How to safely handle new diagnostic and therapeutic radiopharmaceuticals

Niki Bergans – RPE – head of health physics UZ Leuven
niki.bergans@uzleuven.be

UZ Leuven | Herestraat 49 B - 3000 Leuven | www.uzleuven.be tel. +32 16 33 22 11

UNIVERSITY HOSPITALS LEUVEN

KU LEUVEN

Challenges for health physics

Radiation protection of the medical staff

Minimize the occupational dose and prevent internal exposure through justification, optimization and safe practice

Risk factors:

1) High amounts of activity
   - Radionuclide therapy ⇒ during synthesis, dispensing and administration
   - Production of diagnostic tracers ⇒ during synthesis and dispensing

2) Type of emitters used
   - alpha-emitters: Ra-233, Ra-224, Bi-213, At-211,Ac-225…
   - high energy beta-emitters: Zr-89, Y-90 , Ho-166, Re-186,…

Manipulation of high amounts of activity

- Protection against external radiation
- Prevention of uncontrolled release of radioactive substances

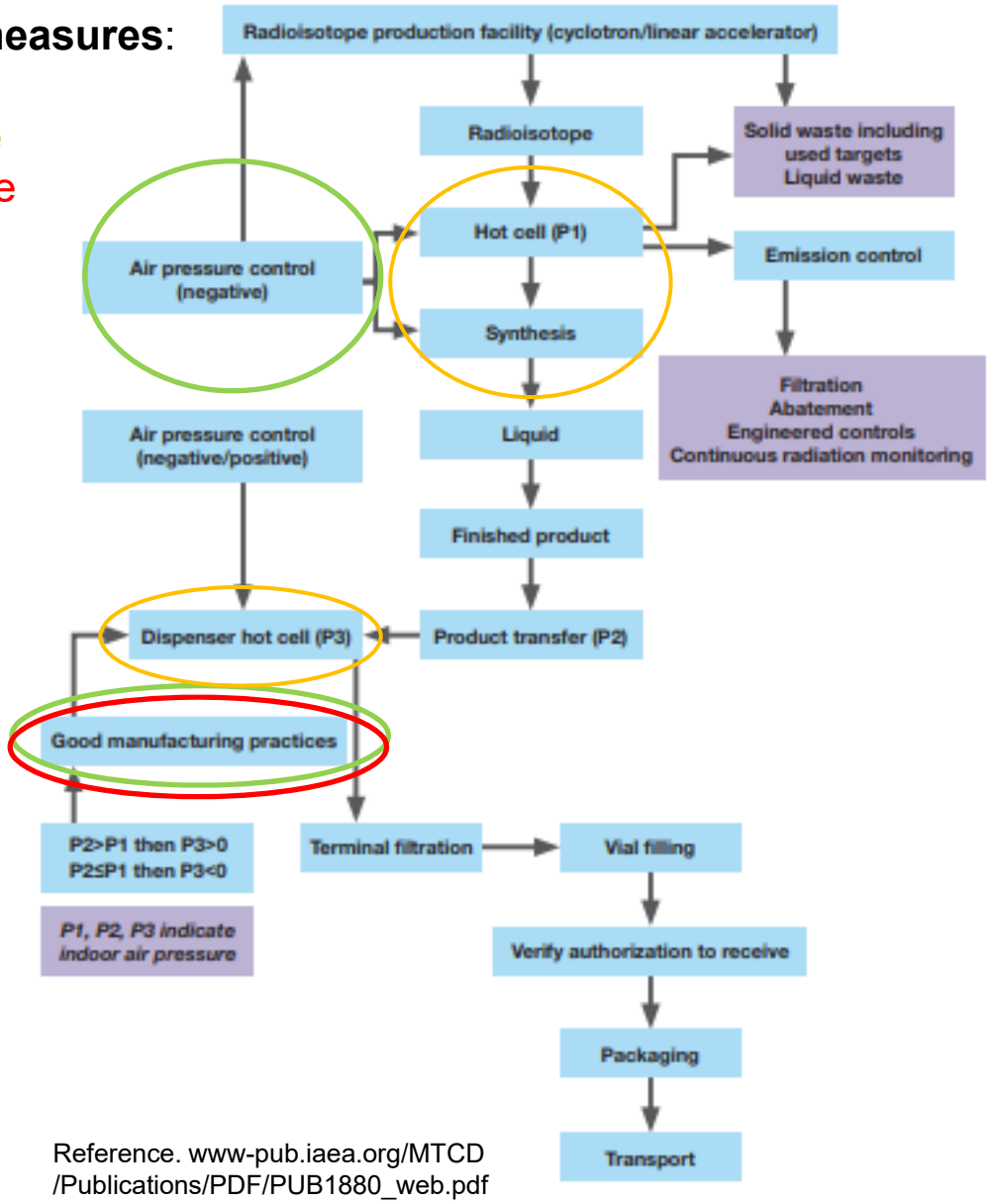
  ⇒ **dedicated work cabinets**

Fume hoods: potential for airborne contamination is high, external dose rates are low
Hot Cells: also high external dose rates

Photo's:
@Comecer
@UZ Leuven

Risk reducing measures:

Internal exposure
External exposure



Reference. www-pub.iaea.org/MTCD /Publications/PDF/PUB1880_web.pdf

FIG. 2. Key areas of radiation risk associated with a radioisotope production facility.

Air-tight cells
Air Renewals

Shielded cells - interlock
Handling using remote tools such as tongs or robotic manipulators, if chemical process is not fully automated.

Shielded cells - interlock
Handling using remote tools such as tongs, tweezers, shielded dispensing containers

Automatic dispensing

Challenges for health physics

Radiation protection of the medical staff

Minimize the occupational dose through justification, optimization and safe practice in the use of new diagnostic and therapeutic radiopharmaceuticals

A higher occupational risk due to:

1) Manipulation of high amounts of activity (GBq level)
   - Radionuclide therapy ⇒ during synthesis and administration
   - Production of diagnostic tracers ⇒ during synthesis and dispensing

2) Type of emitters used in new radiopharmaceuticals
   - alpha-emitters: Ra-223, Ra-224, Bi-213, At-211,Ac-225…
   - high energy beta-emitters: Zr-89, Y-90 , Ho-166, Re-186,…

Radionuclide	Therapeutic emission	Approximate emission range in tissue (mm)	Radionuclide half-life
Yttrium-90	β-	5.30	64.1 hours
Iodine-131	β-	0.8	8.0 days
Samarium-153	β-	0.4	46.5 hours
Lutetium-177	β-	0.62	6.6 days
Astatine-211	α	0.05	7.2 hours
Lead-212/bismuth-212	β-/α	<0.1/0.05	10.6 hours/1.0 hours
Radium-223	α	0.05–0.08	11.4 days
Actinium-225	α	0.05–0.08	10.0 days
Thorium-227	α	0.05–0.08	18.7 days

Beta-emitters in close proximity to skin surfaces:

Electronic dosimeters should be used in radioisotope production, involving potentially hazardous radiation levels.

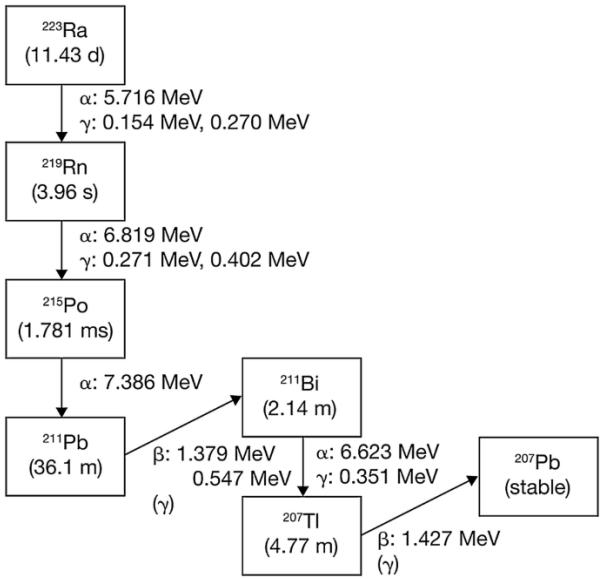
Intake of radionuclides by ingestion or inhalation: monitoring program based on characteristics of the radionuclide

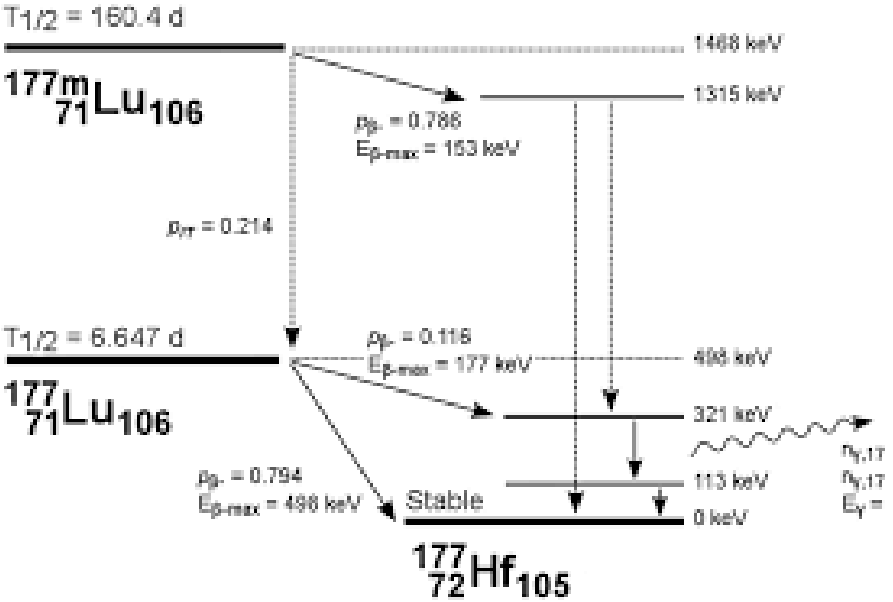
Methods for the assessment of radioisotope intakes: biokinetic modelling, direct in vivo counting, bioassay measurements

Safety guidelines during synthesis and dispensing (recommendations ICRP 106)

Work out protocols for synthesis, dispensing and administration and plan carefully.

- Be aware of all types of emitters that can lead to exposure in the decay scheme!





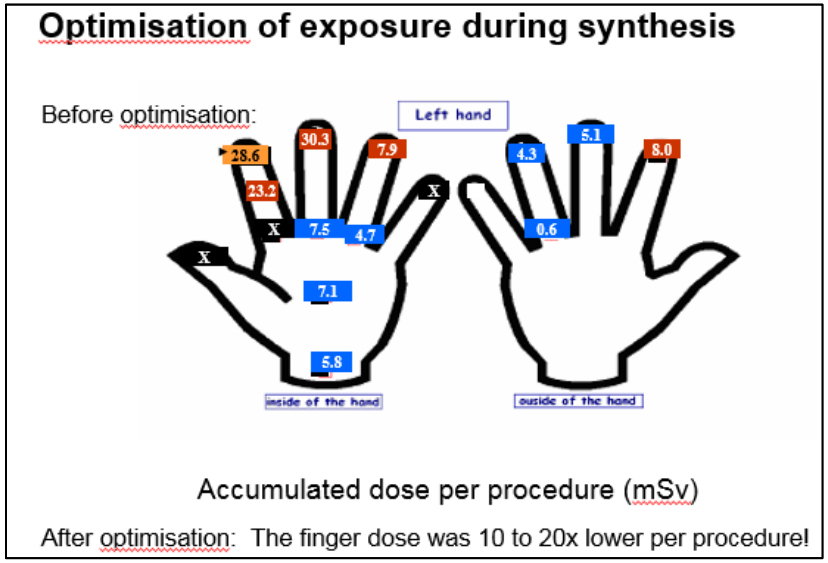
- Foresee a period of intense training to practice manipulations using non-radioactive liquid prior to the RNT synthesis and dispensing.

Safety guidelines during synthesis and dispensing (recommendations ICRP 106)

Use of syringe and vial shielding, tweezers:

Use of dedicated shielded dispensing and administration systems:

SIRT (Y-90)



2015-2020: finger doses of lab technologists preparing RNT < 30 mSv/year

Safety guidelines in RNT hospitalization

© UZ Leuven

Radiation protection instructions and GWP for nursing and other personnel
(cleaning, social services,…)

Radiation protection rules/info specific per radionuclide therapy for patient and visitors during and after hospitalization

Safety guidelines for nursing personnel during hospitalisation of the RNT patient

- Avoid direct contact with excretion products and blood.
- Always use PPE: disposable gloves and coat, if necessary FFP3 mask.
- Washing of hands under a tap when leaving the room.
- Material possibly contaminated does not leave the room (e.g. blood pressure meter, infuse holder, material for patient care..).
- End control of room, linnen, personal belongings patient (glasses, smartphone,…) and radioactive waste by the RPO.
- If possible keep a distance of 0,5-1m from the patient, otherwise limit exposure time (e.g. 30-60min/day): these are general guidance levels and not a strict rule! Depends on which type of RNT is given - Patient care comes first!
- Monitor exposure levels of staff ⇒ dosimetry and contamination control

Current challenges in RNT?

- New radiopharmaceuticals are extensively tested in (clinical) trials
  extra sampling of blood, urine,…of the patient
  extra pre-testing with phantom studies

- New radiopharmaceuticals may **contain long-lived impurities** ⇒ safe disposal of the radioactive waste and excretions of the patient

- New applications, therapies and equipment can **appear in clinical practice before solid evidence** over their **clinical benefits and the risks** they imply is fully established

- The **regulatory framework is on a national base**, but most **RNT start as international multicenter clinical trials!**

The rapid technological development within medical applications is challenging

How to face (future) challenges in RNT?

Professionals working in the field need a forum where they can meet and discuss multiple aspects of radiation protection

Strengthen radiation safety culture in health care

Need for harmonization

⇒ *Define standards between competent authorities, professionals and manufacturers*

Engage in multidisciplinary involvement of medical staff, health physics, medical physicists, occupational physicians, manufacturers of radiopharmaceuticals,…