On the quality control of low-energy photon brachytherapy sources: current practice in Belgium and The Netherlands

A. Aalbers, M. De Brabandere, C. Koedooder, M. Moerland, B. Thissen, A. van ‘t Riet, A. Rijnders, B. Schaeken, S. Vynckier

NCS Subcommittee: “QC of Low-energy photon sources”
Background

- Last decade increase of patients treated with permanent implant prostate therapy (PPBT) in Belgium and The Netherlands

- Netherlands Commission on Radiation Dosimetry (NCS) established a subcommittee to study the current practice of QA in brachytherapy using low-energy photon (LEP) sources with the aim to publish a report with guidelines and recommendations on QC of these sources

  - Questionnaire: implantation methods, treatment planning and source strength determination

  - Mailed user test procedure for treatment planning systems

  - On-site measurement program to verify the source strength determination of LEP sources by medical physicists and vendors

- Findings of the on-site measurements will be reported here
Sources and equipment used in clinical practice in Belgium and the Netherlands during “on-site” visits

<table>
<thead>
<tr>
<th>Sources and equipment</th>
<th>BE</th>
<th>NL</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oncura 6711 (RAPID Strand)</td>
<td>10</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>IBt 1251L (InterSource)</td>
<td>7</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>1251L (Interstrand)</td>
<td>4</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Bebig I25.S06 (Isoseed)</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>I25.S17 (Isocord)</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Bard STM1251</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Isotron 130.002 (selectSeed)</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

\(^{125}\text{I} \text{ source types used in PPBT brachytherapy}

Note: IBt sources were available until 2008

Measurement equipment available for source strength measurements in Belgian and Dutch institutions

<table>
<thead>
<tr>
<th>Measurement equipment</th>
<th>BE</th>
<th>NL</th>
<th>TOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>PTW SourceCheck</td>
<td>9</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>SI (HDR1000/IVB1000)</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>NA 34-070</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Capintec (CRC-10/CRC-15R)</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Veenstra VDC-303</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sun Nuclear 100840</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Method on-site source strength measurement by NCS team

- Measurements conducted with two commercial well-type ionization chambers with single seed adapters appropriate for all source types in clinical use during the period of the on-site visits.

- All involved source types were directly calibrated at NIST (WAFAC) in terms of air kerma. These sources were used to calibrate the well chambers ensuring traceability to NIST. For one source type traceability was obtained from PTB (GROVEX).

- Air kerma measurements performed by NCS team were compared with measurements of the local medical physicists (when available) and with the source strength stated on the certificate of the vendor.
QC-Equipment NCS team

Standard Imaging IVB1000 well-type chamber
+ PTW Unidos E electrometer

PTW SourceCheck TM34051 + Unidos electrometer

Also available calibrated ancillary equipment to measure T,p and %RH
traceable to VSL, Delft

9-12 November 2010
Int. Symp. on Standards, Applications and QA in Med. Rad. Dosimetry, IAEA (Vienna)
Measurement procedure on-site

- In each institution 2-4 single seeds were measured.
- Same geometrical conditions, position of the seed and inserts/applicators during on-site measurement as during calibration.
- All seeds measured twice by reversing the orientation of the seed in the insert.
- Readings were corrected for background, temperature, pressure and decay.
- No corrections for recombination were applied.
Air kerma results for Oncura single seeds

N = 46
Average = 1.006
1sd = 0.020
Min ratio = 0.959
Max ratio = 1.046

N = 46
Average = 0.998
1sd = 0.023
Min ratio = 0.943
Max ratio = 1.045
Air kerma results for IBt single seeds

N = 51
Average = 0.993
1sd = 0.018
Min ratio = 0.951
Max ratio = 1.031

N = 47
Average = 1.002
1sd = 0.019
Min ratio = 0.965
Max ratio = 1.047
In-house measurements during on-site visits

- In-house measurements conducted by local medical physicist with traceable or factory calibrated *) equipment.
- Measurements in terms of air kerma (strength).
- Institution 1, 2 and 4 measurement of strand (10 seeds), 3 and 5 single seeds.
- Ratio institution/NCS: crosses (+)
- Ratio manufacturer/NCS: open circles (o)

*) Calibrated by equipment manufacturer

Institutions performing in-house measurements during on-site visits
Findings

- 31 out of 34 radiotherapy institutes participated in the on-site visits.
- The air kerma strength results of individual seeds of Oncura and IBt measured by the NCS visiting teams agree with the results stated by the manufacturer within 5%.
- Three institutions use each a different source type: Bard, Bebig and Isotron respectively. Except for the Bebig seeds the deviation between the NCS visiting team and the manufacturer is within 5%. A maximum deviation of 7.6% was found for one Bebig seed.
- Very often the local medical physicist base their source strength measurements on baseline values derived from data supplied by the manufacturer (consistency check).
Uncertainty in measurements
NCS visiting team

- Uncertainty estimated in two steps:
  - uncertainty contributions related to calibration with NIST traceable sources (step 1)
  - Uncertainty contributions related to on-site measurement (step 2)

<table>
<thead>
<tr>
<th>Relative expanded uncertainty (k=2)</th>
<th>Bard (%)</th>
<th>Bebig (%)</th>
<th>IBt (%)</th>
<th>Isotron (%)</th>
<th>Oncura (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Imaging IVB1000</td>
<td>2.0</td>
<td>3.2</td>
<td>2.6</td>
<td>2.0</td>
<td>1.9</td>
</tr>
<tr>
<td>PTW SourceCheck</td>
<td>1.9</td>
<td>3.4</td>
<td>2.9</td>
<td>2.0</td>
<td>2.6</td>
</tr>
</tbody>
</table>
Conclusions

- The majority of institutes lack traceable calibration in terms of air kerma (strength) of the QC equipment used for source strength verification.
- The vast majority of local medical physicists does not perform an independent air kerma strength verification of LEP sources used in clinical applications.
- Currently there are no traceable calibration services available for LEP brachytherapy sources in Belgium and The Netherlands.
- Based on the experience of the NCS visiting team independent air kerma strength verification of individual LEP sources in a clinical environment is feasible with a relative expanded uncertainty of about 3.5% (to be considered as “best practice”).
Acknowledgements

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Thank you for your attention!