in the treatment area

**Autoplan start:**
- Automatically
- Technician
### Section 3: Treatment Specific (HN)

<table>
<thead>
<tr>
<th>Head/Neck primary site:</th>
<th>Positive lymph node involvement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Nasopharynx</td>
<td>□ None</td>
</tr>
<tr>
<td>• Oral cavity</td>
<td>□ Right cervical neck</td>
</tr>
<tr>
<td>□ Oropharynx</td>
<td>□ Left retropharyngeal node</td>
</tr>
<tr>
<td>• Hypopharynx</td>
<td>□ Right retropharyngeal node</td>
</tr>
<tr>
<td>• Larynx</td>
<td>□ Left supraclavicular</td>
</tr>
<tr>
<td>• Other</td>
<td>□ Right supraclavicular</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective left cervical neck coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Levels II-IV</td>
<td></td>
</tr>
<tr>
<td>□ Levels IB-V</td>
<td></td>
</tr>
<tr>
<td>□ Level IA-V</td>
<td></td>
</tr>
<tr>
<td>□ None</td>
<td></td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective right cervical neck coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Levels II-IV</td>
<td></td>
</tr>
<tr>
<td>□ Levels IB-V</td>
<td></td>
</tr>
<tr>
<td>□ Level IA-V</td>
<td></td>
</tr>
<tr>
<td>□ None</td>
<td></td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective left retropharyngeal lymph node coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective right retropharyngeal lymph node coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Yes</td>
<td></td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment machine:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ LINAC A</td>
<td></td>
</tr>
<tr>
<td>□ LINAC B</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment technique:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ VMAT</td>
<td></td>
</tr>
<tr>
<td>□ IMRT</td>
<td></td>
</tr>
<tr>
<td>□ Conventional</td>
<td></td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
</tr>
</tbody>
</table>
Case #3: Normal Tissue Autocontouring
Case #3: Target Volume Autocontouring
Case #3: Feedback Survey

a) I would treat this patient with the plan as presented

b) I would have made different choices in the PLAN ORDER, but otherwise the contours and dose distributions appear acceptable

c) The contours would require edits, but the dose distributions are acceptable

d) The dose distributions do not meet my expectations

e) I have no experience in VMAT, so am unable to comment

f) Other

More detailed feedback can be emailed to: bbeadle@stanford.edu
Case #4: Head/Neck Cancer

- 63 year old male who presented with a right neck mass, dysphagia
  - Examination: Confluent right neck adenopathy and large right oropharyngeal mass extending from the tonsil
  - Right tonsil biopsy: Squamous cell carcinoma, p16-positive
  - CT with contrast:
    - AJCC 7: T4a N2b M0 (Stage IVa)
    - AJCC 8: T4 N1 M0 (Stage III)
Case #4: Planning Order

<table>
<thead>
<tr>
<th>Section 1: Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRN:</td>
</tr>
<tr>
<td>Name:</td>
</tr>
<tr>
<td>Treatment Site: Cervix</td>
</tr>
<tr>
<td>Comment:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Section 2: Treatment General</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex/Pregnancy status:</td>
</tr>
<tr>
<td>Female: Not pregnant (verified or not of child-bearing potential).</td>
</tr>
<tr>
<td>Male:</td>
</tr>
<tr>
<td>Female: Pregnant; however, the benefits outweigh the risks, and the patient is aware of potential toxicity to the fetus.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prior radiation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The patient has not received prior radiation treatment to the same area.</td>
</tr>
<tr>
<td>The patient has received radiation treatment to the same area; however, the benefits outweigh the risk, and the patient has been consented for potential increased toxicity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pacemaker/implanted electronic medical device presents?</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes; however, the benefits outweigh the risks, and appropriate monitoring of the device will be performed, and the patient has been consented for potential increased toxicity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other implants (e.g. hip replacement):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient has no known implants in the treatment area</td>
</tr>
<tr>
<td>Patient has implants in the treatment area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Autoplan start:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automatically</td>
</tr>
<tr>
<td>Technician</td>
</tr>
</tbody>
</table>
# Case #4: Planning Order

## Section 3: Treatment Specific (HN)

### Head/Neck primary site:
- Nasopharynx
- Oral cavity
- Oropharynx
- Hypopharynx
- Larynx
- Other

### Positive lymph node involvement:
- None
- Left cervical neck
- Right cervical neck
- Left retropharyngeal node
- Right retropharyngeal node
- Left supraclavicular
- Right supraclavicular

### Elective left cervical neck coverage required:
- Levels II-IV
- Levels IB-V
- Level IA-V
- None
- Other

### Elective right cervical neck coverage required:
- Levels II-IV
- Levels IB-V
- Level IA-V
- None
- Other

### Elective left retropharyngeal lymph node coverage required:
- Yes
- No

### Elective right retropharyngeal lymph node coverage required:
- Yes
- No

### Treatment machine:
- LINAC A
- LINAC B

### Treatment technique:
- VMAT
- IMRT
- Conventional
- Other
Case #4: Normal Tissue Autocontouring
Case #4: Target Volume Autocontouring
Case #4: VMAT Plan with Isodose
Case #4: Feedback Survey

a) I would treat this patient with the plan as presented
b) I would have made different choices in the PLAN ORDER, but otherwise the contours and dose distributions appear acceptable
c) The contours would require edits, but the dose distributions are acceptable
d) The dose distributions do not meet my expectations
e) I have no experience in VMAT, so am unable to comment
f) Other

More detailed feedback can be emailed to: bbeadle@stanford.edu
Case #5: Head/Neck Cancer

- 46 year old male who presented with an enlarging right neck mass
  - Examination: Bulky right neck cystic masses with right tonsil enlargement
  - Right tonsil biopsy: Squamous cell carcinoma, p16-positive
  - MRI:
    - AJCC 7: T4a N2b M0 (Stage IVa)
    - AJCC 8: T4 N1 M0 (Stage III)
# Case #5: Planning Order

## Section 1: Demographics
- **MRN**: 
- **Name**: 
- **Treatment Site**: Cervix
- **Comment**: 

## Section 2: Treatment General

**Sex/Pregnancy status:**
- Female: Not pregnant (verified or not of child-bearing potential).
- **Male**
- Female: Pregnant; however, the benefits outweigh the risks, and the patient is aware of potential toxicity to the fetus.

**Prior radiation:**
- **X** The patient has not received prior radiation treatment to the same area.
- Yes; however, the benefits outweigh the risks, and appropriate monitoring of the device will be performed, and the patient has been consented for potential increased toxicity.

**Pacemaker/implanted electronic medical device presents?**
- **X** No
- Yes; however, the benefits outweigh the risks, and appropriate monitoring of the device will be performed, and the patient has been consented for potential increased toxicity.

**Other implants (e.g. hip replacement):**
- **X** Patient has no known implants in the treatment area
- Yes; however, the benefits outweigh the risks, and appropriate monitoring of the device will be performed, and the patient has been consented for potential increased toxicity.

**Autoplan start:**
- **X** Automatically
- Technician
## Case #5: Planning Order

### Section 3: Treatment Specific(HN)

<table>
<thead>
<tr>
<th>Head/Neck primary site:</th>
<th>Positive lymph node involvement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasopharynx</td>
<td>□ None</td>
</tr>
<tr>
<td>Oral cavity</td>
<td>□ Left cervical neck</td>
</tr>
<tr>
<td><strong>X</strong> Oropharynx</td>
<td><strong>X</strong> Right cervical neck</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>□ Left retropharyngeal node</td>
</tr>
<tr>
<td>Larynx</td>
<td>□ Right retropharyngeal node</td>
</tr>
<tr>
<td>Other</td>
<td>□ Left supraclavicular</td>
</tr>
<tr>
<td></td>
<td>□ Right supraclavicular</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective left cervical neck coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X</strong> Levels II-IV</td>
<td></td>
</tr>
<tr>
<td>□ Levels IB-V</td>
<td></td>
</tr>
<tr>
<td>□ Level IA-V</td>
<td></td>
</tr>
<tr>
<td>□ None</td>
<td></td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective right cervical neck coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Levels II-IV</td>
<td></td>
</tr>
<tr>
<td><strong>X</strong> Levels IB-V</td>
<td></td>
</tr>
<tr>
<td>□ Level IA-V</td>
<td></td>
</tr>
<tr>
<td>□ None</td>
<td></td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective left retropharyngeal lymph node coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X</strong> Yes</td>
<td></td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elective right retropharyngeal lymph node coverage required:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X</strong> Yes</td>
<td></td>
</tr>
<tr>
<td>□ No</td>
<td></td>
</tr>
</tbody>
</table>

### Treatment machine:

<table>
<thead>
<tr>
<th>LINAC A</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ LINAC B</td>
<td></td>
</tr>
</tbody>
</table>

### Treatment technique:

<table>
<thead>
<tr>
<th>VMAT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ IMRT</td>
<td></td>
</tr>
<tr>
<td>□ Conventional</td>
<td></td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
</tr>
</tbody>
</table>
Case #5: Normal Tissue Autocontouring
Case #5: Target Volume Autocontouring
Case #5: VMAT Plan with Isodose
Case #5: Feedback Survey

a) I would treat this patient with the plan as presented
b) I would have made different choices in the PLAN ORDER, but otherwise the contours and dose distributions appear acceptable
c) The contours would require edits, but the dose distributions are acceptable
d) The dose distributions do not meet my expectations
e) I have no experience in VMAT, so am unable to comment
f) Other

More detailed feedback can be emailed to: bbeadle@stanford.edu
Case #3-5: RPA Impact

Based on these examples, would you use RPA for planning head/neck treatments?

a) Yes
b) I would like to, but do not have the right equipment (CT scanner, VMAT-capable LINAC)
c) No - the plans do not have sufficient quality
d) No – other reason

More detailed feedback can be emailed to: bbeadle@stanford.edu
Conclusions

• High-quality radiation treatment plans are crucial to optimal treatment of patients throughout the world.

• Significant progress has been made in the development of an automated treatment planning system:
  – Cervical Cancer (4-field box)
  – Head/neck Cancer (VMAT)

• Ongoing development to improve the system
  – Better normal tissue delineation
  – Workflow
  – Plan optimization

• Requesting partners throughout the world to test the pre-clinical system and identify those interested in clinical development.

More detailed feedback can be emailed to: bbeadle@stanford.edu lecourt@mdanderson.org