Credentialing of Advanced Radiotherapy Technology: An Independent Peer Review Process

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Disclosures

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IROC Mission

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.
Extent of Activities

- 1,827 RT facilities participate in NCTN and monitored by IROC Houston
- 334 other sites (primarily international also audited
- 58 countries monitoring a total of 2161 sites
- Largest QA audit program
# IROC Houston Core Services

<table>
<thead>
<tr>
<th>Core Service</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSLD/TLD beam checks</td>
<td>16,742</td>
</tr>
<tr>
<td>Visits: onsite/virtual</td>
<td>19/55</td>
</tr>
<tr>
<td>Patient treatment chart/benchmarks</td>
<td>495/267</td>
</tr>
<tr>
<td>Phantoms/CSI/letters</td>
<td>746/2405/1978</td>
</tr>
<tr>
<td>Proton (cumulative) Approvals/clinically active</td>
<td>18*/25</td>
</tr>
</tbody>
</table>

* 4 pending
Purpose of Credentialing

- Educate
- Improve understanding of protocol
- Evaluate capability to implement new modality and deliver accurate dose
- Improve treatment delivery
- **Reduce the deviation rate**
Credentialing Technique

- Previous patients treated with technique
- Facility Questionnaire
- Knowledge Assessment Questionnaire
- Benchmark Case
- Electronic data submission
- Protocol patient dosimetry review
- Pre-Treatment (Rapid Review)
- End to End QA Phantoms
Use of Advanced Technologies in clinical trials?

- TRACKING
- TPS
- HETERO CORRECTION
- GATING
- IGRT
- KV OR MV
- IMRT
- SBRT
- Respiratory Control

Global Leaders in Imaging and Radiation Oncology Core
Imaging, Planning and Delivery - QA required at each step

Black Box
Thus the need for an end-to-end QA audit tool to verify the intended treatment goal.

Deliver the correct dose to correct location as planned.
Phantom Family

- 2 prostate phantoms
- 24 H&N phantoms
- 8 Spine phantoms
- 19 SRS phantoms
- 33 lung phantoms
- 10 liver inserts
IROC-H Phantoms for Protons

- prostate phantom
- lung phantom
- Liver phantom
- spine phantom
- H&N phantom
- head phantom
IROC-H Phantom Design

- Anthropomorphic shape
- Water filled or solid
- Plastic inserts containing targets and organs at risk (heterogeneity)
- Point dose (TLD) and planar (radiochromic film) dosimeters
- Purpose is to evaluate the complete treatment process
Benefits of IROC-H 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 Shipped

746 phantoms sent in 2016

Year

Phantoms Mailed


SRS head
Spine/Lung
Spine
Liver
Prostate
Lung
H&N
# Photon Phantom Results

Comparison between institution’s plan and delivered dose.

<table>
<thead>
<tr>
<th>Phantom</th>
<th>H&amp;N</th>
<th>Liver insert</th>
<th>Lung</th>
<th>Prostate</th>
<th>Spine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irradiations</td>
<td>2052</td>
<td>165</td>
<td>1109</td>
<td>566</td>
<td>336</td>
</tr>
<tr>
<td>Pass</td>
<td>1755 (86%)</td>
<td>120 (73%)</td>
<td>921 (83%)</td>
<td>484 (86%)</td>
<td>261 (78%)</td>
</tr>
<tr>
<td>Fail</td>
<td>297</td>
<td>45</td>
<td>188</td>
<td>82</td>
<td>75</td>
</tr>
<tr>
<td>Criteria</td>
<td>7%/4mm</td>
<td>7%/4mm</td>
<td>5%/5mm</td>
<td>7%/4mm</td>
<td>5%/3mm</td>
</tr>
</tbody>
</table>

Global Leaders in Clinical Trial Quality Assurance

IROC™
IMAGING AND RADIATION ONCOLOGY CORE
Proton Phantom Audits

- 136 proton phantoms irradiated, analyzed

<table>
<thead>
<tr>
<th></th>
<th>Brain</th>
<th>Liver</th>
<th>Lung</th>
<th>Prostate</th>
<th>Spine</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Irradiations</td>
<td>25</td>
<td>14</td>
<td>38</td>
<td>38</td>
<td>21</td>
<td>136</td>
</tr>
<tr>
<td># Passed</td>
<td>24</td>
<td>7</td>
<td>24</td>
<td>30</td>
<td>17</td>
<td>102</td>
</tr>
<tr>
<td>Pass Rate [%]</td>
<td>96%</td>
<td>50%</td>
<td>63%</td>
<td>79%</td>
<td>81%</td>
<td>75%</td>
</tr>
</tbody>
</table>
Problems that have been detected
Varian 6 MV IMRT H&N

Measurement vs. Monte Carlo

Criteria: 3%/2 mm

![Dose distribution graph and lateral view of IMRT planning]

**Axial**

**LATERAL**

**P**
Lung Phantom TLD results

Average $= 0.967 \pm 2.9\%$
274 irradiations
Algorithms included:
AAA/Superposition/MonteCarlo
Lung Phantom TLD results

- **Irradiation Lung Phantom**
  - Average = 0.967 +/- 2.9%
  - 274 irradiations
  - Algorithms included: AAA/Superposition/MonteCarlo

- **Average = 0.994 +/- 3.3%**
  - 30 irradiations
  - Algorithms included: MonteCarlo

![Graph showing TLD results with various irradiation levels and corresponding RPC/Inst values.](Image)
Lung Phantom Results
Percent of pixels passing 5%/3mm gamma criteria

<table>
<thead>
<tr>
<th>System</th>
<th>Percent Passing ±5%/3mm Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinnacle SC</td>
<td>96</td>
</tr>
<tr>
<td>Eclipse AAA</td>
<td>90</td>
</tr>
<tr>
<td>Eclipse PB</td>
<td>50</td>
</tr>
<tr>
<td>XiO SC</td>
<td>86</td>
</tr>
<tr>
<td>XiO Clarkson</td>
<td>52</td>
</tr>
<tr>
<td>TomoTherapy SC</td>
<td>85</td>
</tr>
<tr>
<td>MultiPlan MC</td>
<td>94</td>
</tr>
<tr>
<td>MultiPlan PB</td>
<td>31</td>
</tr>
<tr>
<td>Corvus PB</td>
<td>61</td>
</tr>
</tbody>
</table>
Proton Lung Phantom Concerns

• Overall lung phantom pass rate 66%
  – Disagreement between measurements and TPS
• Concerns about analytic (pencil beam) TPS algorithms
  – Subset of phantom plans recalculated using Monte Carlo algorithms
• BIG improvements seen with Monte Carlo
Lung Phantom Results

Right-Left Profile
Axial plane

Distance (cm)

Dose (Gy(RBE))

PTV

-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7

Left

Right

- IROC Film
- Institution values
Lung Phantom Results

Right-Left Profile
Axial plane

Dose (Gy(RBE))

Distance (cm)

PTV

IROC Film
Institution values
Lung Phantom Results

Right-Left Profile
Axial plane

Dose (Gy(RBE))

Distance (cm)

PTV

IROC Film  Institution values
Lung Phantom Results

Pencil Beam original calc

Monte Carlo recalc
Summary

• Credentialing takes on many forms

• Introduction of new technologies present challenges that need to be verified prior to treating patients

• End-to-end QA phantoms detect errors, improve dose delivery accuracy and provide confidence

• Improved compliance with protocol prescription specifications and reduced deviation rate
Questions?