KNOWLEDGE BASED PLANNING
RapidPlan™—knowledge-based planning

RapidPlan™ knowledge-based planning software is a comprehensive treatment planning tool that provides clinicians with standard models to use as a baseline for developing plans.
RapidPlan™—knowledge-based planning

Increase Quality, Reduce Repetition

Designed to enable clinicians to streamline the planning process by using shared clinical knowledge embedded in DVH Estimation Models.

By limiting variability and potentially reducing planning time, RapidPlan can bring about consistency in the standard while providing truly individualized patient care.
DVH Estimation Models — Moving beyond templates

- DVH Estimation Models are dynamic
- Adaptable to clinic and patient specific requirements
- Allow standardization of treatment quality across sites and institutions

Quality
Efficiency
Consistency
RapidPlan™— Included DVH Estimation Models

- Developed in conjunction with leading cancer centers globally
- Clinics can create their own institution specific models
## RapidPlan™—knowledge-based planning Benefits

<table>
<thead>
<tr>
<th>Software Solution</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMRT Novice</td>
<td>• Increase confidence and plan quality</td>
</tr>
<tr>
<td>IMRT Expert</td>
<td>• Increase consistency and reduce variability</td>
</tr>
<tr>
<td>Busy Clinic</td>
<td>• Increase efficiency by reducing the number of iterative interactions</td>
</tr>
<tr>
<td>Health Network</td>
<td>• Evaluate against clinical standard to promote “best practices” implementation</td>
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<tr>
<td>QA</td>
<td>• Check plans independently</td>
</tr>
<tr>
<td>ART</td>
<td>• Subcomponent to enable ART</td>
</tr>
</tbody>
</table>
RapidPlan overview

- DVH estimation algorithm
- Use dose and anatomy information from existing plans, incorporated in configured models, used to estimate dose for new plans
- Estimated dose should be representative of clinical practice captured in scope of model
- Only available with new photon optimiser PO
- Models configured, trained and managed in the DVH estimation model configuration workspace
DVH Estimation Algorithm – Optimization Dialog

- DVH estimation algorithm provides
  - DVH estimates (upper and lower bound)
  - Objectives
DVH Estimation Algorithm – Optimization Dialog

- Objectives
  - Objectives are generated using user preferences
    - Separate embedded algorithm
    - For dynamic objectives location varies based on DVH estimates
  - Fixed objectives can be added
  - Priorities can be user defined or generated by DVH estimation algorithm
    - Target distribution is used to calculate the priorities

From the structure set of current plan

Regression coefficients from the DVH Estimation model

The estimated DVH PC

DVH estimates

Automatic objectives
RapidPlan™— Motivation

• Variation is inherent in the treatment planning process

• Variation degrades quality and the minimization of variation increases quality and decreases costs

• The process of creating a good inverse plan is fraught with inconsistency and variability
RapidPlan™ — Key Features

- Pre-loaded DVH Estimation Models from leading academic institutions
- Full access to DVH Estimation Model configuration allowing sites to create institution specific models
- The ability to export and import DVH Estimation Models
- Model Analytics
- Apply knowledge to future patients
### Prostate model - Royal Surrey County Hospital NHS Foundation

**Comparison of standard optimization versus RapidPlan model**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Statistic</th>
<th>Standard Plan (mean)</th>
<th>RapidPlan Model (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV78Gy</td>
<td>D99% [GY]</td>
<td>75.0</td>
<td>75.0</td>
</tr>
<tr>
<td>PTV71Gy</td>
<td>D99% [GY]</td>
<td>69.0</td>
<td>68.7</td>
</tr>
<tr>
<td>PTV60Gy</td>
<td>D99% [GY]</td>
<td>58.0</td>
<td>58.7</td>
</tr>
<tr>
<td>Rectum</td>
<td>V30Gy [%]</td>
<td>72.6</td>
<td>71.8</td>
</tr>
<tr>
<td></td>
<td>V50Gy [%]</td>
<td>37.9</td>
<td>34.8</td>
</tr>
<tr>
<td></td>
<td>V70Gy [%]</td>
<td>8.5</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td>D1% [GY]</td>
<td>75.2</td>
<td>74.9</td>
</tr>
<tr>
<td></td>
<td>Dmean [GY]</td>
<td>41.5</td>
<td>40.4</td>
</tr>
<tr>
<td>Bladder</td>
<td>V50Gy [%]</td>
<td>25.5</td>
<td>22.0</td>
</tr>
<tr>
<td></td>
<td>V70Gy [%]</td>
<td>8.6</td>
<td>8.4</td>
</tr>
<tr>
<td></td>
<td>D1% [GY]</td>
<td>77.5</td>
<td>77.5</td>
</tr>
<tr>
<td></td>
<td>Dmean [GY]</td>
<td>30.3</td>
<td>28.1</td>
</tr>
<tr>
<td>Total MUs</td>
<td></td>
<td>667</td>
<td>657</td>
</tr>
</tbody>
</table>

Fig. 3 Average DVHs for rectum, bladder, Lt Fem Head, Rt Fem Head, PTVp(78Gy), PTVp2(71Gy), PTVsv(60Gy) for clinical (solid), initial RP model (dashed) and final RP model (dotted) plans.
Conclusion*:

- RapidPlan is able to generate clinically acceptable plans with significant time saving compared to ‘conventional’ optimization
  - Average planning time reduced by 93 min
  - Planning time was less dependent on planner experience / case complexity
- Model was also found to work successfully for 74Gy IMRT prostate with 3 dose levels
- 90% of final RP plans as good as the original and 60% better
  - 10% require additional iterations of optimization

*DATA SOURCE ON FILE
Spine Model: Patient Group 38 Patients

- SBRT Spine
- PTV = 3 X 10 Gy
- OAR: Spinal cord, Cord PRV (2mm), Esophagus, Heart, Trachea, Pharynx, Larynx, L/R Kidney
Conclusion:
• All validation cases met the dose objectives for modeled OARs without user intervention
• 6/10 model-generated plans had equal or better PTV coverage
  • Fig. 4 shows similar OAR metrics and slightly improved target coverage between model-generated vs. manual validation plans.
• Manually created plans required 4-5 iterations of modifying planning parameters (~1-1.5 hours)
• Model-generated plans required little to no human intervention (~15-20 minutes)
Conclusions:

- Knowledge-based planning for spine SBRT has shown to be highly effective for efficiently creating quality treatment plans.

- While plans produced using RapidPlan may require some modification to achieve an optimal plan, this can be done in typically one or two alterations to the cost function.

- In addition, while manually created plans may require hours to complete, RapidPlan may be used to achieve similar quality plans in 10-20 minutes.
Lung SABR model – Beatson West of Scotland Cancer Centre

Current Practice
• Treated >300 Lung SABR patients (various protocols)
  • Limited to eight patients per month
  • planning/delineation barriers
• Plans calculated using different algorithms
• Patients treated using 2 energies:
  • 6MV Flattened Beams
  • 10MV FFF Beams
• Patients treated using two different Linac/MLC types:
  • TrueBeam STx (70%)
  • Clinac iX (30%)
• Up to 1 day of a senior Physicist/Dosimetrist per plan
Lung SABR model – Beatson West of Scotland Cancer Centre

Lung SABR Model: 90 plans
• Standard prescription of 55Gy/5fx
• Single lesion
• 30 6MV Flattened plans
• 30 Standard MLC plans
• 60 10MV FFF plans
• 60 HD MLC plans

Model ‘trained’ in one day
RapidPlan – 13 minutes to plan

Principal Physicist – 4 hours to plan
Can this model work in other situations?

- Follow principles of RTOG 0813
- Two bilateral lung lesions
- Central lesions
RapidPlan time – 40 minutes
Average Physicist Planning time for dual lesions >1 day
Highly complex RTOG 0813 plan
- 55Gy/5# standard RapidPlan model - 40 minutes
Purpose: The purpose of this work was to investigate the impact of a predictive DVH (pDVH) model developed at one institution on IMRT plan quality control (QC) at an unrelated radiotherapy facility.

Conclusion: DICOM-based pDVH modeling methods based on patient geometry accurately predict achievable rectum and bladder DVH parameters that are clinically relevant and may facilitate improved IMRT plan quality across multiple institutions.
Clinic Specific Data

PTV DVH
Rectum pDVH
Rectum DVH
Bladder pDVH
Bladder DVH

Courtesy of Appenzoller, L. et al.
Clinic Specific Data Compared Against Another Institutions Model

PTV DVH
Rectum pDVH
Rectum DVH
Bladder pDVH
Bladder DVH

Courtesy of Appenzoller, L. et al.
Sharing Knowledge Enhanced Clinician Skills and Experience

Courtesy of Appenzoller, L. et al.
KBP Clinical Motivation – New User

- Increase confidence with new disease sites

Training Site
- Prostate

Organ model
- Bladder

Application Site
- Prostate

Prior knowledge reliably extended to new disease site

Courtesy of Wu, Q.J., and et al.
KBP Clinical Motivation – New User

- Increase confidence with new disease sites

Training Site
- Prostate

Organ model
- Bladder

Application Site
- Anal Rectal

Prior knowledge reliably extended to new disease site

Courtesy of Wu, Q.J., and et al.
KBP Clinical Motivation – Busy Clinics

Head&Neck

- 100-150 iterations
- 2-5 min

Prostate

- 75-100 iterations
- 2-3 min
Summary

Variation is inherent in the treatment planning process and degrades quality

Minimization of variation increases quality and decreases costs

By limiting variability and potentially reducing planning time, RapidPlan can bring about consistency in the standard of care while providing truly individualized patient care

Leading institutions are using RapidPlan in the clinic and are experiencing gains in quality, efficiency and consistency
KNOWLEDGE BASED PLANNING

- ANY QUESTIONS?
THANK YOU