The New ICRU/GEC-ESTRO Report in Clinical Practice

Christian Kirisits, MSc, PhD; Richard Pötter, MD
Medical University of Vienna, Vienna, Austria
On behalf of the Committee:
B. Erickson, C. Haie-Meder, E. van Limbergen, J. Lindegaard
J. Rownd, K. Tanderup, B. Thomadsen

Disclosures

Christian Kirisits, MSc, PhD, was a consultant to Nucletron, an Elekta Company.

Richard Pötter, MD, does not have any financial relationships or products or devices with any commercial interest related to the content of this activity of any amount during the past 12 months.

The Medical University of Vienna receives financial and equipment support for training and research activities from Nucletron, an Elekta Company and Varian Medical.
Table of Contents

• 1 - INTRODUCTION
• 2 - PREVENTION, DIAGNOSIS, PROGNOSIS, TREATMENT AND OUTCOME
• 3 - BRACHYTHERAPY TECHNIQUES AND SYSTEMS
• 4 - BRACHYTHERAPY IMAGING FOR TREATMENT PLANNING
• 5 - TUMOR AND TARGET VOLUMES AND ADAPTIVE RADIOTHERAPY
• 6 - ORGANS AT RISK AND MORBIDITY-RELATED CONCEPTS AND VOLUMES
• 7 - RADIOBIOLOGICAL CONSIDERATIONS
• 8 - DOSE AND VOLUME PARAMETERS FOR PRESCRIBING, RECORDING, AND REPORTING OF BRACHYTHERAPY ALONE AND COMBINED WITH EXTERNAL BEAM RADIOTHERAPY
• 9 - 3D VOLUMETRIC DOSE ASSESSMENT
• 10 - RADIOGRAPHIC DOSE ASSESSMENT
• 11 - SOURCES AND DOSE CALCULATION
• 12 - TREATMENT PLANNING
• 13 - SUMMARY OF THE RECOMMENDATIONS
• APPENDIX – EXAMPLES, SPREADSHEETS, DRAWINGS

Level Concept

Concepts and terminology for prescribing

Reporting and recording in a level concept:

• Level 1 – Minimum standard for reporting
• Level 2 – Advanced standard for reporting
• Level 3 – Research-oriented reporting
From Planning Aims to Prescription

Traditional concepts:

“when prescribing to a target, the prescription dose is the planned dose to cover this target as completely as possible.”

or

prescription to a 100% isodose which is “to cover” the target volume

Chapter 8

Need for Common Terminology According to ICRU Reports on Proton Treatment and IMRT

- **Planning aim dose**
  - Set of dose and dose/volume constraints for a treatment

- **Prescribed dose**
  - Finally accepted treatment plan (which is assumed to be delivered to an individual patient)

- **Delivered dose**
  - Actually delivered dose to the individual patient

Chapter 8
Need for Common Terminology According to ICRU Reports on Proton Treatment and IMRT

Example:
Previously: 4x7 Gy ~ 84 Gy EQD2 prescribed, D90 was mean 93 Gy

Planning aim was to deliver 4 x 7 Gy ~ 84 Gy, $D_{2cm}^3$ for rectum, sigmoid <70 Gy EQD2, bladder <90 Gy EQD2

Prescribed dose was mean 93 Gy ± 13 Gy (1SD) EQD2 to $D_{90}$ HR CTV

Delivered dose? Depending on variations and uncertainties – on average no systematic deviation from prescribed dose

Various Patterns of Tumor Response-Adapted CTV

Chapter 5
Various Patterns of Tumor Response-Adapted CTV

Chapter 5

Level 1 – Minimum Standard for Reporting

• Comprehensive clinical gynecologic examination
• Volumetric imaging (MRI, CT, US, PET CT) at time of diagnosis and BT
• FIGO/TNM stage
• Baseline morbidity and QoL assessment
• Schematic 3D documentation on a clinical diagram indicating dimensions and volumes for:
  – GTV_{init} (GTV at diagnosis)
  – GTV_{res} (GTV at brachytherapy)
  – CTV_{HR} (GTV_{res} plus residual pathologic tissue plus whole cervix)
  – (CTV_{HR}: GTV_{init} and CTV_{HR} plus safety margin if used for prescription)
### Example – Clinical Drawings

![Clinical Drawings Example](image)

---

### Example

<table>
<thead>
<tr>
<th>Dimensions and volumes of GTVs and CTVs at diagnosis and at brachytherapy</th>
<th>Diagnosis</th>
<th>BT1+2</th>
<th>BT3+4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical dimensions GTV $w \times t$ (mm)</td>
<td>60 *40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MRI dimensions GTV $w \times t \times h$ (mm)</td>
<td>55<em>40</em>45</td>
<td>35<em>35</em>43</td>
<td>35<em>35</em>43</td>
</tr>
<tr>
<td>MRI volume GTV (cm$^3$)</td>
<td>52</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Clinical dimensions CTV$_{HR}$ $w \times t$ (mm)</td>
<td>-</td>
<td>50*40</td>
<td>50*40</td>
</tr>
<tr>
<td>MRI dimensions CTV$_{HR}$ $w \times t \times h$ (mm)</td>
<td>-</td>
<td>48<em>35</em>43</td>
<td>46<em>32</em>41</td>
</tr>
<tr>
<td>CTV$_{HR}$ (cm$^3$)</td>
<td>-</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>CTV$_{IR}$ (cm$^3$)</td>
<td>-</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Left parametrium</td>
<td>proximal</td>
<td>proximal</td>
<td>proximal</td>
</tr>
<tr>
<td>Right parametrium</td>
<td>proximal</td>
<td>proximal</td>
<td>proximal</td>
</tr>
<tr>
<td>Vagina</td>
<td>upper third</td>
<td>not involved</td>
<td>not involved</td>
</tr>
<tr>
<td>Bladder</td>
<td>not involved</td>
<td>not involved</td>
<td>not involved</td>
</tr>
<tr>
<td>Rectum</td>
<td>not involved</td>
<td>not involved</td>
<td>not involved</td>
</tr>
</tbody>
</table>
Level 1 – Minimum Standard for Reporting

Dose reporting:
• TRAK
• Point A dose
• Recto-vaginal reference point dose
• $D_{0.1cm^3}, D_{2cm^3}$ for bladder, rectum
or
Bladder reference point for radiographs

Chapter 8 and Chapter 10

Point A

Axial

Coronal

Sagittal

Chapter 10
Level 2 – Advanced Standard for Reporting

All that is reported in level 1 plus:

3D delineation of volumes (on volumetric images with applicator and on clinical diagrams):

- $GTV_{res}$
- $CTV_{HR}$
- $(CTV_{IR}$ if used for prescription)$
- With maximum width, height, thickness and with volume

Chapter 5

Level 2 – Advanced Standard for Reporting

All that is reported in level 1 plus:

Dose reporting for defined volumes:

- $D_{98}$, $D_{90}$, $D_{50}$ for $CTV_{HR}$
- $(D_{98}$, $D_{90}$ for $CTV_{IR}$ if used for prescription)$
- $D_{98}$ for $GTV_{res}$
- $D_{98}$ for pathological lymph nodes

Chapter 8
Level 2 – Advanced Standard for Reporting

All that is reported in level 1 plus:

Dose reporting OARs:

- Bladder reference point dose
- \( D_{0.1cm^3}, D_{2cm^3} \) for sigmoid*
- \( D_{2cm^3} \) bowel (if fixed)*
- Intermediate and low dose parameters in bladder, rectum, sigmoid, bowel (e.g. \( V_{25Gy} \), \( V_{35Gy} \), \( V_{45Gy} \), or \( D_{98\%}, D_{50\%}, D_{2\%} \))
- Vaginal point doses at level of sources (lateral at 5 mm)**
- Lower and mid vagina doses (PIBS, PIBS ±2cm)**

Vaginal Reference Points

EBRT

BT

Chapter 8
Chapter 8

**DVH for OAR**

- **Total dose α/β=3 Gy**

**45 Gy Whole Pelvis EBRT plus 4 Fractions of HDR Brachytherapy (Total Target Dose: 85 Gy EQD2)**

- $V_{40\,03} = 94\%$
- $V_{50\,03} = 42\%$
- $V_{60\,03} = 10\%$

Chapter 8
45 Gy Whole Pelvis EBRT plus 15 Gy EBRT Tumor Boost plus 2 Fractions of HDR Brachytherapy (Total Target Dose: 85 Gy EQD2)

\[ V_{40\text{ Gy}} = 92\% \]

\[ V_{50\text{ Gy}} = 75\% \]

\[ V_{63\text{ Gy}} = 49\% \]
### Example

<table>
<thead>
<tr>
<th>Planning aim</th>
<th>Prescribed dose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CTV&lt;sub&gt;HR&lt;/sub&gt;</strong></td>
<td>( D_{90} \text{EQD}_{210} \geq 85 \text{ Gy} )</td>
</tr>
<tr>
<td><strong>Bladder</strong></td>
<td>( D_{2\text{cm}^3} \text{EQD}_{23} \leq 90 \text{ Gy} )</td>
</tr>
<tr>
<td><strong>Rectum</strong></td>
<td>( D_{2\text{cm}^3} \text{EQD}_{23} \leq 70 \text{ Gy} )</td>
</tr>
<tr>
<td><strong>Sigmoid</strong></td>
<td>( D_{2\text{cm}^3} \text{EQD}_{23} \leq 75 \text{ Gy} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1st application</th>
<th>2nd application</th>
<th>Total dose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BT1</strong></td>
<td><strong>BT2</strong></td>
<td><strong>BT3</strong></td>
</tr>
<tr>
<td>(Gy)</td>
<td>(Gy)</td>
<td>(Gy)</td>
</tr>
<tr>
<td><strong>Point A</strong></td>
<td>right</td>
<td>x*</td>
</tr>
<tr>
<td>left</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>Pelvic Wall Point</strong></td>
<td>right</td>
<td>1.1</td>
</tr>
<tr>
<td>left</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Bladder ICRU point</strong></td>
<td>right</td>
<td>2.8</td>
</tr>
<tr>
<td>left</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Recto-Vaginal ICRU point</strong></td>
<td>right</td>
<td>7.5</td>
</tr>
<tr>
<td>left</td>
<td>7.3</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>Vagina 5 mm</strong></td>
<td>right</td>
<td>7.5</td>
</tr>
<tr>
<td>left</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>PIBS** +2 cm</td>
<td>5.9</td>
<td>5.9</td>
</tr>
<tr>
<td>0 cm</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>-2 cm</td>
<td>0.6</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Example

<table>
<thead>
<tr>
<th></th>
<th>1st application</th>
<th>2nd application</th>
<th>Total dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BT1 (Gy)</td>
<td>BT2 (Gy)</td>
<td>BT3 (Gy)</td>
</tr>
<tr>
<td>GTV_{res} D_{98}</td>
<td>10.1</td>
<td>10.1</td>
<td>10.7</td>
</tr>
<tr>
<td>CTV_{HR} D_{98}</td>
<td>6.5</td>
<td>6.5</td>
<td>6.7</td>
</tr>
<tr>
<td>D_{98}</td>
<td>7.9</td>
<td>7.9</td>
<td>8.1</td>
</tr>
<tr>
<td>D_{50}</td>
<td>11.7</td>
<td>11.7</td>
<td>11.5</td>
</tr>
<tr>
<td>Bladder D_{0.1cm}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{1cm}</td>
<td>7.2</td>
<td>7.2</td>
<td>7.2</td>
</tr>
<tr>
<td>V_{2cm}</td>
<td>5.6</td>
<td>5.6</td>
<td>5.4</td>
</tr>
<tr>
<td>Rectum D_{0.1cm}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{1cm}</td>
<td>4.8</td>
<td>4.8</td>
<td>5.0</td>
</tr>
<tr>
<td>V_{2cm}</td>
<td>3.8</td>
<td>3.8</td>
<td>3.9</td>
</tr>
<tr>
<td>Sigmoid D_{0.1cm}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{1cm}</td>
<td>1.9</td>
<td>1.9</td>
<td>4.4</td>
</tr>
<tr>
<td>V_{2cm}</td>
<td>1.5</td>
<td>1.5</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Dose Estimation in Case of Radiographs

Chapter 10
## Conclusion

Concepts and terminology for prescribing, recording, and reporting

In a level concept:

- Level 1 – *Minimum standard for reporting*
- Level 2 – *Advanced standard for reporting*
- Level 3 – *Research oriented reporting*

Thanks for your attention!