Use Advanced Planning Tools to Improve Plan Quality, Efficiency, and Consistency

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Disclosures

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Dr. Verhey was the Chief Physicist in Radiation Oncology at UCSF from 1991-2008
My Concerns 23 Years Ago

- In 1995, I became the third medical physics resident at UCSF.
- I was told that I could be the last one because the department had some doubts about the value of medical physics residents.

Dr. Verhey’s Advice

- Go to clinic daily (attend chart round, clinical conferences).
- Be Involved in treatment planning.
- Demonstrate the values of physics residents.
- Do research: a systematic approach to solve clinical problems.

Your Concerns 23 Years Later

- Can some of the physicist positions be replaced by physics assistants due to financial pressure in current health environment?
- Can some of the physicist positions be replaced by computer automation or artificial intelligence (AI)?
Medical Physics 3.0

• One of three pillars in medical phys. 3.0 is treatment planning.
• How to be involved in treatment planning?
  – It is not a physics job.
  – It is what dosimetrists do.
• Physicists should lead the dosimetry group to advance treatment planning.

Advance Planning Tools

• Use and Implement advanced planning tools to improve plan quality, efficiency, and consistency.
  – Knowledge based planning (KBP)…
  – Automatic planning (Auto, AP)…
  – Multiple criteria planning (MCO)…

How Does Knowledge Based Planning Work?
How Does Auto Planning Work?
Auto-Planning in Pinnacle System

- Mimics the planners’ thought process
- Utilizes the planners’ tricks to create surrounding structures and tuning contours automatically
- Automatically runs multiple loops while adjusting planning objectives – similar to what planners manually do

Automatic Created Planning Objectives

Advance Tool Setting
Multi-Criteria Optimization (MCO)

Pareto Frontier

MCO Implemented in RaySearch

- Requires a set of dose constraints (anchor points) – no violation allowed.
- Requires a set of dose objectives (tradeoffs) – negotiations allowed.
- Multiple \((2n+1)\) plans are created automatically according number \(n\) of tradeoffs.
- Users can lock the satisfied tradeoffs to narrow the search space.
Can Advance Planning Tools Improve Plan Quality, Consistency, and Efficiency?

- Selected four clinically challenging sites, physicists from three institutions use knowledge based planning (KBP), auto-planning (AP), and MCO tools to plan the same 20 cases (5 each) from partial brain, prostate + LN, HN, and spine SRS.
- Each institution received a general planning guideline for each site, including Rx, OAR tolerance.
- It is more challenging for MCO and KBP institutions because the selected cases were from the AP institution.

Partial Brain Cases
63 Gy, 60 Gy, 51 Gy, 45 Gy, 35 Gy

<table>
<thead>
<tr>
<th>OARs</th>
<th>Goals</th>
<th>Clinical</th>
<th>AP</th>
<th>KBP</th>
<th>MCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brainstem</td>
<td>&lt;60 Gy</td>
<td>61.1 Gy</td>
<td>60.99 Gy</td>
<td>59.95 Gy</td>
<td>59.47 Gy</td>
</tr>
<tr>
<td>Chiasm</td>
<td>&lt;56 Gy</td>
<td>54.5 Gy</td>
<td>55.59 Gy</td>
<td>55.44 Gy</td>
<td>50.15 Gy</td>
</tr>
</tbody>
</table>

Prostate + Pelvic LN Cases
Oropharynx Cases
Spinal SBRT Cases
### The Ideal World

- **Knowledge Based Planning**
  - Patient specific DVH predictions
  - No "one size fits all" Dose constraints

- **Auto Planning**
  - Automatically create a plan that meets the predicted DVHs

- **Multiple Criteria Optimization**
  - Provide trade-off solutions

### Summary

- Using advanced planning tools can further improve plan qualities and efficiency while reducing variations.
- Even with these advance planning tools, clinical judgment and experience are still important.
- We still did not find the "Pareto frontier", due to that the clinical problems cannot be clearly defined.
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