Radiological Physics Center

David Followill, Ph.D.
and RPC Staff
Radiological Physics Center

- Funded continuously by the NCI for nearly 45 years even as structure of cooperative group programs have changed over the years.

Only Four Directors

1. R Shalek (1968-1985)
2. W. Hanson (1985-2001)
4. D Followill (2010-present)
RPC Mission

1. Assure NCI and cooperative groups that institutions participating in clinical trials deliver prescribed doses that are comparable and consistent. (Minimize dose uncertainty)

2. Help institutions to make any corrections that might be needed.

3. Report findings to the community.
Clinical Trial Participants

- Number of Active Institutions – 1,925
  ~3,900 megavoltage machines
  ~24,000 active megavoltage beams
# Growth in Participation

<table>
<thead>
<tr>
<th></th>
<th>1/1/2006</th>
<th>5/1/2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutions</td>
<td>1,350</td>
<td>1,925 (43% ↑)</td>
</tr>
<tr>
<td>Machines</td>
<td>2,630</td>
<td>3,870 (47% ↑)</td>
</tr>
<tr>
<td>Beams</td>
<td>16,069</td>
<td>24,325 (51% ↑)</td>
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</table>

NCI funding has been level since 2000.
• RPC audits reach out to 1925 institutions worldwide
  • majority of sites are in USA and Canada
  • 232 institutions in 42 other countries (70% ↑ past 6 yr)
• NCI supported trials are enlisting international participation
  (KROG, EORTC, JGOG, KGOG, ANZGOG, AMC, GCIG)
RPC Verification of Institutions’ Delivery of Tumor Dose

- Reference calibration (NIST traceable)
- Correction Factors: Field size & shape, Depth of target, Transmission factors, Treatment time
- Tumor Dose

Evaluated by:
- RPC Dosimeters
- RPC visits and chart review
- RPC phantoms
Sp. Aim 1: Assurance of Constancy of Basic Machine Calibration

- RPC monitors 1,925 institutions worldwide, of which ~1,700 are in the USA

- Number of radiation beams has increased rapidly in recent years

- Audited 15,436 beams in 2012
Sp. Aim 2: Assurance of validity of treatment planning data

- On-site dosimetry review visits
- Compilation of “standard data”
- Virtual visits – review of data submitted electronically or by mail
2012 visits

• 26 institutions visited
  • 13 new
  • (previous year, only 1/3 of institutions were new)

• 54 accelerators
  • 369 megavoltage beams (photons or electrons)
  • Met desired number of beams

• Full implementation of MLC and IGRT tests

• Small field size SRS measurements to start
Sp. Aim 3: Assurance of consistency of treatment records

- RPC reviews records for GOG, NSABP, NCCTG, RTOG (brachy)
- Independent recalculation of patient doses
- Expanding use of Eclipse workstation
- Plans to incorporate Monte Carlo calculation of treatment plans
# Record Review Results

<table>
<thead>
<tr>
<th></th>
<th>Pre-Treatment Reviews</th>
<th>On-Treatment Reviews</th>
<th>Post-Treatment Reviews</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>90</td>
<td>7</td>
<td>539</td>
</tr>
<tr>
<td>(50% re-submitted</td>
<td></td>
<td></td>
<td>(461 Clinical)</td>
</tr>
<tr>
<td>1 or more times)</td>
<td></td>
<td></td>
<td>Deviations</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>17 Tx Mods</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>73 Minors</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>11 Majors</td>
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</table>
Treatment record reviews

• RPC performs independent retrospective review and recalculation of doses for RTOG, NCCTG and GOG.

• Only QA office to review cervical brachytherapy patients

• Errors in dose calculation and doses reported to study groups are discovered and corrected

  • The RPC review has resulted in changing the reported dose on 546 (27%) of the 1993 protocol patients reviewed since 2005.

    - 13% are EBRT

    - 87% are brachytherapy

We revise the dose data in 1 of every 3 charts
Sp. Aim 4: Credentialing of advanced technology procedures

- Questionnaires – check of understanding
- Rapid reviews – check of treatment records and planning procedures
- Benchmarks – check treatment planning capability
- Phantoms – most widely used end-to-end test of advanced technologies
- All designed to assure correct use of technology, minimize uncertainty on trials
Benefits of RPC Phantoms

- Independent “end to end” audit
  - Imaging
  - Planning/dose calculation
  - Setup
  - delivery
- Uniform phantoms and dosimeters
- Standardized analysis
- Uniform pass/fail criteria
- Allows inst. to inst. comparison
- Established infrastructure
## Phantom Results

Comparison between institution’s plan and delivered dose.

<table>
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<tr>
<th>Phantom</th>
<th>H&amp;N</th>
<th>Liver insert</th>
<th>Lung</th>
<th>Prostate</th>
<th>Spine</th>
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<tr>
<td>Irradiations</td>
<td>1351</td>
<td>9</td>
<td>484</td>
<td>411</td>
<td>168</td>
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<tr>
<td>Pass</td>
<td>1118</td>
<td><strong>6 (67%)</strong></td>
<td><strong>394 (81%)</strong></td>
<td><strong>352 (86%)</strong></td>
<td><strong>113 (67%)</strong></td>
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<tr>
<td>Fail</td>
<td>233</td>
<td>3</td>
<td>90</td>
<td>59</td>
<td>55</td>
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<tr>
<td>Criteria</td>
<td>7%/4mm</td>
<td>7%/4mm</td>
<td>5%/5mm</td>
<td>7%/4mm</td>
<td>5%/3mm</td>
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</table>
Proton Therapy Facilities

• 12 clinically-active proton centers wanting to participate in clinical trials (several trials in development)

• 2013 - Funds available through MGH federal share funds for proton center approvals as a cost sharing with proton centers (beginning in 2013 Proton Therapy fee for approval process - $12,000)
# Proton Facility Approval

<table>
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<tr>
<th>NAME</th>
<th>Beam Technique</th>
<th>Questionnaire</th>
<th>E Data Transfer</th>
<th>TLD</th>
<th>Site Visit</th>
<th>Site Visit Report</th>
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<td>Spot Scan</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Mar-13</td>
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<td>Yes</td>
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</table>
Cognizant of Study Groups’ Needs

• RPC attends all study group meetings and is a member of most RT committees

• Review of concepts and protocols

• Interacts with protocol PIs regularly

• Interacts with NCI
RPC Research Program

• Research focus is on dosimetry and how to either measure or calculate radiation doses more accurately and precisely.

• 46 peer reviewed publications (2011-2013)

• 61 abstracts/talks (2011-2013)

• 11 graduate students funded from many sources
RPC website (http://rpc.mdanderson.org)
Provide integrated radiation oncology and diagnostic imaging quality control programs in support of the NCI’s NCTN Network thereby assuring high quality data for clinical trials designed to improve the clinical outcomes for cancer patients worldwide.
Members of IROC

ACR IROC Grant
Contact PI, Co-Director RT:
D. Followill, Houston;
Co-Director Imaging:
M.V. Knopp, Ohio

IROC Ohio
PI: M. V Knopp

IROC Houston
PI: D. Followill

IROC Rhode Island
PI: TJ FitzGerald

IROC St Louis
PI: J Michalski

IROC Philadelphia (RT)
PI: J. Galvin

IROC Philadelphia (Imaging)
PI: M. Rosen

Subaward

Subaward

Subaward

Subaward

Subaward
Significance

• Institutions make errors
  • Compilations by the IAEA, ICRU, ROSIS database, etc.

• Clinical trials can be degraded by even small dose discrepancies (pubs by Bentzen, Boyer)

• The RPC regularly detects discrepancies at institutions
  • Output calibration deviations
  • Remote audits and on-site measurements show same frequency of discrepancies
  • Calculation errors detected in treatment records
  • Failures to treat phantoms in agreement with plan
Questions?

http://rpc.mdanderson.org