PATIENT QUALITY ASSURANCE IN RADIOTHERAPY USING AN ELECTRONICAL PORTAL IMAGING DEVICE (EPID)

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### Accidents in Radiotherapy

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panama City, Panama 2000</td>
<td>Software bug, untested shortcut</td>
<td>+100%</td>
<td>28 (pelvic) 17 deaths after 3 years</td>
</tr>
<tr>
<td>Bialystok, Poland 2001</td>
<td>Diode failure during power outage</td>
<td>10-20 x dose</td>
<td>5 (breast) all injured - itchy &amp; burning sensation</td>
</tr>
<tr>
<td>Epinal, France 2004</td>
<td>English acronyms used in French software</td>
<td>+7 - 34%</td>
<td>23 (prostate) 1 death, 16 injured - rectal inflammation</td>
</tr>
<tr>
<td>Glasgow, UK 2006</td>
<td>Digital upgrade</td>
<td>+58%</td>
<td>1 (CNS) 1 death</td>
</tr>
<tr>
<td>Rotterdam, Netherlands 2006</td>
<td>New data management system</td>
<td>+100%</td>
<td>1 (non-hodgkin lymphoma) 1 death</td>
</tr>
<tr>
<td>UK 1982-1990 (8 years)</td>
<td>New software, correction applied twice</td>
<td>-30%</td>
<td>1045 (various sites) 492 recurrences</td>
</tr>
</tbody>
</table>

Source: Leah McDermott, @NKI
• *In Vivo* measurements are important for:
  
  – Patient safety;
  
  – Adequate dose delivery;

  – It is conceivable that, for legal purposes, *In Vivo* measurements will be required for every patient in the future.
The ideal RT verification tool should:

- Verify dose before treatment;
  - Systematic errors, eg: MLC, TPS
- Verify dose during treatment
  - Check actual delivery, random errors, anatomy changes
- Take very little time
- Have high resolution
- Be digital and 3D
- Be accurate: Pass good plans and catch bad plans
Patient QA

- At the moment...
  - Diodes;
  - Arrays;
  - Matrix;
  - Phantoms;

- Time consuming;
- Pre-treatment;
- Less resolution.
Objective

Demonstrate the feasibility of QA and *In Vivo* measurements using EPID dosimetry
EPID Dosimetry

• Using the Portal Imaging Device:
  – Pre and during treatment

• More efficient;

• Higher resolution;
• Software developed at NKI-AVL in Amsterdam;

• Elekta Synergy®;
  – Elekta users group - test the product commercially.
Method

1: planning

2: irradiation

3: *back projection*

4: comparison

Method

- IMRT;
  - Field by field acquisition.
Method

- VMAT:
  - Continuous movie acquisition.

Axial plane through the isocenter. Source: Anton Mans@NKI Amsterdam
### EPID Dosimetry Report

**Patient name:**
**Treatment site:** OESOPHAGUS

<table>
<thead>
<tr>
<th>Field</th>
<th>G, C, T, E</th>
<th>% Δ&lt;1</th>
<th>Plan</th>
<th>Epid</th>
</tr>
</thead>
<tbody>
<tr>
<td>240II/240II</td>
<td>240,0,0,10</td>
<td>71.1</td>
<td>41.9</td>
<td>41.4</td>
</tr>
<tr>
<td>315II/315II</td>
<td>315,0,0,10</td>
<td>89.9</td>
<td>73.4</td>
<td>71.9</td>
</tr>
<tr>
<td>45II/45II</td>
<td>45,0,0,10</td>
<td>91.3</td>
<td>39.1</td>
<td>37.5</td>
</tr>
<tr>
<td>120II/120II</td>
<td>120,0,0,10</td>
<td>76.6</td>
<td>46.7</td>
<td>46.7</td>
</tr>
<tr>
<td>180II/180II</td>
<td>180,0,0,10</td>
<td>73.2</td>
<td>47.9</td>
<td>47.9</td>
</tr>
<tr>
<td>0II/0II</td>
<td>0,0,0,10</td>
<td>91.5</td>
<td>60.7</td>
<td>63.8</td>
</tr>
</tbody>
</table>

**Analysis, Gamma:** joep.stroom 30/07/2012 11:32:01, 3.0%, 3.0 mm

**Plan Name:** PTV_Cer_Esoph_30

**Linac, Cal, Th:** Default, E1B, ROI

**Isoc (cGy):**
- Plan: 305.5
- Epid: 309.2 (1.2%)
VMAT Example
Results @ FC

- 17 measurements;
  - 12 *in vivo* (7 IMRT and 5 VMAT);
  - 5 Phantom (1 IMRT and 4 VMAT).

<table>
<thead>
<tr>
<th></th>
<th>IMRT</th>
<th>VMAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔD_{isoc} (%)</td>
<td>%gamm&lt;1 (3%/3mm)</td>
<td>ΔD_{isoc} (%)</td>
</tr>
<tr>
<td>Mean</td>
<td>0,0</td>
<td>81</td>
</tr>
<tr>
<td>SD</td>
<td>2,7</td>
<td>7</td>
</tr>
</tbody>
</table>

- Time decrease around 60%;
Advantages

• *In vivo:*
  • More effective in error detection;

• Enhances efficiency and department quality;

• Doesn’t require great effort and time in data acquisition;

• Less expensive;

• Perspectives: 100% automated;
  • @ NKI-AVL Amsterdam
Objective

- *In vivo:*
Simplifies department.
and feasible;

- Time saving;

- In the future may become important for legal purposes;
Thank you

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