CONTENTS

1. Introduction
2. Radiation therapy principles: Clinical indications, outcome and applied radiobiology
3. Altered fractionation
4. Overall QA and review
5. Equipment selection, acceptance testing, commissioning and QA/QC
6. Evolution of RT from 2-D to 3-D CRT and IMRT
7. Treatment delivery hardware/software for 3-D CRT
8. Delivery techniques for IMRT
9. Evidence-based medicine and new technology
10. Patient set-up and immobilisation
11. Imaging for target volume and organ at risk determination
12. Definition of target volumes and organs at risk
13. Contouring and prescribing for specific clinical sites for 3-D CRT (and IMRT)
14. Geometric uncertainties
15. Treatment planning 2-D RT to 3-D CRT
16. Treatment planning 3-D CRT to IMRT
17. Plan evaluation for 3-D CRT and IMRT
18. Additional physics equipment QA for IMRT
19. Patient specific physics QA for IMRT
20. Treatment verification: imaging and dosimetry
21. Special treatment techniques
1. Introduction

Worldwide distribution of cancer types in 2002, ranked by total number of cases (in thousands)


![ACRO Logo](image)

### TABLE 1: Analysis for Radiation Oncology Usage, First Course of Treatment
**American College of Surgeons National Cancer Data Base 2004 - 2005**

<table>
<thead>
<tr>
<th>SITE</th>
<th>% Total Cases (ACSNCDB)</th>
<th>Estimated Cases (ACS - 2008)</th>
<th>% XRT AVG</th>
<th>% Cases XRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head and Neck Sites</td>
<td>3.7%</td>
<td>3.7%</td>
<td>61.3%</td>
<td>2.3%</td>
</tr>
<tr>
<td>Digestive System</td>
<td>17.8%</td>
<td>18.8%</td>
<td>15.5%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Respiratory System</td>
<td>14.1%</td>
<td>16.16%</td>
<td>36.9%</td>
<td>5.2%</td>
</tr>
<tr>
<td>Soft Tissue/Bone</td>
<td>0.9%</td>
<td>0.89%</td>
<td>33.0%</td>
<td>0.3%</td>
</tr>
<tr>
<td>Skin</td>
<td>3.8%</td>
<td>4.71%</td>
<td>1.8%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Breast</td>
<td>17.3%</td>
<td>12.8%</td>
<td>45.6%</td>
<td>7.9%</td>
</tr>
<tr>
<td>Gynecologic</td>
<td>6.1%</td>
<td>8.7%</td>
<td>22.4%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Genitourinary System</td>
<td>19.9%</td>
<td>19.1%</td>
<td>24.5%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Nervous System</td>
<td>3.3%</td>
<td>3.5%</td>
<td>32.4%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Hematologic/Lymphoid System</td>
<td>7.4%</td>
<td>8.3%</td>
<td>8.9%</td>
<td>0.7%</td>
</tr>
<tr>
<td>Other/Unknown</td>
<td>5.7%</td>
<td>3.34%</td>
<td>27.1%</td>
<td>1.5%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.00%</td>
<td>100%</td>
<td>28.0%</td>
<td></td>
</tr>
</tbody>
</table>
2. Radiation therapy principles: Clinical indications, outcome and applied radiobiology

Clinical indications and outcome


Other material


Applied radiobiology


Other material


3. Altered fractionation

4. Overall QA and review


FIG. 2. CT-simulator room drawing showing wall lasers and the overhead sagittal laser


Other material


5. Equipment selection, acceptance testing, commissioning and QA/QC


**FIG. 2.** CT-simulator room drawing showing wall lasers and the overhead sagittal laser.


FIG. 10. Surface and buildup dose for 10_10 cm2 field of a 6 MV beam with various detectors. The actual surface dose is also marked by the arrow.
Other material


6. Evolution of RT from 2-D to 3-D CRT and IMRT


IAEA-TECDOC-1588. Transition from 2-D Radiotherapy to 3-D Conformal and Intensity Modulated Radiotherapy. IAEA, Vienna, Austria, 2008.

Other material


7. Treatment delivery hardware and software for 3-D CRT


Other material

8. Delivery techniques for IMRT


Other material

• Auj-E-Taqaddas. Investigation of VMAT algorithms and dosimetry. Authorhouse, Bloomington, IN, USA, 2011.

9. Evidence-based medicine and new technology


Other material

10. Patient set-up and immobilisation


![Headrests used for patient positioning and immobilization in external beam radiotherapy](image)

**FIG. 7.3. Headrests used for patient positioning and immobilization in external beam radiotherapy**


Other material


- Faiz M. Khan, Treatment Planning in Radiation Oncology, second edition, Lippincott Williams & Wilkins, 2006.
11. Imaging for target volume and organ at risk determination


*Figure 3.5b. T0.10 Leeds test object – fluoroscopic image.*

FIG. 6. A quality assurance phantom for three-dimensional radiation treatment planning.


Other material


• EMERALD project (http://www.emerald2.eu)
12. Definition of target volumes and organs at risk


Other material


13. Contouring and prescribing for specific clinical sites for 3-D CRT (and IMRT)


**Other material**


• Brachial Plexus Contouring Atlas (http://rtog.org/atlasases/BrachialAtlas/Brachial%20plexus%20contouring.pdf)


• Pelvic Lymph Node Volumes for Prostate Cancer Atlas (http://rtog.org/Atlases//PelvicLymphNodeProstateAtlas/Pel%20LN%20Vol%20Prostate.ppt)


• ESTRO-FALCON: Multifunctional platform for contouring and delineation (http://www.estro-education.org/elearning/Pages/Falcon.aspx)

• ESTRO-TIGER: Tutorial for Image Guided External Radiotherapy (http://www.estro-education.org/elearning/Pages/TIGER.aspx)
14. Geometric uncertainties


Other material

15. Treatment planning 2-D RT to 3-D CRT

Other material


16. Treatment planning 3-D CRT to IMRT


**FIG. 4.** CT images of a patient with a hip prosthesis (~cup, head, and stem!): ~a! frontal image/scout, ~b! lateral view scout, ~c! transversal slice showing artifacts, and ~d! same image as in ~c!, but contrast level adjusted to better visualize the contour of the prosthesis.

![Figure 27.](https://example.com/figure27.png)

*Figure 27. Correction factor for a 15 MV x-rays, 5 x 5 cm² field as a function of depth below the surface of the phantom for densities of 0.015 (humid air) and 0.18 and 0.31 (lung) g cm⁻³.*


![Axial and Transverse Images](image)

**FIG. 11.** Opposed, oblique field treatment plan (15 MV photons) showing the 100% isodose coverage for MC (modified DPM, University of Michigan/UMPlan) in the solid line, and an equivalent path length (EPL, University of Michigan/UMPlan) algorithm in the dashed line. The PTV is demarcated in white.

**Other material**

• Faiz M. Khan, Treatment Planning in Radiation Oncology, second edition, Lippincott Williams & Wilkins, 2006.


17. Plan evaluation for 3-D CRT and IMRT


Other material


18. Additional physics equipment QA for IMRT


Other material

19. Patient specific physics QA for IMRT


Other material

20. Treatment verification: imaging and dosimetry


![Figure 5. Schematic diagrams for entrance (a) and exit (b) dose calibration factors.](image)


Figure II.1: Schematic representation of the different doses involved in in vivo dosimetry for a single beam.


- FIG. 4. Conventional geometry for cone-beam CT.


Figure I-C-2. Schematic illustration of a typical treatment process using in-room radiographic imaging.


Other material


21. Special treatment techniques

Total body irradiation (TBI), half body irradiation (HBI), total marrow irradiation (TMI), total lymphoid irradiation (TLI)


(http://www-naweb.iaea.org/nahu/dmrp/pdf_files/ToC.pdf)

(http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/total_body_irradiation.aspx)

Other material


Stereotactic radiosurgery (SRS), stereotactic radiotherapy (SRT), stereotactic body radiotherapy (SBRT)


<table>
<thead>
<tr>
<th>Characteristic</th>
<th>3D/IMRT</th>
<th>SBRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dose/fraction</td>
<td>1.8-3 Gy</td>
<td>6-30 Gy</td>
</tr>
<tr>
<td>No. of fractions</td>
<td>10-20</td>
<td>1-3</td>
</tr>
<tr>
<td>Target definition</td>
<td>CTV/PTV (gross disease + clinical extension); Tumor may not have a sharp boundary.</td>
<td>GTV/CTV/PTV; PTV (well defined margins)</td>
</tr>
<tr>
<td>Margin</td>
<td>Centimeters</td>
<td>Millimeters</td>
</tr>
<tr>
<td>Physical/dosimetry monitoring</td>
<td>Indirect</td>
<td>Direct</td>
</tr>
<tr>
<td>Required setup accuracy</td>
<td>TG40, TG102</td>
<td>TG40, TG102</td>
</tr>
<tr>
<td>Primary imaging modalities used for treatment planning</td>
<td>CT</td>
<td>Multimodality: CT/MR/PET/CT</td>
</tr>
<tr>
<td>Redundancy in geometric verification</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Maintenance of high spatial targeting accuracy for the entire treatment</td>
<td>Moderately enforced</td>
<td>Strictly enforced (adjust patient positioning and monitoring)</td>
</tr>
<tr>
<td>Need for respiratory motion management</td>
<td>Moderate...Must be at least considered</td>
<td>Highest...Must be at least considered through integrated image guidance</td>
</tr>
<tr>
<td>Staff training</td>
<td>Highest</td>
<td>Highest</td>
</tr>
<tr>
<td>Technology implementation</td>
<td>Highest</td>
<td>Highest</td>
</tr>
<tr>
<td>Radiobiological understanding</td>
<td>Moderately well understood</td>
<td>Poorly understood</td>
</tr>
<tr>
<td>Interaction with systemic therapies</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Other material


Intra-operative radiotherapy (IORT)


![Image of the Mobetron system](image)

**FIG. 1.** The soft-docking system used by the Mobetron. (a) The electron applicator, in contact with the tumor bed, is rigidly clamped to the surgical bed using a modified Bookwalter clamp. (b) The gantry being moved for soft docking to the applicator. (c) The LED display and electron applicator. The green light in the center of the display indicates that proper alignment has occurred and the gantry is properly docked. Note the air gap (4 cm±1 mm) between the end of the gantry and the top surface of the applicator.

**Other material**

Total skin electron irradiation (TSEI)


![Diagram of treatment setup with labels and notes: Treatment plane, calibration point, beam center line, scatterer and degrader, 3 meters, and 132 cm. Figure 1a: Geometrical arrangement of the symmetrical dual-field treatment technique. Equal exposures are given with each beam. The calibration point dose is at (x0, y0) in the treatment plane.](image_url)

Other material
