REVISITING ICRU VOLUME DEFINITIONS

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Objective:

To introduce target volumes and organ at risk concepts as defined by ICRU.

- 3D-CRT is the standard
- There was a need for a common language
- Volumes need be defined and then contoured/delineated
- ICRU reports provide standards for prescribing, recording and reporting
- Do not recommend RT doses
In 2D radiotherapy:

- Dose is prescribed to a reference point
- ... or to an isodose line
- The TPS algorithm calculates dose-distributions on a plane
- The treatment plan is evaluated on a plane (or various planes: “2.5 D”)
- There is no true concept of volume
In 3D radiotherapy:

- Dose is prescribed to a **volume** or several volumes
- The TPS algorithm calculates dose-distributions in a volume
- The dose to volumes of healthy organs can be quantified
- The treatment plan is evaluated looking at volumes (BEV)
- Or to a quantitative analysis of doses/volumes (DVH)
Prescribing, Recording and Reporting Photon Beam Therapy
GTV
Gross Tumour Volume

Is the gross demonstrable extent and location of the malignant growth.

GTV 1 – primary
GTV 2 – + lymph nodes
GTV clinical and radiological
Difficulties in GTV determination

Larger lateral and posterior wall extension

CT-scan

Larger cartilage, extralaryngeal and contralateral side extension

FDG-PET

MRI

Daisne et al., Radiother Oncol 69, 247-250, 2003
GTV on CT

- Use the right window settings
- Use the right contrast and delay
Inter-observer variation in GTV and CTV delineation

Cervix

Leunens et al., Radiother Oncol 29: 169-175, 1993

Dimopoulous et al., Radiother Oncol 89: 164-171, 2008
In the post-operative setting ...

Anaplastic meningioma

Post Prostatectomy

Guidelines based on anatomic boundaries or co-registered pre-op MRI?
CTV
Clinical Target Volume

Is a tissue volume that contains a demonstrable GTV and/or subclinical malignant disease that must be eliminated.

This volume must be treated adequately in order to achieve the aim of radical therapy.
Cervical lymph node regions

Surgical levels

RO levels for 3D-CRT

A margin must be added to the CTV to compensate for expected physiologic movements and variations in size, shape and position of the CTV during therapy. Includes the CTV and an “Internal Margin”
Is a geometrical concept used for treatment planning and it is defined to select appropriate beam sizes and beam arrangements, to ensure that the prescribed dose is actually delivered to the CTV.
GTV is the gross tumour volume

CTV is the GTV + subclinical disease

PTV = CTV + patient movements, set-up and beam inaccuracies

These are oncological (clinical) concepts

This is a geometrical concept (for the purpose of planning)
Is the tissue volume that (according to the approved treatment plan) is planned to receive at least a dose selected and specified by the radiation oncology team as being appropriate to achieve the purpose of treatment e.g. tumour eradication or palliation, within the bound of acceptable complications.
Irradiated Volume

Is the tissue volume that receives a dose that is considered significant in relation to normal tissue tolerance.
Organ at risk (OAR): Organ whose radiation sensitivity is such that the dose received by the treatment may be significant compared to its tolerance.

OARs may significantly influence treatment planning and/or prescribed dose.

PRV: Includes margin around the OAR to compensate for changes in shape and internal motion and for setup variation.
GTV and CTV: NSCLC stage IIIA
ITV
Treated volume (TV)
Irradiated volume (IV)
GTV  CTV  PTV  TV  IV
ICRU Report 83

- 2010
- 3-D CRT to IMRT
- More availability of CT
- Additional imaging – CT + MRI, PET, PET/CT
- Improved conformality
- Reduced doses to normal tissues
- More detailed dose-volume information on TPS
- Use of dose-volume constraints
- Automated optimization
ICRU 83 – Dose Specification

The graph illustrates the absorbed dose (in Gy) against the relative volume (%) for different reference points:

- $D_{98\%}$
- $D_{95\%}$
- $D_{50\%}$
- $D_{2\%}$

The dashed line labeled $D_{\text{mean}}$ indicates the mean absorbed dose.

The text box notes: "~= dose to ICRU reference point."
The RVR is defined by the difference between the volume enclosed by the external contour of the patient and that of the CTVs and OARs on the slices that have been imaged.

The RVR is of importance in evaluating plans; if not specifically evaluated, there could be unsuspected regions of high absorbed dose within the patient that would otherwise go undetected.
Dose distribution for conventional beam (A) and IMRT (B) treatment of an oropharyngeal tumour. The patient experienced a lip desquamation (dashed arrow) and hair loss in the occipital/posterior area (solid arrow), which are not expected with conventional bilateral opposing beams (Zhen et al., Med. Dos. 27, 155-159, 2002).
3 Clinical Scenarios [A]

- GTV

- CTV = GTV + subclinical

- PTV = CTV + IM + SM
3 Clinical Scenarios [B]

- The IM and the SM have been considered together into a “global“ safety margin
- The PTV is smaller
When an OAR is closer to the GTV, this reduces the width of the acceptable safety margin ...
Cervix BRACHYTHERAPY

GEC-ESTRO definitions

ICRU Report 89 (2016)

Initial GTV
Residual GTV
High-risk CTV
Intermediate-risk CTV
Low-risk CTV

Thank you!!