

Implementing a Clinical Program for Stereotactic Body Radiation Therapy (SBRT)

A Practical Medical Physics Course
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SPEAKERS:

1. *Stanley H. Benedict, Ph.D.*
University of Virginia, Department of Radiation Oncology
2. Paul Read, MD, PhD
University of Virginia, Department of Radiation Oncology
3. D. Michael Lovelock, PhD
Memorial SloanKettering Cancer Center, New York
4. Brian Kavanagh, MD
University of Colorado, Department of Radiation Oncology

Implementing a Clinical Program for Stereotactic Body Radiation Therapy (SBRT)

OUTLINE OF PRESENTATIONS

1. Stanley H. Benedict, Moderator **WHAT?**
 - * Introduction
 - * Task Group No. 101: SBRT
2. Paul Read, MD, PhD **WHO?**
 - * Clinical Overview
 - * Protocols for SBRT
 - * Critical Organ dose tolerances
3. D. Michael Lovelock, PhD **HOW? WHERE?**
 - * Technology
 - * IGRT, Immobilization, & Relocalization systems
4. Brian Kavanagh, MD **WHY?**
 - * Radiobiological considerations
 - * Future trends in SBRT

DISCLOSURES

UVa and the Dept of Radiation Oncology has Grants with Siemens, TomoTherapy, and Elekta.

SBRT: Clinical Implementation

- 1. Introduction: SBRT vs Conventional RT
- 2. Establish scope of program
 - Treatment sites
 - Clinical endpoints
- 3. Equipment considerations
 - Immobilization
 - Imaging
 - Verification
- 4. Time and Personnel requirements
- 5. Commissioning and QA guidelines

Conventional RT vs. SBRT

Characteristic	Conventional RT	SBRT
Dose / Fraction	1.8 – 3 Gy	6 – 30 Gy
# Fractions	10 – 30	1-5
Target definition	CTV / PTV	GTV only
Margin	Centimeters	Millimeters
Physics / dosimetry monitoring	Indirect	Direct
Required setup accuracy	TG40-conventional	TG40 - SRS

Conventional RT vs. SBRT

Characteristic	Conventional RT	SBRT
Redundancy in geometric verification	No	Yes
Need for respiratory motion management	High	Highest
Staff training	High	Highest
Technology implementation	High	Highest
Radiobiological understanding	Well understood	Uncertain, but getting better..
Interaction with systemic therapies	Yes	Yes to an uncertain but likely higher extent

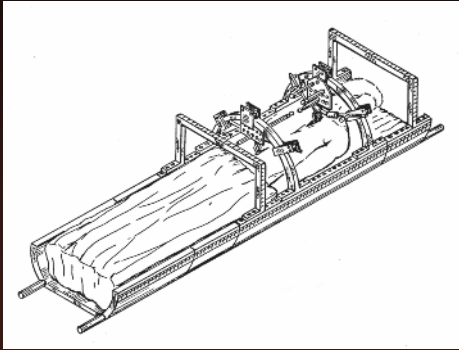
Establish Scope of Program

- Physics team should understand the limitations of the technology
- Clinical guidelines from national protocols and published literature should guide decisions
- Roles and responsibilities should be designated along the lines of the ASTRO/ACR practice guidelines for SBRT

L. Potters, et al, "American Society for Therapeutic Radiology and Oncology and American College of Radiology practice guideline for the performance of stereotactic body radiation therapy," Int J Radiat Oncol Biol Phys 60, 1026-1032 (2004).



Equipment Considerations: Commercial versus In-house creations



Equipment Considerations

- Primary issues are physical space and ability to integrate new technology
- In many cases, existing accelerators may be adequate for SBRT
- Must verify treatment planning system algorithms are appropriate and accurate for SBRT (e.g. Pencil beam algorithms are NOT recommended!)

Time and Personnel

- Requires increased physicist involvement
- SBRT requires a level of involvement similar to that required for IMRT and SRS
- In many cases SBRT is using aspects of IMRT and IGRT
- Continuing education vital as technology continues to advance
- Use the 2008 Abt study as a guide

Time and Personnel

The Abt Study of Medical Physicist Work Values for Radiation Oncology Physics Services: Round III
Final Report March 2008

Prepared for
American College of Medical Physics
And
American Association of Physicists in Medicine

Prepared by
Abt Associates Inc.

Available on-line at:
<http://www.aapm.org/pubs/reports/ABTIIIReport.pdf>

Procedural Time Estimates

Procedural Time (hours) for various Special Medical Physics Consultation (77370) – Abt round III final report – March 2008

77370 Procedure	Minimum	First Quartile	Median	3rd Quartile	Maximum
Routine 77370 Procedure	0.50	1.00	2.00	3.00	8.00
Total Skin Electron Irradiation	1.00	6.50	8.50	9.75	10.00
Total Body Irradiation	1.00	7.00	9.50	10.00	10.00
Remote Afterloading Brachytherapy	1.00	1.50	2.00	4.50	8.00
Stereotactic Body Radiotherapy	2.00	2.50	4.00	4.00	12.00
Stereotactic Radiotherapy (Single Fraction)	1.00	4.00	6.00	8.00	10.00
Stereotactic Radiotherapy (Multiple Fractions)	1.00	2.00	3.50	5.00	10.00
Intraoperative Radiotherapy	2.00	3.00	4.00	5.00	6.00
Prostate Seed Brachytherapy	0.50	2.50	4.00	5.00	8.00
Intensity Modulated Radiation Therapy	0.50	2.00	4.00	5.75	10.00
Image Guided Radiation Therapy	0.10	1.00	1.00	2.50	12.00

Intensity Estimates

Intensity estimate for various Special Medical Physics Consultation (77370) – Abt round III final report – March 2008

77370 Procedure	Minimum	First Quartile	Median	3rd Quartile	Maximum
Routine 77370 Procedure	0.50	2.00	2.00	3.00	6.00
Total Skin Electron Irradiation	2.00	2.25	5.00	9.25	30.00
Total Body Irradiation	2.00	3.00	3.00	3.50	6.00
Remote Afterloading Brachytherapy	1.50	3.00	3.00	4.00	5.00
Stereotactic Body Radiotherapy	2.00	4.00	4.00	4.00	4.00
Stereotactic Radiotherapy (Single Fraction)	3.00	4.00	5.00	6.00	10.00
Stereotactic Radiotherapy (Multiple Fractions)	2.00	3.00	4.00	5.75	7.00
Intraoperative Radiotherapy	3.00	3.38	3.75	4.50	6.00
Prostate Seed Brachytherapy	1.00	2.00	3.00	4.63	6.00
Intensity Modulated Radiation Therapy	1.50	3.00	4.50	6.00	8.00
Image Guided Radiation Therapy	0.50	2.00	4.50	6.00	8.00

Work Estimates

Overall work estimates for various Physics activities relative to CPT 77370. Work = Intensity * Time

CPT Code	Procedure Description	Minimum	First Quartile	Median	3rd Quartile	Maximum
77336	Consulting Medical Physics Consultation	0.10	0.37	1.00	2.00	6.00
77369	Basic Dosimetry Plan	0.07	0.24	0.49	0.89	6.25
77365	Simple Isodose Plan	0.14	0.41	0.69	1.32	16.42
77310	Intermediate Isodose Plan	0.25	0.65	0.83	2.19	12.80
77315	Complex Isodose Plan	0.09	0.89	1.63	3.28	17.07
77321	Special Radiotherapy Test Plan	0.38	1.00	1.64	3.68	19.07
77326	Simple Brachytherapy Isodose Plan	0.57	2.52	3.88	6.46	81.50
77327	Intermediate Brachytherapy Isodose Plan	2.02	4.19	5.64	11.27	95.43
77328	Complex Brachytherapy Isodose Plan	2.12	8.68	11.98	24.95	161.27
77331	Special Dosimetry	0.19	1.14	2.66	5.60	51.50
77332	Simple Treatment Device	0.02	0.05	0.12	0.34	2.51
77333	Intermediate Treatment Device	0.01	0.12	0.30	0.57	2.19
77334	Complex Treatment Device	0.01	0.09	0.45	0.86	9.65
77370	Special Medical Physics Consultation	0.21	6.75	13.94	23.69	236.00
77295	Therapeutic Radiology Simulations-Aided Field Testing	0.00	0.94	1.63	3.42	23.34
77301	IMRT Treatment Planning	2.63	18.14	28.66	47.92	161.90
77781	High Intensity Brachytherapy 1 to 4 Dwell Positions	0.57	3.07	5.72	10.45	83.00
77782	High Intensity Brachytherapy 5 to 8 Dwell Positions	1.14	4.73	10.34	17.34	96.83
77783	High Intensity Brachytherapy 9 to 12 Dwell Positions	1.72	8.67	14.67	21.31	97.33
77784	High Intensity Brachytherapy Over 12 Dwell Positions	1.72	8.24	13.85	23.74	105.89

Work Estimates: Really Big Calculations



Physicist Presence

Single-Fraction SRS	Physicist present for entire procedure
Multiple-Fraction SRS	Physicist present for 1 st fraction and at setup of remaining fractions
SBRT	Physicist present for 1 st fraction, and setup for every fraction to verify imaging, registration, gating, immobilization

Acceptance, Commissioning, QA

- Acceptance tests should be designed to verify contractual (commercial) obligations of functionality
- Commissioning tests should be detailed and should provide a complete baseline performance evaluation
- Rigorous periodic QA should verify changes from baseline and minimize systematic error

Desk notes from Wendell Lutz on the development of linac based SRS

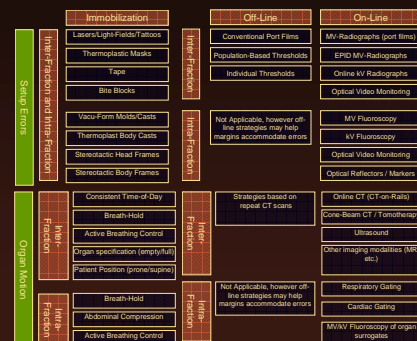
Test the system's ability to treat a target of known coordinates.

Most Important
Do you know where to aim?
Can you hit what you're aiming at?

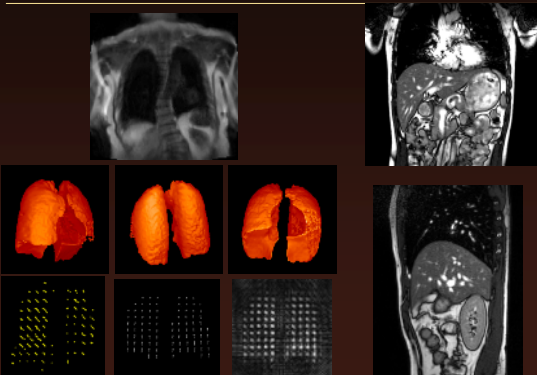
THREE TESTS

1. "Known" Target - Localization
2. Head Ring Movement
3. Rigorous Verification of Treatment Setup
4. Semi-quantitative "Confidence builder" Supplements above tests

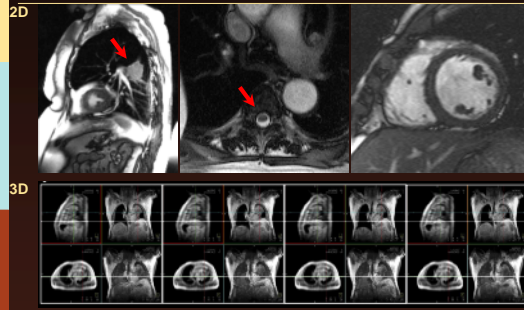
Error Management Overview



Motion Management: TG 76:
The role of respiratory management



Respiration does not account for all motion.....
Spinal Cord Motion Measurement with MRI



Dinkel et al, 2009, 3D time-resolved echo shared gradient echo technique combining parallel imaging with view sharing (TREAT) sequence; ~ 1 frame/sec; voxel size ~ 3 mm.

Task Groups and Reports for SBRT

TG-40	Comprehensive QA for radiation therapy
TG-142 (in press)	Update of TG-40. Includes info relevant to SBRT (imaging, gating, MLCs, etc.)
TG-53	Quality assurance for clinical radiotherapy treatment planning
TG-76	The management of respiratory motion
TG-104 (in review)	The Role of In-Room kV X-Ray Imaging for Patient Setup and Target Localization

Acknowledgments



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