Radiological Protection in Medicine

Overview and Introduction of TG101

Fukushima Medical University

3rd October 2017

Yoshiharu Yonekura

National Institutes for Quantum and Radiological Science and Technology (QST)

Chair, ICRP TG101

ICRP

- Founded in 1928 “International X-ray and Radium Protection Committee” at 2nd International Congress of Radiology (ICR)
- Renamed “International Commission on Radiological Protection (ICRP) in 1950
- Registered charity in UK

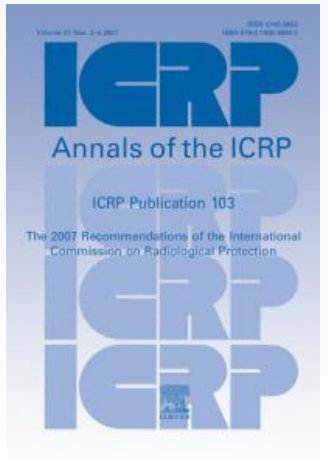
- Main Commission and four Committees
  - Chair: Dr. Claire Cousins (2009 -)
  - Scientific Secretary: Chris Clement

Mission and Publication

Advance for the public benefit the science of radiological protection, in particular by providing recommendations and guidance on all aspects of protection against ionising radiation

- Publication series since 1959
- *Annals of the ICRP* since 1977

- Task Groups and Working Parties

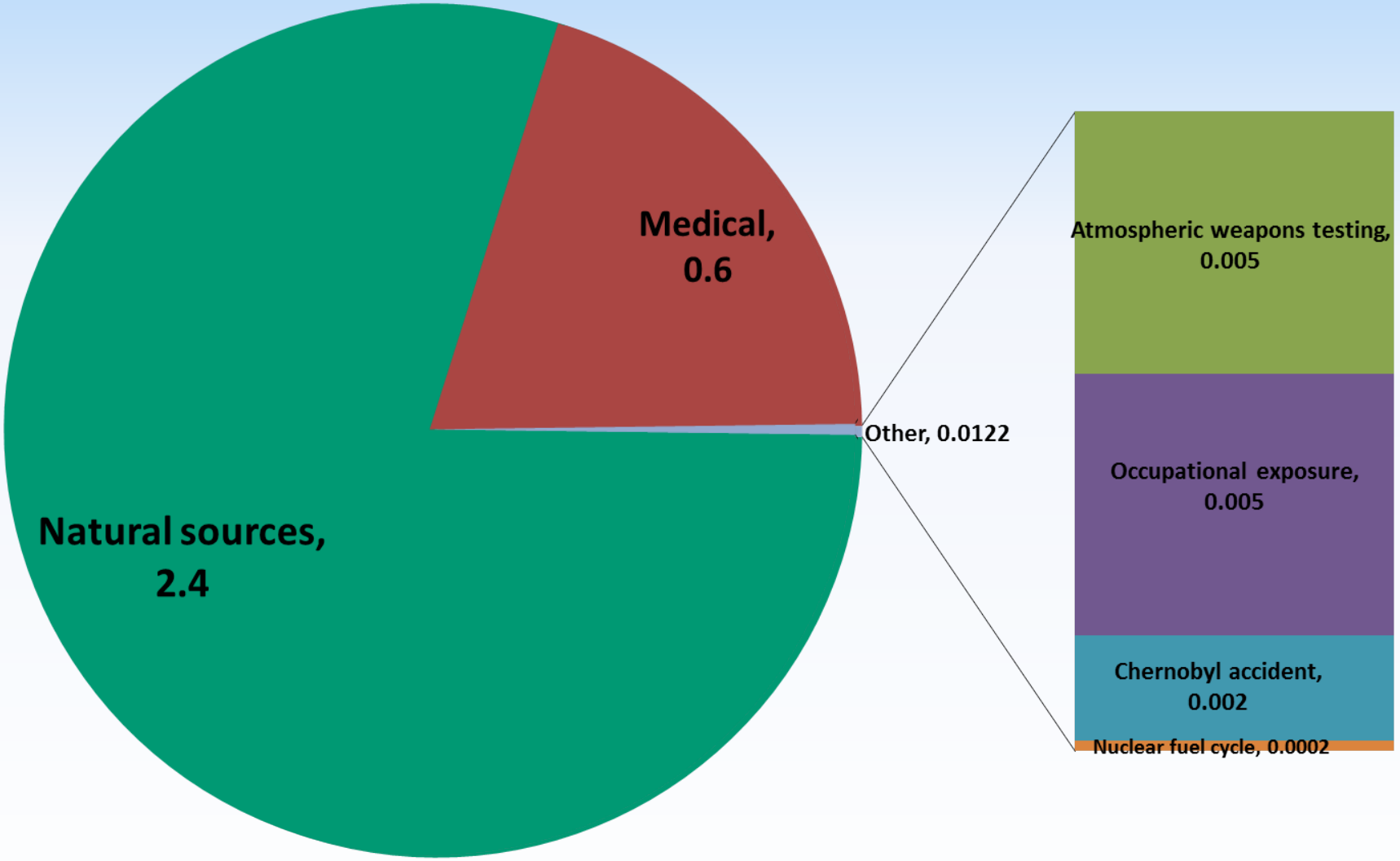


Committee 3

- Protection in Medicine
  - Patients (Diagnosis, IVR, Radiotherapy)
  - Comforters and carers
  - Volunteers in biomedical research
  - Staff (occupational exposure)

- Key publications
  - Publication 105: Radiological Protection in Medicine
  - Radiation and Your Patient: A guide for medical practitioners http://www.icrp.org/page.asp?id=32

Global Average Exposure



Source: UNSCEAR 2008 Report

Radiological Protection in Medicine

- Unique aspects of RP for patients
  - Deliberate exposure
  - Voluntary exposure

- No dose limit
- Justification: more good than harm
  - Three levels: general, procedure, individual patient
- Optimization: as low as reasonably achievable, but maintaining the image quality for diagnosis or therapeutic outcomes

Recent Publications by ICRP C3

- Publication 129: Radiological protection in cone beam computed tomography (CBCT).
- Publication 128: Radiation dose to patients from radiopharmaceuticals: A compendium of current information related to frequently used substances.
- Publication 127: Radiological protection in Ion beam radiotherapy.
- Publication 121: Radiological protection in paediatric diagnostic and interventional radiology.
- Publication 120: Radiological protection in cardiology.
- Publication 119: Compendium of dose coefficients based on ICRP Publication 60.
- Publication 117: Radiological protection in fluoroscopically guided procedures outside the imaging department.
- Publication 113: Education and training in radiological protection for diagnostic and interventional procedures.
- Publication 112: Preventing accidental exposures from new external beam radiation therapy technologies.

2009 - 2016

Therapy with Radiopharmaceuticals

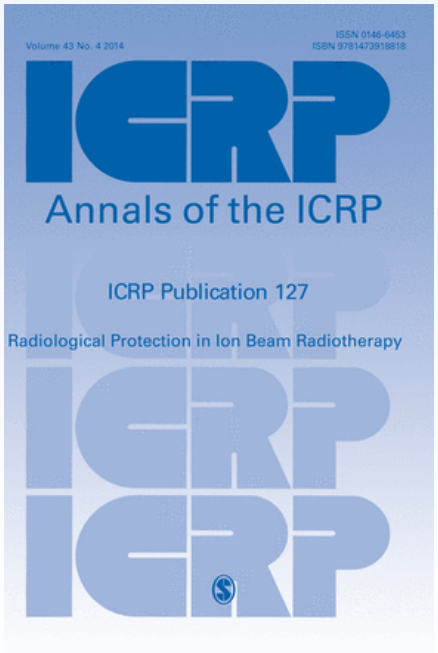
- Need to improve dosimetry
  - Excellent dose distribution in external radiotherapy
  - EU: Council Directive 2013/59/Euratom (5 Dec. 2013)

Article 56: *For all medical exposure of patients for radiotherapeutic purposes, exposures of target volumes shall be individually planned and their delivery appropriately verified taking into account that doses to non-target volumes and tissues shall be as low as reasonably achievable and consistent with the intended radiotherapeutic purpose of the exposure.*

Article 106: *Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 6 February 2018.*

Radiological Protection in External Beam RT

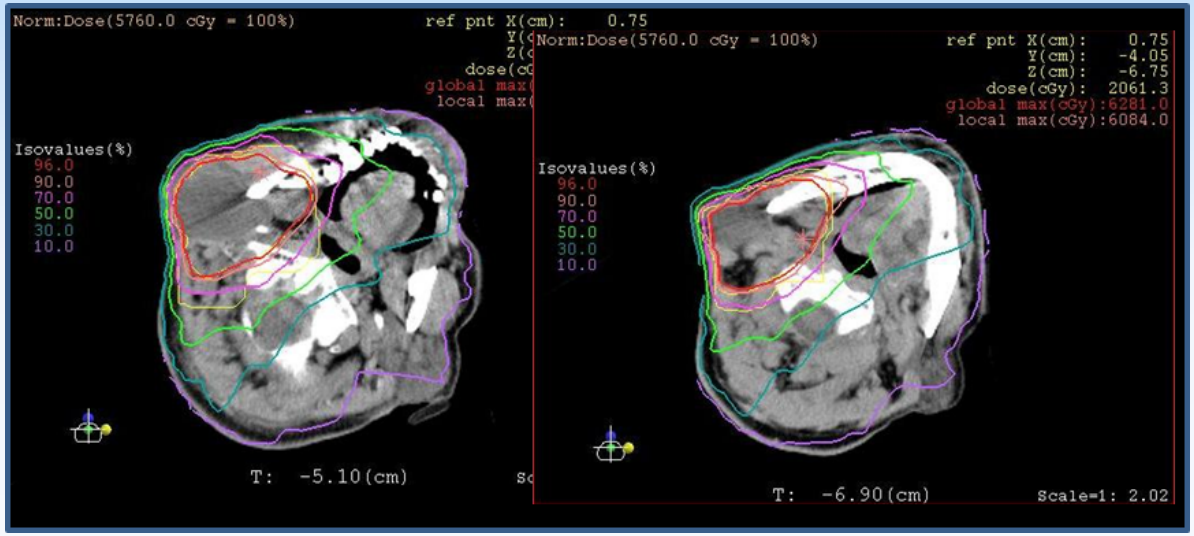
- Publication 86 (2000); Prevention of accidental exposure to patients undergoing radiation therapy.
- Publication 112 (2009); Preventing accidental exposures from new external beam radiation therapy technologies.
- Publication 127 (2014); Radiological protection in ion beam radiotherapy.



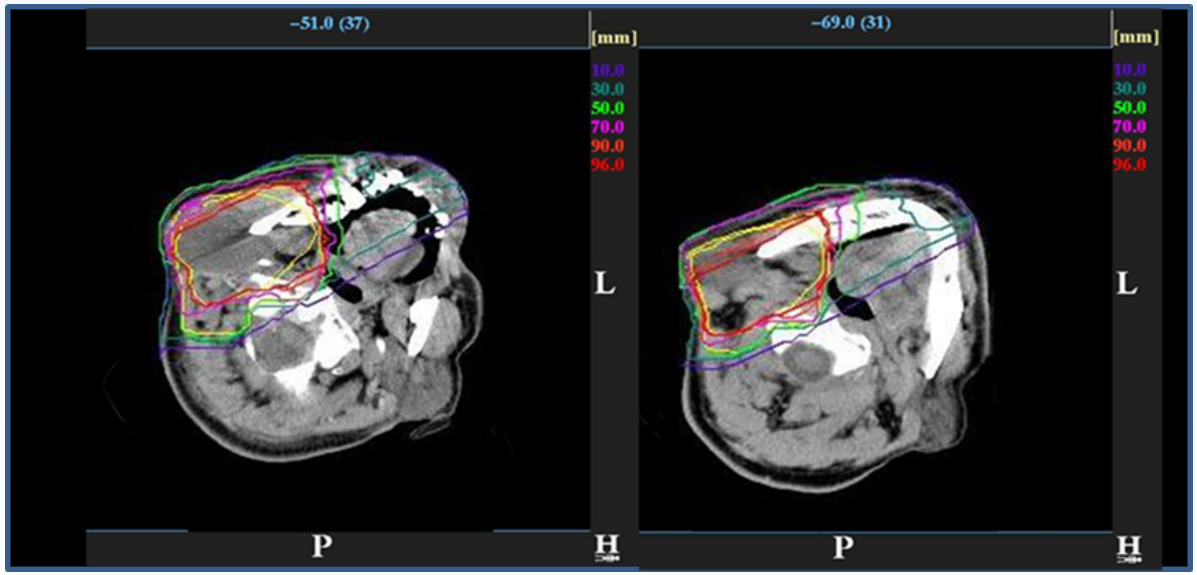
Planning in External Beam RT

ICRP *Publication 127* (Fig. 5.1)

IMRT



C-ion RT



Therapy with Radiopharmaceuticals

- Need to improve dosimetry
  - No access to individual dosimetry in most facilities
  - Quantitative imaging and dosimetry should be the basis for treatment planning
  - Variation in patient kinetics at therapeutic levels

- New document to encourage individual dosimetry

TG101: Radiological Protection in Therapy with Radiopharmaceuticals

Member:	Yoshiharu Yonekura (Co-chair, C3)
	Sören Mattsson (Honorary Co-chair, C3)
	Wesley E. Bolch (C2)
	Laurence T. Dauer (C3)
	Glenn Flux (UK)
Corresponding Member:	Chaitanya Divgi (US)
	Mark Doruff (C4)
	Darrell R. Fisher (US)
	Makoto Hosono (Japan)
	Michael Lassmann (Germany)
	Stig Palm (Sweden)
	Pat Zanzonico (US)

Progress

- October 2011; Initial proposal of WP
- April 2012; Main Commission approved WP
- October 2013; C3 decided to continue WP with Y. Yonekura (co-chair) and S. Mattsson (honorary co-chair).
- October 2014; Co-chairs assigned the role of each member, and asked the contributions by the end of March 2015.
- August 2015; The first draft submitted to C3.
- September 2015; Co-chairs and selected members (G. Flux and S. Palm) discussed in Malmö:
  - Need to improve dosimetry considering the dose in individual patient and biological effect of radiation.

Progress (cont.)

- October 2015; Proposed to C3 to establish TG
- February 2016; Approval of TG101 by MC
- July 2016; TG101 meeting in Malmö
- October 2016; Joint symposium with EANM
- March 2017; TG101 meeting in Malmö
- May 2017; Draft2.2 to C3 review
- August 2017; Draft2.4 to C3 new members
- September 2017; Draft2.5 to C3 and MC
- October 2017; FMU-ICRP workshop and AOFNMB-ICRP symposium
- October 2017; C3 approval and MC discussion

Contents

1. Introduction (S. Mattsson)
2. Current ICRP recommendations related to therapy with radiopharmaceuticals (S. Mattsson)
3. Radionuclide therapy treatment methods and their optimisation (G. Flux)
4. Biokinetic data collection (M. Lassmann, S. Palm)
5. Methods for absorbed dose calculations (D. Fischer)
6. Specific radiation protection issues (L.T. Dauer)
7. Summary of ICRP recommendations (Y. Yonekura)

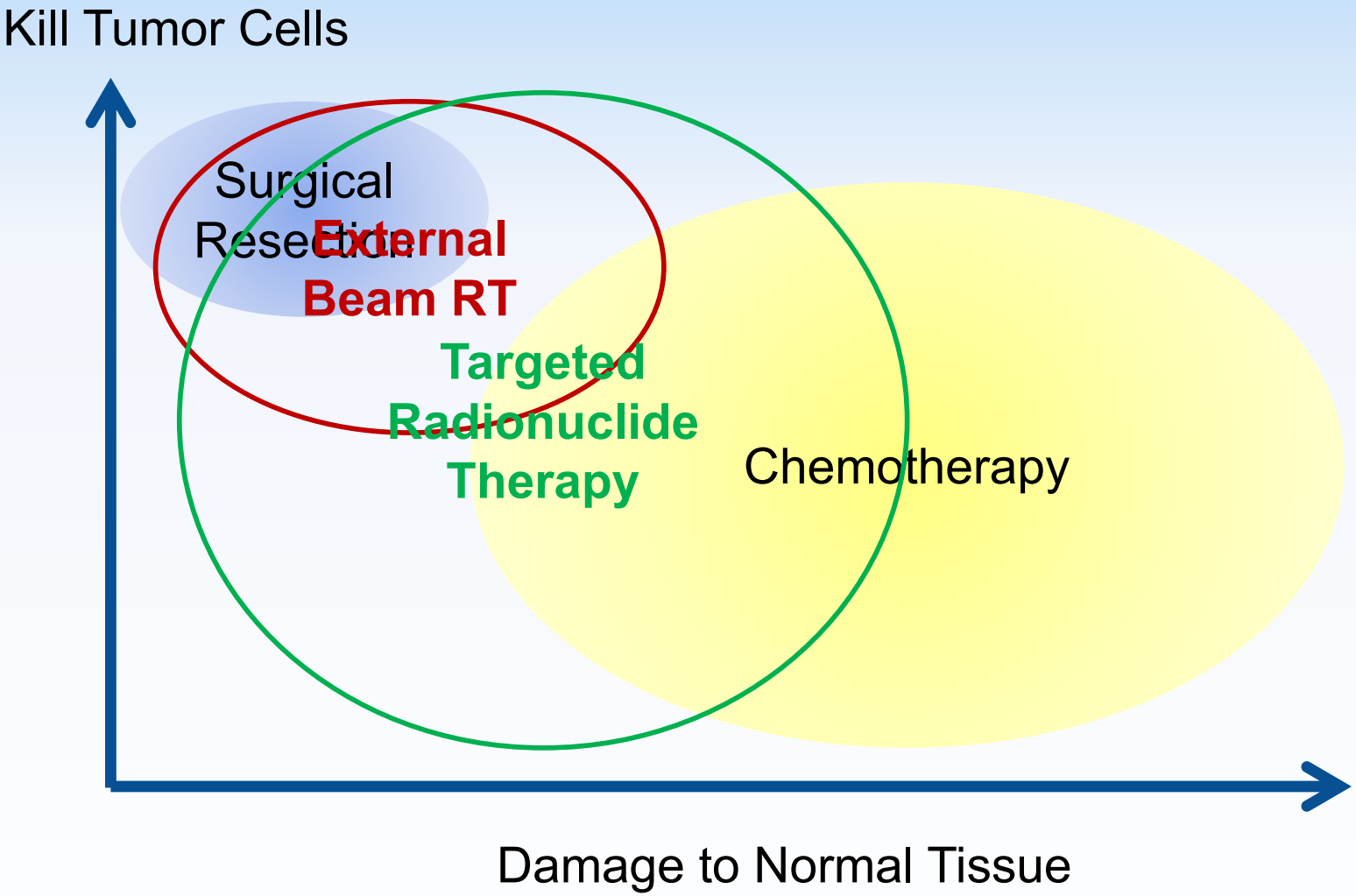
Cancer Therapy

- Surgical Resection:
  - Complete removal of tumor cells, but limited to the localized tumor.
- External Beam Radiotherapy:
  - Efficient to localized tumor with less toxicity in surrounding tissues.
- Targeted Radionuclide Therapy:
  - Efficient for disseminated tumor cells with less toxicity, but needs better targeting and improved dosimetry.
- Chemotherapy:
  - Efficient for disseminated tumor cells, but variable efficiency and toxicity in normal cells.

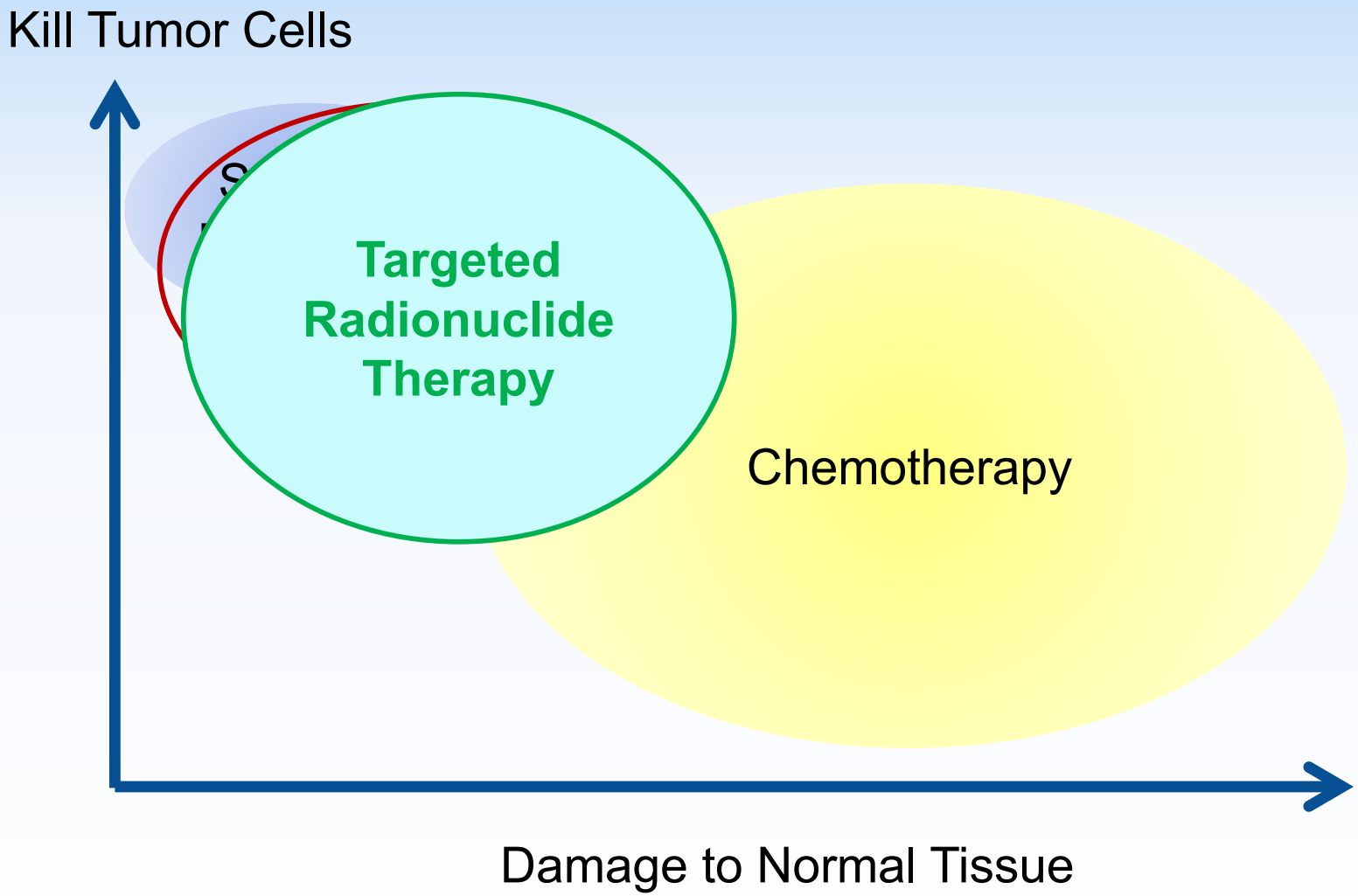
Cancer Therapy

- Surgical Resection:
  - Complete removal of tumor cells, but limited to the localized tumor.
- External Beam Radiotherapy:
  - Efficient to localized tumor with less toxicity in surrounding tissues.
- Targeted Radionuclide Therapy:
  - Efficient for disseminated tumor cells with less toxicity, but needs better targeting and improved dosimetry.
- Chemotherapy:
  - Efficient for disseminated tumor cells, but variable efficiency and toxicity in normal cells.

Cancer Therapy



Cancer Therapy



Key Issues

- Improve dosimetry in individual patient
  - Physical and Biological aspects
    - ✓ RBE of high LET radiation (alpha particles, Auger electrons)
  - Dose in target (tumor) and normal healthy tissues
    - ✓ Radionuclide distribution (Imaging, others)
- Improve quality of therapy with radiopharmaceuticals
  - Learn from external RT
  - Need systematic approach for treatment planning, monitoring the effect, and archiving the data
- Protection of workers and public
  - Patient release & waste management

Next Step

- TG101 document
  - Approval of ICRP C3
  - Review and approval by ICRP MC
  - Public consultation
  - Publication

- Sharing Information
  - Nuclear medicine community; EANM, AOCNMB (JSNM), SNM, etc
  - Medical experts and public community

Need your support !

FMU-ICRP Workshop

- Introduction of new treatment facility of targeted alpha-particle therapy in FMU (Oriuchi)
- Individual risk estimates in radiology (Mattsson)
- Pediatric phantoms or dosimetry calculations (Bolch)
- Individual treatment planning (Flux)
- Current status on radionuclide therapy (Hosono)

www.icrp.org