Redesigning the Planner and Physicist Roles in the Era of Automated Planning

(AAPM 2019, MO-A-302, 7/15/19, Professional Symposium)

Kevin Moore, PhD
Associate Professor
Deputy Director of Medical Physics
Radiation Medicine & Applied Sciences
UC San Diego Health

Automated Planning and the Role of the Physicist

Disclosures

Funding support
Agency for Healthcare Research and Quality
Padres Pedal the Cause
UCSD Academic Senate
UCSD MEET innovation grant
Varian Medical Systems

Travel and honoraria from Varian Medical Systems

2 patents related to knowledge-based dose estimation
Outline

- What effect will automated planning have on clinical radiotherapy?

- What is the physicist's role in driving this change?

The twin claims of automated planning

<table>
<thead>
<tr>
<th></th>
<th>Evidence from retrospective studies</th>
<th>Evidence in real-world clinical practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved quality</td>
<td>Lots(^{2,16})</td>
<td>Little(^{1,16})</td>
</tr>
<tr>
<td>Higher efficiency</td>
<td>Lots (of claims)(^{2,16})</td>
<td>Little(^{1,16})</td>
</tr>
</tbody>
</table>

Evidence from retrospective studies:

- Moore et al., IJROBP, 81, 545-551 (2010)
- Appenzoller et al., Med Phys, 39, 7446 (2012)
- Shiraishi et al., Med Phys, 42, 908-917 (2014)
- Moore et al., Journal of Physics, 489, 012055 (2014)
- Moore et al., IJROBP, 92, 228-235 (2015)
- Shiraishi and Moore, Med Phys, 43, 378-387 (2016)
- Li et al., IJROBP, 97, 164-172 (2017)
- Li et al., Radiotherapy and Oncology, 123, 325-330 (2017)
- Ziemer et al., PRO, 7, e569-e578 (2017)
- Kaderka et al., PMID: 30826481 (2019)
- Cornell et al., submitted (2019)
- Kaderka et al., submitted (2019)
Roadmap for implementation

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase</th>
<th>Implementation Action</th>
<th>Implementation Endpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>Phase 0 (&lt;500 pts)</td>
<td>KBP modeling and validation</td>
<td>KBP development, quality gap quantification</td>
</tr>
<tr>
<td></td>
<td>Phase 1 (576 pts)</td>
<td>Blinded comparison</td>
<td>Establishment of KBP non-inferiority</td>
</tr>
<tr>
<td></td>
<td>Phase 2 (&gt;1500 pts)</td>
<td>KBP, then human planner</td>
<td>Efficiency + any improvements</td>
</tr>
</tbody>
</table>
|      | Phase 3 | KBP only | "Planning as a service"

Phase 0-2 methods

\[ \Delta D = D_{\text{clinical}} - D_{\text{KBP}} \]

- Mean → Plan quality
- Standard deviation → Plan variability

- If \( \Delta D > 0 \) → KBP plan is superior for this metric
- If \( \Delta D < 0 \) → Clinical plan is superior for this metric

Phase 0 analysis

Phase 1 results

![Graph showing relative excess dose to parotid gland](image)

WashU 2009

UCSanDiego Health

M. Cornell et al, submitted

AAPM 2019/

#13

Moore

Phase 2 methods

(a) Timing study

Patient care

<table>
<thead>
<tr>
<th>Workflow steps</th>
<th>Patient care</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Set up/enter QA</td>
</tr>
<tr>
<td>1</td>
<td>Create plan</td>
</tr>
<tr>
<td>2</td>
<td>Review QA</td>
</tr>
<tr>
<td>3</td>
<td>Simulation</td>
</tr>
<tr>
<td>4</td>
<td>Plan review</td>
</tr>
<tr>
<td>5</td>
<td>Treatment plan review</td>
</tr>
<tr>
<td>6</td>
<td>QA review</td>
</tr>
<tr>
<td>7</td>
<td>Treatment plan review</td>
</tr>
<tr>
<td>8</td>
<td>QA review</td>
</tr>
<tr>
<td>9</td>
<td>Treatment plan review</td>
</tr>
<tr>
<td>10</td>
<td>QA review</td>
</tr>
</tbody>
</table>

Baseline planning days for patient

3 mos. before QC

3 mos. after QC

UCSanDiego Health

R. Kaderka et al, submitted

Phase 2 results

(b) Create Plan

![Graph showing manual and post-KBP planning times](image)

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Manual planning (hrs)</th>
<th>Post-KBP planning (hrs)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head-and-neck</td>
<td>12.9</td>
<td>3.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lung SBRT</td>
<td>9.9</td>
<td>2.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prostate Fossa</td>
<td>11.1</td>
<td>3.7</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Prostate hadro</td>
<td>7.6</td>
<td>1.8</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

UCSanDiego Health

R. Kaderka et al, submitted

Moore / AAPM 2019 / v14
The durability of KBP QC effect

Dosimetric comparison pre-KBP vs. post-KBP

The physicist's role in clinical KBP

Prior observations

Knowledge model for each trained organ

The physicist's role in clinical KBP
The physicist's role in clinical KBP

Which to focus on as physicists?

Mitigating the risks of automated planning implementation

vs.

Accelerating the pace of automated planning adoption

Current radiotherapy workflow
Automation implies new conversations

Physicist-driven shared decision making?

Conclusions

- This time is different.
- Inaction is risky. To patients, and to the health of our field.
- If you are not currently involved heavily in the day-to-day treatment planning design process, the implementation of automated planning is the perfect opportunity to reclaim a critical role.
Collaborators
Mariel Cornell, CMD
Robert Kaderka, PhD
Xenia Ray, PhD
Todd Almed, PhD
Todd Pawlicki, PhD
AJ Mundt, MD

Support
AHRQ R01 HS025440
Padres Pedal the Cause
UC Academic Senate
UCSD MEET Innovation
Varian Medical Systems