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**Treatment Planning for Complex Cases**

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**Learning objectives**

- Identify factors that lead to complexity during treatment planning
- Review strategies that can be used to improve plan quality in the context of
  - Complex target/normal tissue geometries
  - Complex dose prescriptions
- Identify ways in which diverse and multiple sources of information can contribute to plan complexity

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**Challenges in treatment planning**

- Complex Geometry/Calculations
  - Complex target/NT geometry
  - Calculation accuracy
- Complex Prescription
  - Dose painting
  - Fractionation
  - NT constraints
- Complex Information
  - Planning images
  - Respiratory Control, Patient motion monitoring
  - Treatment Verification Images and Data
Beam selection matters! (particularly for complex cases)
Number of fields must increase as:
- Dose gradient between target and normal tissues increases
- Need for target dose homogeneity increases
More fields (potentially) =
- Higher integral dose, higher "volume" dose
- More complexity

Complex Geometry: Beam Number and Direction

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Complex Geometry: Recurrent Head and Neck

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Complex Geometry: Large or highly irregular target volumes

- May require atypical beam arrangement
  - Mixed modality (x-ray + electron)
  - (mesothelioma, breast + nodal volumes)
  - Multiple isocenters (whole abdomen)
  - “Partial PTV” irradiation (WVX)

Constructions
- Prescription dose
- Dosimetric effects
- Effect of machine and setup uncertainty
- Tumor extent

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Complex Geometry: Highly irregular target volumes: IMRT alone

- Mixed modality (x-ray + electron)
  - (mesothelioma, breast + nodal volumes)
  - Multiple isocenters (whole abdomen)
  - “Partial PTV” irradiation (WVX)

Constructions
- Prescription dose
- Dosimetric effects
- Effect of machine and setup uncertainty
- Tumor extent

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Complex Geometry: Highly irregular target volumes: IMRT + electrons

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Target and normal tissue contouring:
- For each site:
  - Specify standard normal tissues of interest
  - Guidelines for contour definition (tumor extent, wall thickness, PTV margin, etc.)
- Contour accuracy:
  - For each patient:
    - Review adherence to guidelines
    - Structure “smoothness” or regularity
    - Anatomic “logic”
    - Fidelity of data transfer

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Complex Geometry: Target/Normal Tissue Delineation

CT Simulation

TPS
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**Complex Prescription: Fractionation**

- Single Fraction/Hypofractionation + SBRT
  - Bone mets
  - Paraspinal Lesions
  - Early stage lung
- Normal tissue dose limits are not well understood
  - BED calculations should be used with caution
  - Determine dose limits before starting program
  - Review emerging clinical data on regular basis

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<table>
<thead>
<tr>
<th>Structure</th>
<th>Total Dose</th>
<th>Limit or Guideline</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spinal Cord</strong></td>
<td>≤ 14 Gy</td>
<td>For inadequate GTV coverage and request of physician</td>
<td></td>
</tr>
<tr>
<td>Max point dose (Myelo-defined cord)</td>
<td>≤ 24 Gy/8 Gy</td>
<td>Or ≤ 25 Gy/5 Gy</td>
<td></td>
</tr>
<tr>
<td>Use if no previous radiation</td>
<td>12 Gy</td>
<td>Max point dose (Myelo-defined cord)</td>
<td>14 Gy/2.8 Gy</td>
</tr>
<tr>
<td>With previous radiation. Previous prescription</td>
<td>≤ 30 Gy/3 Gy frac, 45-50 Gy/1.8-2 Gy frac or other</td>
<td>≤ 3 Gy per frac.</td>
<td></td>
</tr>
<tr>
<td>OR 14 Gy max cord dose from either single or hypo frac IGRT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larynx Prescrip. Max point dose</td>
<td>Prescrip. Max point dose</td>
<td>Guideline</td>
<td>No hot spots</td>
</tr>
<tr>
<td>Liver 15% NTCP</td>
<td></td>
<td></td>
<td>Using Lyman mean dose model, Liver_Mean_AB3 (n=1, m=0.12, a/b=3), Evaluate Liver_not_GTV</td>
</tr>
</tbody>
</table>

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**Complex Prescription: Fractionation**

- 50 70 90 95 100 %

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**Complexity Factors**

- Geometry
- Fractionation
- Simple Plan
- Fraction
- NT constraints
- Time
- Respiratory Control
- IGRT
- Previous treatment
- Simulation Imaging
- Patient motion monitoring
- Previous treatment

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**Complex information: Strategies**

- Organize image sets, planning and treatment data
  - Understand relationship between different computer systems
  - QA procedures for data transfer and review
- Recognize weaknesses in data “chain” attributable to lack of systems integration (or due to it!)
  - Implement QA procedures at these steps
- Valiant attempts to retrieve all previous treatment records
  - Review accuracy and agreement with records
- Standardize procedures whenever possible

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**Complex information: Simulation**

- Physics Review
  - 4DCT, gating data
  - Image fusion
  - IMRT
  - Multileaf review
- Data transfer
  - Isocenter check
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Complexity of Information: Preparation for Treatment

- Verification/reference images and data
  - Can originate from variety of computer systems
  - Positional verification
  - Confirm coordinate system transformation
  - Confirm isocenter, fiducial coordinates

- Verify proper electronic transfer of data
  - Beam parameters
  - Fluence profiles
  - Structures

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TPS ARIA

ARIA

Excel

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Complex Information: Previous Treatment

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Summary

- Plans become complex for a variety of reasons including geometry, prescription or information.
- Clever use of IMRT provides unparalleled opportunities for creating dose distributions.
- Increasing use of non-conventional fractionation schemes pose new concerns and issues for planners.
- Standardization and rigorous procedures are crucial to seamless handling of complex and copious amounts of planning data.

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