ADVANCED TECHNOLOGY
CLINICAL TRIALS

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Acknowledgements

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- Walter Bosch, D.Sc.  Computer Scientist
- John Matthews, D.Sc.  Computer Scientist
- Sean O’Leary, M.S.  Programmer Analyst
- Mary Harms  Data Analyst
• **April 1, 1992**: 3DQA Center established at WU-St. Louis to provide QA for RTOG 3DCRT clinical trials.

• **May 1, 1993**: RTOG & 3DQA Center awarded NCI grant for Operation/Statistical Center for prostate dose escalation study (3DOG).
3DQA Center’s Original Challenge

- Define basic technical and clinical QA criteria for participation in RTOG 3DCRT protocols to ensure minimum variability among protocol participants.
- Develop a mechanism for participating institutions to report their treatment planning and verification (TPV) data.
- Develop a QA program for review of submitted TPV data to insure compliance with protocol.
3DQA CENTER

Protocol Credentialing Requirements

• Complete Facility Questionnaire
  – Personnel
  – Treatment Equipment
  – Immobilization/Repositioning System
  – Treatment Verification System
  – 3D Computer Planning System
  – Digital Data Transfer Capability

• Submit Dry-Run (Benchmark) Test Dataset
  – Digital TPV data
  – Hard copy support documentation
What’s Special About 3D TPV Data?

• Quantitative 3D image data
  – Patient model (images, contours)
  – Volumetric dose representation
  – Treatment geometry
• Large volume of data
### What’s Special About 3D TPV Data? 3D Data Storage Requirements

<table>
<thead>
<tr>
<th>Data Object</th>
<th>Typical Storage per Patient</th>
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<tbody>
<tr>
<td>Patient CT images</td>
<td>$85 \times 512$ KB/image = 43,520 KB</td>
</tr>
<tr>
<td>Target and organ volumes</td>
<td>$85 \times 8$ KB/slice = 680 KB</td>
</tr>
<tr>
<td>Treatment plan specifications</td>
<td>$4 \times 7$ KB/plan = 28 KB</td>
</tr>
<tr>
<td>Computed dose distributions</td>
<td>$4 \times 1400$ KB/plan = 5,600 KB</td>
</tr>
<tr>
<td>Dose-volume statistics</td>
<td>$4 \times 50$ KB/plan = 200 KB</td>
</tr>
<tr>
<td>Simulation/DRR images</td>
<td>$20 \times 1200$ KB/image = 24,000 KB</td>
</tr>
<tr>
<td>Portal images</td>
<td>$120 \times 128$ KB/image = 15,360 KB</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>87 MB</strong></td>
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What’s Special About 3D TPV Data?

Treatment Planning-Verification Database

- TPV database linked to clinical outcomes database for evaluating response statistics and developing dose-response models.

- Loss of Spatial Information in DVHs
  - Spatial distribution of higher dose areas (white zones) throughout an OAR may lead to different expectations of normal tissue toxicity for some organs.
Digital Data Communication for Radiation Oncology

- RTOG Data Exchange Format (AAPM Report #10)
  - NCI Particle 3DRTP CWG
  - NCI Photon 3DRTP CWG
  - NCI Electron 3DRTP CWG
  - NCI Tools CWG
RTOG 3DCRT DATA EXCHANGE

Participating Institution

RTOG 3DCRT DATA EXCHANGE

INTERNET

3D RTP System

FTP

Files on Disk

Tape Cartridge

Fed-Ex, etc.

Write Data Exch

FTP

Read Data Exch

Write Data Exch

3D RTP System

Sybase Database

Files on Disk

Read Data Exch

RTOG 3D QA Center

Image-Guided Therapy Center
Washington University – St. Louis

DICOM 3.0 RT Implementation Workshop
March 16, 2002
RTOG 94-06 3DCRT PROTOCOL
A Phase I/II Dose Escalation Study Using 3D Conformal Radiation Therapy for Adenocarcinoma of the Prostate

- **52 institutions** credentialed to enroll patients on study.

- **Dose Levels**
  - 68.4 Gy (1.8 Gy/fraction)
  - 73.8 Gy (1.8 Gy/fraction)
  - 79.2 Gy to GTV; 73.8 Gy to PTV (1.8 Gy/fraction)
  - 74.0 Gy to PTV (2 Gy/fraction)
  - 78.0 Gy to PTV (2 Gy/fraction)

- **Accrual History**
  - May 2, 1994 Activation Date
  - Oct 31, 2000 1084 Patients (study closed)

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DICOM 3.0 RT Implementation Workshop March 16, 2002
NCI ADVANCED TECHNOLOGY QA CENTERS

- NCI funded two Advanced Technology QA Centers in 1999.
  - RCET (University of Florida)
  - Advanced Technology QA Consortium
    - 3DQA Center ➔ Image-Guided Therapy Center (ITC)
    - RPC
    - QARC
    - RTOG
ATC’s were charged to provide a resource for support of high technology radiation therapy clinical trials.

This support includes the following:
- develop basic technical/QA criteria for each protocol assessed
- credential institutions to participate in trials
- develop efficient methodologies for electronic data exchange of TPV data between the participating institutions and the ITC
- Create mechanisms and software tools to facilitate QA reviews of TPV data to assure that they are within protocol specifications.
- develop and maintain a comprehensive database of TPV images and data, including tumor and normal structure definitions, which can be correlated with treatment outcomes.
Advance Technology QA Consortium Approach

- Capitalizes on infrastructure and strengths of existing national QA programs.
- Avoids duplication of effort and promotes uniformity in QA for advanced technology clinical trials.
Advanced Technology QA Consortium
Capitalizes on Infrastructure/Strengths of Existing National QA Programs

- RTOG Modality Committees
  - IGRT Committee
  - Medical Physics Committee

- RTOG Site Committees
  - RTOG Lung Committee
  - RTOG GU Committee
  - RTOG H&N Committee

- RTOG Participating Institutions

- RTP Vendors

- RPC

- ITC

- QARC

- RTOG HQ & Statistical Office

- ASTRO 3D Workshops
ITC has pioneered digital data exchange mechanisms of treatment planning-verification data for use in clinical trials.

- Patient Volumetric CT Data Set
- Contours: GTV, CTV, PTV, OAR’s
- Volumetric 3-D Dose Distribution Data (Including Fractionation)
- Dose-Volume Histograms
- Beam Modality/Geometry Specification
- Digital Simulator and Portal Images
IMAGE-GUIDED THERAPY CENTER
Digital Data Submission

Participating Institution

<table>
<thead>
<tr>
<th>3D RTP System</th>
<th>Write RTOG Data Exch</th>
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<tr>
<td></td>
<td>Write DICOM†</td>
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<tr>
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INTERNET

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ITC

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Sybase Database

†In development
Data Exchange Technical Workshops for RTP Vendors

- **Mar 10, 1995, St. Louis**: implementation of RTOG Data Exchange standard for participation in multi-institutional clinical trials.

- **Sep 10-11, 1999, St. Louis**: implementation of RTOG Data Exchange standard (emphasis on prostate brachy).

- **March 16-17, 2001, St. Louis**: implementation of DICOM 3.0 standard for participation in multi-institutional clinical trials.

- **March 16, 2002, St. Louis**: implementation of DICOM 3.0 standard for participation in multi-institutional clinical trials.
3D QA CENTER DEVELOPMENTAL ACTIVITIES
Remote Case Review Tools

- Data Exchange
- CT Scan
- Organs at Risk Contours
- Target Volumes Contours
- Field Shape
- Field Placement
- Dose Prescription
- Dose uniformity
RTOG 3DCRT PROTOCOLS

- **RTOG 93-11 3DCRT PROTOCOL**: Phase I/II Dose Escalation Study Using 3D Conformal Radiation Therapy in Patients with Inoperable NSCLC
  - 26 institutions credentialed to enroll patients on study.
  - Accrual History
    - Oct 31, 1995 Activation Date
    - Study now closed 180 Patients

- **RTOG L-0117 3DCRT PROTOCOL**: Phase I/II dose intensification study using 3DCRT and concurrent chemotherapy for patients with inoperable, non-small cell lung cancer.
  - Currently 29 institutions eligible to enroll patients on study.
  - Accrual History
    - Jan 1, 2002 Activation Date
    - Mar 8, 2002 3 Patients
RTOG 3DCRT/IMRT PROTOCOLS

• **RTOG 98-03 3DCRT PROTOCOL**: Phase I/II Radiation Dose Escalation Study Applying Conformal Radiation Therapy in Supratentorial Glioblastoma Multiforme
  – Currently **40 institutions** eligible to enroll patients on study.
  – Accrual History
    • Sep 8, 1998 Activation Date
    • Mar 8, 2002 124 Patients

• **RTOG H-0022 (H&N) 3DCRT/IMRT PROTOCOL**: Phase I/II Study Of Conformal And Intensity Modulated Irradiation for Oropharyngeal Cancer
  – Currently **5 institutions** eligible to enroll patients on study.
  – Accrual History
    • Jan 1, 2002 Activation Date
    • Mar 13, 2002 1 Patient
RTOG ADVANCED TECHNOLOGY CLINICAL TRIALS: In Development

• ITC is assisting in the development of appropriate credentialing and QA guidelines for the following clinical trials:
  – **RTOG P-0126**: Phase III protocol that will randomize patients with intermediate risk localized prostate cancer to receive 3DCRT/IMRT to a standard dose of 70 Gy vs maximally tolerated dose established in 94-06 dose escalation study.
• ITC has played a key role in ASTRO 3DCRT Practicums by facilitating the exchange of CT and contour data to participating RTP vendors.

• Each one-day workshop designed for physicians, physicists, dosimetrists, and radiation therapists working together as a team in the treatment planning of cancer patients.
  - June 16-18, 2000, Chicago: ASTRO 3DCRT Practicum for Prostate Cancer.
  - March 1-3, 2001, Dallas, Texas: ASTRO 3DCRT Practicum (H&N, Lung, Prostate)
  - February 15-16, 2002, St. Petersburg, Florida: ASTRO 3DCRT/IMRT Practicum (H&N, Lung, Prostate)
• http://itc.wustl.edu
• Use it as a resource
SUMMARY AND CONCLUSION

• ITC has been in operation for nearly a decade and has provided RTOG the unique ability to conduct 3DCRT multi-institutional clinical trials in which volumetric 3DCRT clinical data can be collected, reviewed, and analyzed.
SUMMARY AND CONCLUSION

- Advanced Technology QA Consortium concept has been in operation for approximately 3 years.
- RTP manufacturers implementation of DICOM to meet clinical trials needs will be a significant contribution in advancing radiation oncology.