More than Pretty Pictures: 3D Treatment Planning + Conformal Therapy

Benedick A Fraass PhD, FAAPM, FASTRO, FACR

Vice Chair for Research, Professor and Director of Medical Physics
Department of Radiation Oncology
Cedars-Sinai Medical Center, Los Angeles, CA 90048
Clinical Professor, Radiation Oncology, UCLA
Professor Emeritus, University of Michigan

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- UM licensing arrangement with Scanditronix for Scandiplan (early 90s)
the 60s and early 70s: thinking about dose in 3D


1970s: CT
A Crucial Development

the late 70s

Rhode Island: McShan
the late 70s

Rhode Island: McShan


Rhode Island: McShan
the late 70s

PDP 11/45
80K words memory
16K overlays
“Large” 116 MB disk

Rhode Island: McShan

and here’s the mouse!

early 80s: Multiplanar Display


MGH: Goitein

early 80s: BEV w/ Aperture Design

MGH: Goitein
early 80s: DRRs


early 80s: DVHs


early 80s: Plan Comparison + Uncertainty

early 80s: DKFZ

W Schlegel et al: Three-dimensional radiotherapy treatment planning using CT data, in Proc World Congress on Medical Physics and Biomedical Engineering, Bleifeld, Hamburg, 1982, pp 21-27

early 80s: SRS Planning

Hartmann et al: IJROBP 11: 1185-1192, 1985

DKFZ: Hartmann, Schlegel

NCI 3D Treatment Planning Contracts

1982-6: Evaluation of Tx Planning for Heavy Particles
- U Penn/Fox Chase
- LBL/UCSF
- MGH
- MD Anderson

1984-7: Eval. of Tx Planning for Ext. Beam Photons
- U Penn
- MSKCC
- MGH
- Wash U St Louis

1986-9: Eval. of Tx Planning for Ext. Beam Electrons
- UM
- Wash U St Louis
- MD Anderson

1989-94: Development of RT Tx Planning Tools
- UNC
- Wash U St Louis
- U Washington
The NCI contracts spurred development of 3-D planning

- RTH, ASL, BAF arrived in AA July 1984, and DLM in Sept. 1984
- Electron contract proposal due: Jan. 5, 1985
- Our 3-D Hogstrom pencil beam algorithm and 3-D display code worked together: Jan 4, 1985

The NCI Treatment Planning Contracts Worked!

1984:
- $250 K: Vax 750, 8 MB
- $250 K: 4 Gould/DeAnza Displays

1986+ Clinical 3-D Planning Systems

Clinical 3-D systems begin to be introduced

UMPlan, March 1986:
- 3-D anatomy
- CT, MR, PET imaging + dataset registration
- 3-D beams, dose calcs
- DVHs
- BEV, BEV blk design
- 3-D electrons
- 3-D brachytherapy (incl. brain implants)
What do we do with a 3-D planning system?

1986: Conformal Treatment of the Prostate

Late 80s: Learning to Conform

Lichter et al in New Directions in Cancer Treatment, Springer Verlag, 53-84, 1989

Leibl, IJROBP 20, 823-33, 1991

Marks et al: IJROBP 33: 1209-019, 1995

UNC: Gratis

1992: A Crucial Tool: ICRU 50

Prescribing, Recording, and Reporting Photon Beam Therapy (Report 50)
Some Early Conformal Therapy Clinical Dose Escalation Studies

<table>
<thead>
<tr>
<th>Site</th>
<th>Institution</th>
<th>Start</th>
<th>Dose(Gy)</th>
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<tbody>
<tr>
<td>Prostate</td>
<td>UM</td>
<td>1986</td>
<td>60 → 80.4</td>
</tr>
<tr>
<td>Liver</td>
<td>UM</td>
<td>1987</td>
<td>30 → 90</td>
</tr>
<tr>
<td>Prostate</td>
<td>MSKCC</td>
<td>1988</td>
<td>64.8 → 75.6, +</td>
</tr>
<tr>
<td>Brain</td>
<td>UM</td>
<td>1989</td>
<td>60 → 70,80,90</td>
</tr>
<tr>
<td>Lung</td>
<td>UM</td>
<td>1991</td>
<td>60 → 102.9</td>
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</tbody>
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The 3-D Hypothesis

By tightly conforming the shape of the high dose volume to the shape of the target, one could increase target dose without increasing complications

2000s: 3-D is the State of the Art

Finally,
• We have 3-D planning capabilities
• We know how to treat patients conformally
• We have clinical data on dose escalation and/or minimization of normal tissue toxicity
• Cost for computer systems continues to fall
• Commercial planning systems provide some 3-D planning capabilities

Widespread acceptance of 3-D and conformal therapy: it’s now time for computer-controlled machines and IMRT, as well as the next talk!
Summary

3-D planning was made possible by

- Development of CT (and other imaging)
- Continually increasing computer power + decreasing costs
- A lot of smart and clever people
- Vision of the improvements in therapy that the new capabilities would make possible
- Careful implementation and clinical studies which led to real improvements in clinical use and improved outcomes for patients

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