Implementation of Pinnacle Auto-Planning for GU sites at Liverpool and Macarthur Cancer Therapy Centres – Our Experience

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Department of Radiation Oncology

Disclosures

• No disclosures
Not all animals in Australia want to kill you

Overview

• Quick overview of Radiotherapy in Australia
• Our experience with Pinnacle Autoplanning
  ➢ Why we chose Pinnacle Autoplanning
  ➢ The implementation processes
  ➢ Study undertaken to measure success
  ➢ Department status
Radiotherapy in Australia

Cancer Therapy Centres – New South Wales

- Mix of Private and Public hospitals: 75% public & 25% private
- 30 Centres within the state of New South Wales alone
Our Centres: Liverpool and Macarthur Centres

- 2 sites across 26kms (16.2miles) apart
- Comprehensive Cancer service for in/out patient patients,
- Radiotherapy Facilities = 6 Linacs
  - 5 Elekta -3 Versa HD, 1 Tomo, Xstrahl Orthovoltage & Brachy
  - IMRT, VMAT, SABR, BRACHY, MRI
  - MRI Linac – Research bunker
Liverpool and Macarthur Centres Cont.

- Pinnacle, Tomotherapy, Oncentra and MiM
- 70 Radiotherapy Staff, 20 Radiation Oncologist, 15 medical physicist
- Patient Numbers of attendances for 2017 – 33,500

Role of Radiation Therapists (RT) in Australia

- Bachelor Degree – 3 years full time + 1 year professional development
- Radiation therapists are trained to carry out:
  - Treatment, including image guidance procedures
  - Planning – all aspects
  - CT/MR simulation – all sites
  - Up to date clinical professional development
Role of Radiation Therapists (RT) in Australia

- Undergo extensive in house training
- Very few specialist roles
- Planning becoming more complex and time consuming e.g. VMAT and SABR calc times
- Staff do more with same resources

Planning Process Review

- Identified bottle necks, inefficiencies and quality control requirements with current IMRT/VMAT planning
- Complexity in planning = longer planning time
- Plan quality was planner dependent
- Staffing levels and rotations contributing factor
- Department had Adaptive Radiotherapy (ART) as a goal
Solution?

Department needed a solution to aid planning efficiency in a quality driven manner

Solution?

Pinnacle³ Auto-Planning
Accelerated IMRT therapy & VMAT planning
Why Autoplanning (AP)?

- Already using Pinnacle
- Assessed the market tools – cost effective
- Department wanted to develop Adaptive Radiation Therapy (ART)
- Decision made purchase AP and MiM June 2016 (clinical Nov 2016) to assist with the ART goal

How did we implement?

- One 12 month RT manager secondment position
- Internal interview process
- Section manager position backfilled
- Funded by Radiation Oncology Trust fund (starting November 2016)
How did we implement?

- Responsible for overseeing entire AP project
- KPIs
- Training and education
- Documentation creation and review
- Protected time
- Removed from clinical setting

How did we implement

- Co-ordinated Multi Disciplinary Team: 6 RT’s, 3 physicists, and 2 RO’s
- Identified prostate as first implementation site
- Established an implementation model for initial and future sites
- Test out techniques in a clinical setting
- Collect timing data
Automation Literature

- Automated planning promises to address limitations in current practice
  - Plan quality
  - Time taken to generate a plan

- Growing body of evidence in clinical setting
  - Very little on efficiency
Pre clinical implementation - Ground Work

SAY YOU DON'T DO GROUNDWORK

ONE MORE TIME

Clinical Implementation Model

Phase 1  Development
Phase 2  Testing
Phase 3  Clinical Trials
Phase 4  Implementation

The Clinical Practice Improvement Model:
1. What are we trying to accomplish?
2. How will we know that change was successful?
3. What changes can we make that will result in an improvement?


Easy Guide to Clinical Practice Improvement, NSW Health Department, 2002
Clinical Implementation Model

**DEVELOPMENT**
- Create learning database n=15 (intact prostate and prostate + whole pelvis)
- Use retrospective clinical cases
- AP group members develop technique based of departmental GU goals
- Save best techniques

**TESTING**
- Test across all learning database patients
- Use first run results only
- Qualitative & quantitative comparison
- Physics QA to validate AP technique
- Based on results progress to Clinical Trials or back to Development
Clinical Implementation Process

CLINICAL TRIALS
- Prospective parallel planning study with patients undergoing manual planning
- Perform plan comparison focused on comparing planning times and plan quality
- Based on results implement or go back to Development

IMPLEMENTATION
- Update clinical documentation
- Update QA procedures
- Education and training
- Clinical release
- Monitor and feedback
Ready to Go!

ONE DOES NOT SIMPLY

"PUSH A BUTTON" AND PRODUCE
A QUALITY CLINICAL PLAN

Intact Prostate Clinical Technique used for parallel planning study

Target Optimisation Goals define the targets and structures used for PTV target dose
The target goals have been kept similar to clinical goals
Optimised target volumes have been created to achieve optimal dose coverage

QAR Optimisation Goals
A combination of mean, max dvh and max dose objectives have been applied to OARs and planning volumes to achieve clinical goals. Priority setting determines optimisation weight and has been determined on importance of clinical goal.
Prostate+WP Clinical Technique used for parallel planning study

Target Optimisation

Goals define the Targets and structures used for PTV target dose

The target goals have been kept similar to clinical goals

Optimised Target volumes have been created to achieve optimal dose coverage

OAR Optimisation

Goals

A combination of mean, max dvh and max dose objectives have been applied to OARs and planning volumes to achieve clinical goals. Priority setting determines optimisation weight and has been determined on importance of clinical goal

Proposed workflow used for Parallel planning timing study

Step 1
- ROs contours Target Volumes, RTs contour remaining OARs

Step 2
- RT select AP script - site dependent and target dependent

Step 3
- AP script generates planning and dose reporting contours and loads appropriate technique for site

Step 4
- Planner starts AP optimisation

Step 5
- Plan Evaluation based on quantitative scorecard and qualitative assessment of plan

Step 6
- Adjust plan if necessary - otherwise ready for approval
Clinical Trials Phase: Parallel planning

Study aim

By eliminating user variability, could Autoplanning (AP) reduce treatment planning time and give at least equal if not superior plan quality than manual inverse planning.

Parallel planning study Methodology

- N= 18 - 9 intact prostate and 9 prostate + whole pelvis (WP) patients were prospectively parallel planned with AP
- Comparison data collected include:
  - Plan contouring time
  - Planning time
  - Coverage of target volumes
  - Oar at Risk (OAR) doses
### Results (1): Intact Prostate PTV78Gy Coverage

<table>
<thead>
<tr>
<th>Dose Value</th>
<th>Manual plan (Ave)</th>
<th>AP (Ave)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D50 (Gy)</td>
<td>79.8</td>
<td>79.9</td>
</tr>
<tr>
<td>D95 (Gy)</td>
<td>77.7</td>
<td>77.9</td>
</tr>
<tr>
<td>D2 (Gy)</td>
<td>81.2</td>
<td>81.4</td>
</tr>
</tbody>
</table>

### Results (2): Intact Prostate + Whole Pelvis (WP) PTV78Gy Coverage

<table>
<thead>
<tr>
<th>Dose Value</th>
<th>Manual plan (Ave)</th>
<th>AP (Ave)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D50 (Gy)</td>
<td>79.97</td>
<td>80.32</td>
</tr>
<tr>
<td>D95 (Gy)</td>
<td>77.8</td>
<td>77.77</td>
</tr>
<tr>
<td>D2 (Gy)</td>
<td>81.22</td>
<td>81.66</td>
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</table>
### Results (2): Intact Prostate + WP PTV56,55Gy Coverage

<table>
<thead>
<tr>
<th>Dose Value</th>
<th>Manual plan PTV56,55 (Ave)</th>
<th>AP PTV56,55 (Ave)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D50 (Gy)</td>
<td>57.61</td>
<td>57.71</td>
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<tr>
<td>D95 (Gy)</td>
<td>55.33</td>
<td>54.99</td>
</tr>
<tr>
<td>D2 (Gy)</td>
<td>66.59</td>
<td>66.38</td>
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</table>

### Results (3): Intact Prostate Organ at Risk (OAR) doses

<table>
<thead>
<tr>
<th>OAR Value</th>
<th>Manual Inverse plan (Avg %)</th>
<th>AP (Avg %)</th>
<th>Average Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECTUM V40</td>
<td>27.4</td>
<td>25.7</td>
<td>-1.7</td>
</tr>
<tr>
<td>RECTUM V60</td>
<td>15.7</td>
<td>15</td>
<td>-0.7</td>
</tr>
<tr>
<td>RECTUM V75</td>
<td>7.4</td>
<td>6.3</td>
<td>-1.1</td>
</tr>
<tr>
<td>BLADDER V50</td>
<td>19.6</td>
<td>18.7</td>
<td>-0.9</td>
</tr>
<tr>
<td>BLADDER V60</td>
<td>14.7</td>
<td>14.2</td>
<td>-0.5</td>
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</tbody>
</table>
### Results (4): Intact Prostate+WP OAR doses

<table>
<thead>
<tr>
<th>OAR Value</th>
<th>Manual Inverse plan (Avg %)</th>
<th>AP (Avg %)</th>
<th>Average Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECTUM V40</td>
<td>42.15</td>
<td>39.42</td>
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<tr>
<td>RECTUM V60</td>
<td>17.94</td>
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<tr>
<td>RECTUM V75</td>
<td>8.28</td>
<td>6.88</td>
<td>-1.4</td>
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<tr>
<td>BLADDER V50</td>
<td>52.12</td>
<td>31.9</td>
<td>-20.22</td>
</tr>
<tr>
<td>BLADDER V60</td>
<td>22.12</td>
<td>18.8</td>
<td>-3.32</td>
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### Results (5): Intact Prostate+WP OAR doses

<table>
<thead>
<tr>
<th>OAR Value</th>
<th>Manual Inverse plan (Avg %)</th>
<th>AP (Avg %)</th>
<th>Average Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIGMOID V40</td>
<td>43.8</td>
<td>32.67</td>
<td>-11.11</td>
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<tr>
<td>BOWELBAG D1</td>
<td>0.50</td>
<td>0.84</td>
<td>+0.34</td>
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<tr>
<td>BOWELBAG-PTVD10</td>
<td>2.37</td>
<td>3.86</td>
<td>+1.49</td>
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</table>
Plan Comparison: Intact Prostate+WP

Manual

AutoPlan

Results (6): Plan contouring Time Comparison – Intact Prostate

![Chart showing comparison of manual and auto plan contouring times for Intact Prostate+WP plan.](chart.png)
Results (7): Planning Time Comparison – Intact Prostate

![Comparison of planning time for intact prostate, showing inverse plan time vs autoplanned time for patients 1 to 9.

Results (8) Manual Inverse plan vs Autoplan Average times comparison – Intact Prostate

![Comparison of manual inverse plan time vs autoplanned time for planning contours and Iso check, showing a saving of 4.3 hours per patient.

Planning Contours
- Manual
  - Mean: 313.3
  - SD: 55.8
  - P: <0.001

Planning Time
- Manual
  - Mean: 36.1
  - SD: 34.3
  - P: <0.001

AP saved 4.3 hrs / patient.]
Results (9): Planning Time Comparison – Intact Prostate + WP

Results (10): Planning Time Comparison – Intact Prostate + WP
Results (11) Manual Inverse plan vs AP Average times comparison – Intact Prostate + WP

Inverse vs Autoplan planning time

- AP saved 4.9 hrs / patient

Planning Contours

<table>
<thead>
<tr>
<th>Planning</th>
<th>Manual</th>
<th>Auto</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>46.1</td>
<td>31</td>
</tr>
<tr>
<td>SD</td>
<td>22.9</td>
<td>3.3</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.001</td>
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</tbody>
</table>

Planning Time

<table>
<thead>
<tr>
<th>Planning</th>
<th>Manual</th>
<th>Auto</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>555</td>
<td>372</td>
</tr>
<tr>
<td>SD</td>
<td>40.3</td>
<td>35.9</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

Results (12) Blind RO review of Manual vs AP – Intact Prostate & Prostate + WP

Preferred plan

- Manual
- Autoplan

Number of patients

- Manual
- Autoplan
Discussion

- Efficiency & reduction in overall resources used
- Quality and consistency can be achieved
- Standardised automated streamlined process
- Reduces Inter-planner variability which can affect overall plan quality

Discussion

- Requires sound IMRT knowledge
- AP can get planners to the same end point quicker, consistently and efficiently
- Can never replace an expert planner
- Tool to help aid efficiency, plan output and consistency in quality
Implementation Challenges

- Big load on the clinical system during technique development phase
- Takes time to develop, refine and test AP techniques in a clinical setting
- Time taken to do QA on machines – Requires a lot of resources!
Implementation Challenges

- Documentation Updates, protocols – Lots of it!
- Educational needs – training packages created pre release of any site
- Sign off competencies created
- Changing approach to education and training

Implementation Challenges

- Initial Buy in from staff
- Once convinced.. Staff became beliebers
AP Future at LMCTC

• AP replaced manual planning as routine for GU sites at LCTC and MCTC in mid 2017.
• AP has been implemented as routine for:
  – Prostate bed
  – Hypofractionated Prostate
  – Prostate+WP
  – H&N all sites
  – Lung IMRT

• H&N data showed similar results to GU data
• Ongoing development of other AP sites including Breast, Gynae, Lung, GU and Liver SABR
• 20 clinical techniques developed – with many more on the way
• Multiple department studies utilising AP
AP Future at LMCTC

- Collaborative centre study with NKI and Odense evaluating AP techniques across Centre's
- Utilise AP for more off protocol cases – Adapted AP techniques for these instances
- Continue to evaluate, refine and improve on current clinical techniques

Conclusion

- AP can be integrated into routine clinical practice with potential to be more consistent in both time taken and plan quality
- AP plan quality and efficiency is independent of planner experience
- Potential to free up resources
- Can never replace an expert planner!
- Important not to let automation diminish skills!
Challenge to us!

- Challenge of automation requires transition of skills
- Use efficiency gains in training and education

Acknowledgements

- AP implementation team
- Physics Team—Phil Vial, Brad Beeksma, Richard Short & Sankar Arumugam for QA, Data analysis and Support
- RT support for collect timing data
- Radiation Oncology Executive
- Support from RT, MP, RO staff across LCTC and MCTC
Take home message

An MDT collaborative approach is vital to successfully integrate Automated processes within a clinical setting.

References

• J.M.AM Kusters, et al. “Is it possible to create high quality inverse treatment plans with the Pinnacle automated planning module?”. ESTRO ePoster (2015)