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CENTRO DE CIÊNCIAS E TECNOLOGIAS NUCLEARES

Quality and Safety of Patient Healthcare and Personalized Medicine Using Ionizing Radiation

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encontro CIÊNCIA '18

ENCONTRO COM A CIÊNCIA E TECNOLOGIA EM PORTUGAL

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Centro de Congressos de Lisboa

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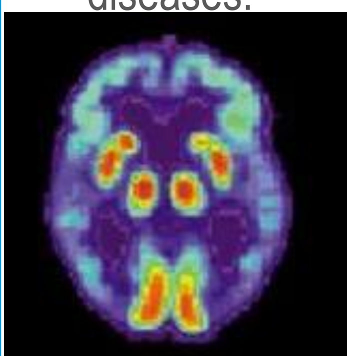
SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD

3 GOOD HEALTH AND WELL-BEING

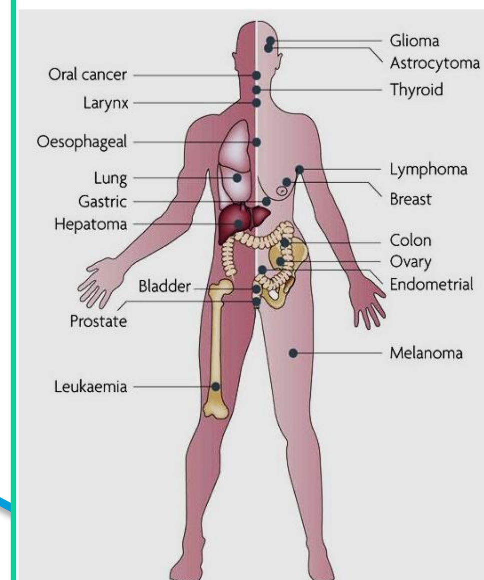
By 2030, reduce by one third premature mortality from non-communicable diseases (NCD) through prevention and treatment and promote mental health and wellbeing.

Cardiovascular diseases:

Neurodegenerative diseases:



Cancer:

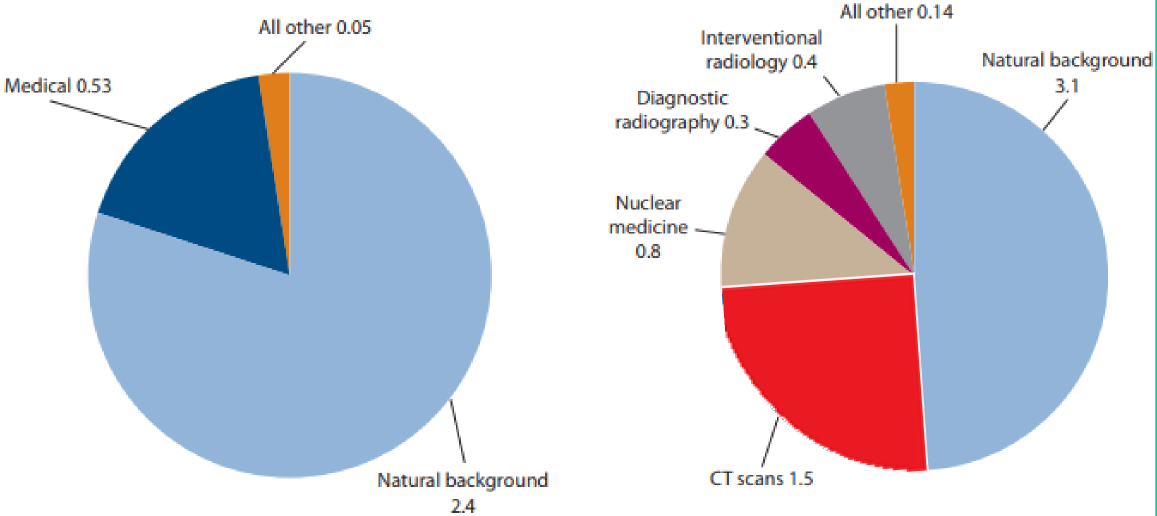


Ionizing radiation (IR) is used to diagnose and treat

But undue exposures to IR can translate into harmful and detrimental effects to the human health!

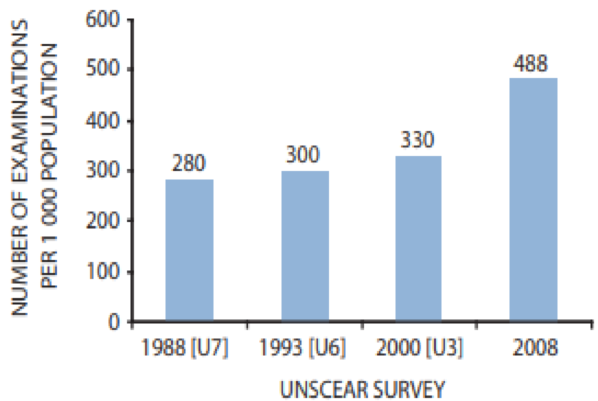
Exposures from medical settings

- Concerns regarding radiation exposures from medical settings:
  – great contribution to the increase of the total population dose and the associated cancer, cardiovascular, cerebrovascular and cataracts´ risks:



Source: UNSCEAR, Medical radiation exposures Report, Annex A, 2008

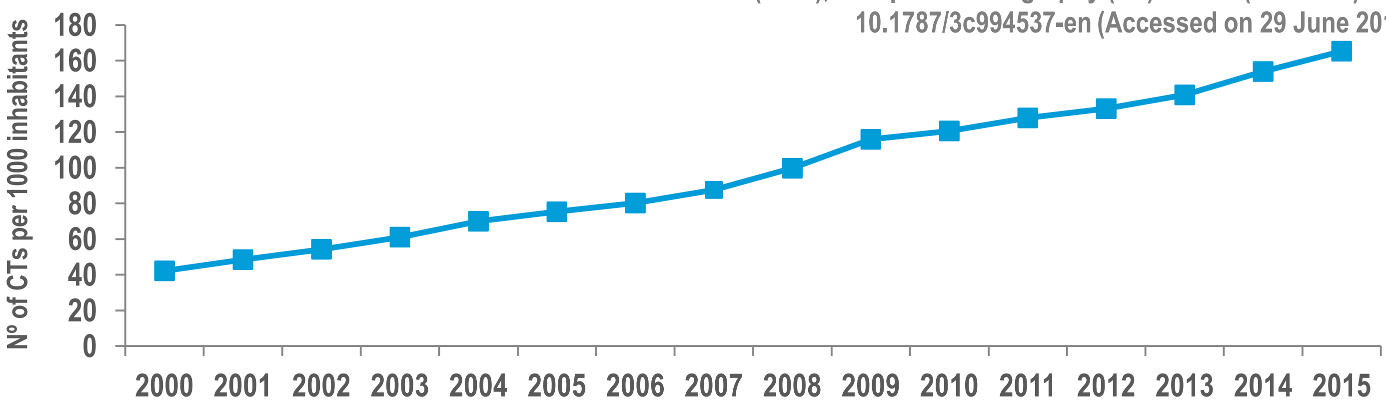
Trend in the annual frequency of diagnostic medical radiological examinations:



In Portugal

Computed tomography (CT) exams, in hospitals, per 1 000 inhabitants, 2000 – 2015:

Source: OECD (2018), Computed tomography (CT) exams (indicator). doi: 10.1787/3c994537-en (Accessed on 29 June 2018)



Radiation dose

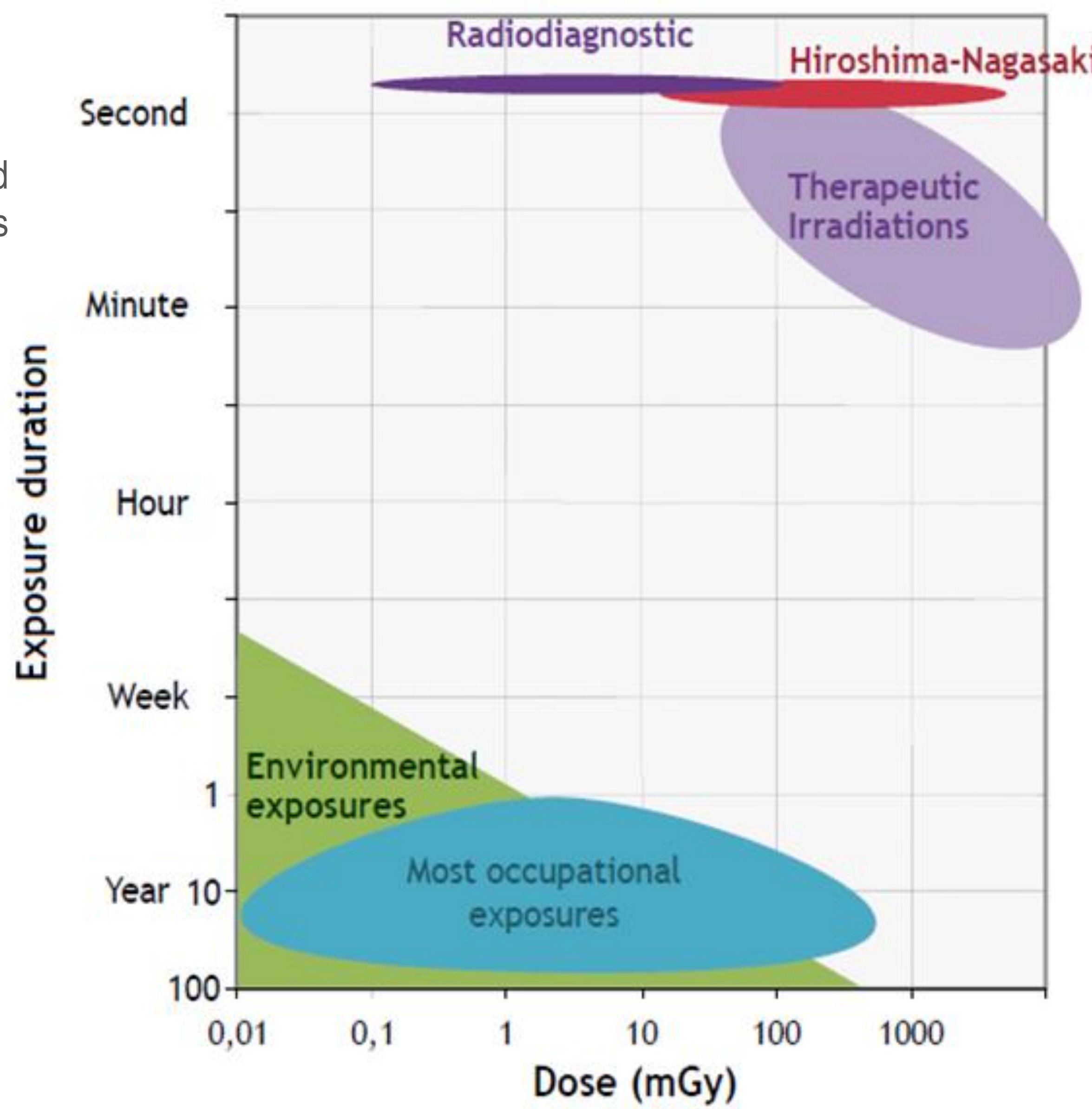
What is the absorbed dose?

The amount of radiation energy absorbed per kilogram of tissue, expressed in units called grays (Gy).

↓

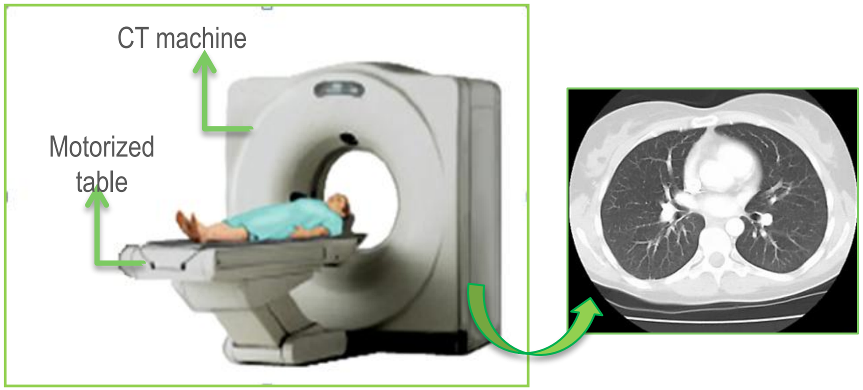
Dose is a surrogate for risk

The assessment of organ doses of health professionals, patients, carers and members of the public is of paramount importance and is a Public Health issue!



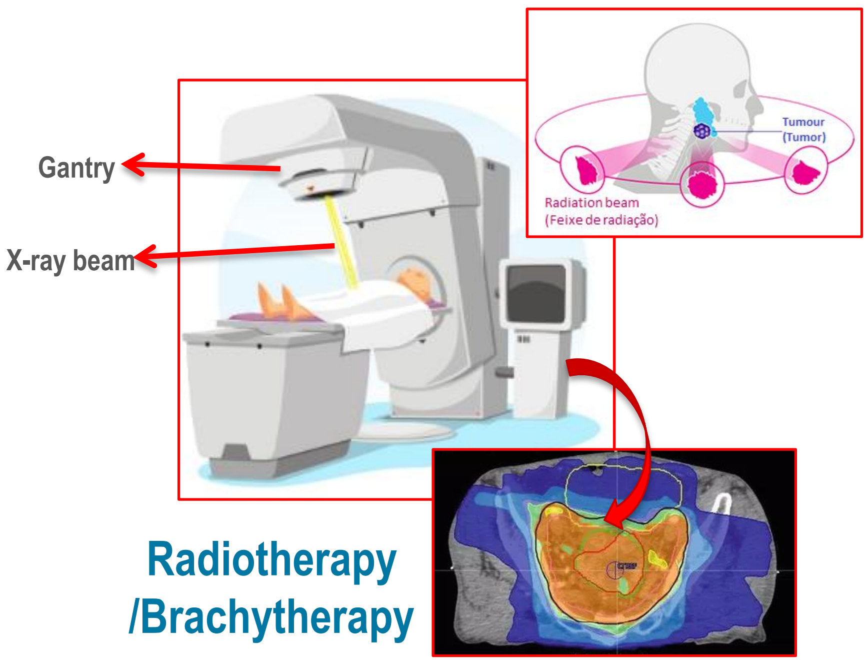
Medical applications of IR

- IR is used in several diagnostic medical imaging procedures and treatments:

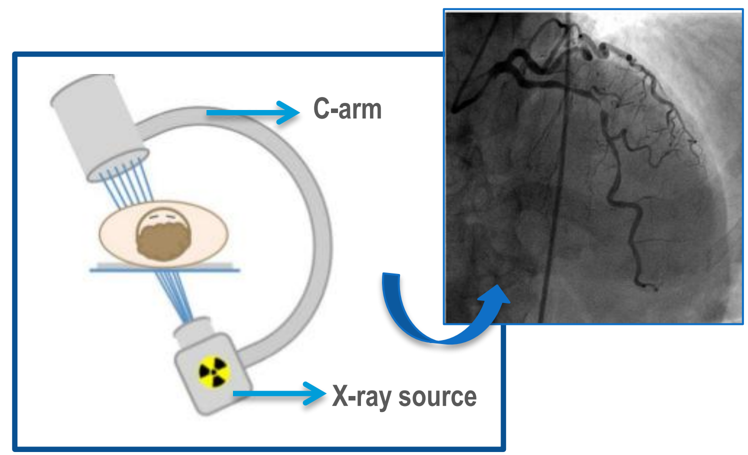


Radiodiagnostic

Nuclear medicine



Radiotherapy /Brachytherapy



Interventional procedures

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At C^{2}TN…

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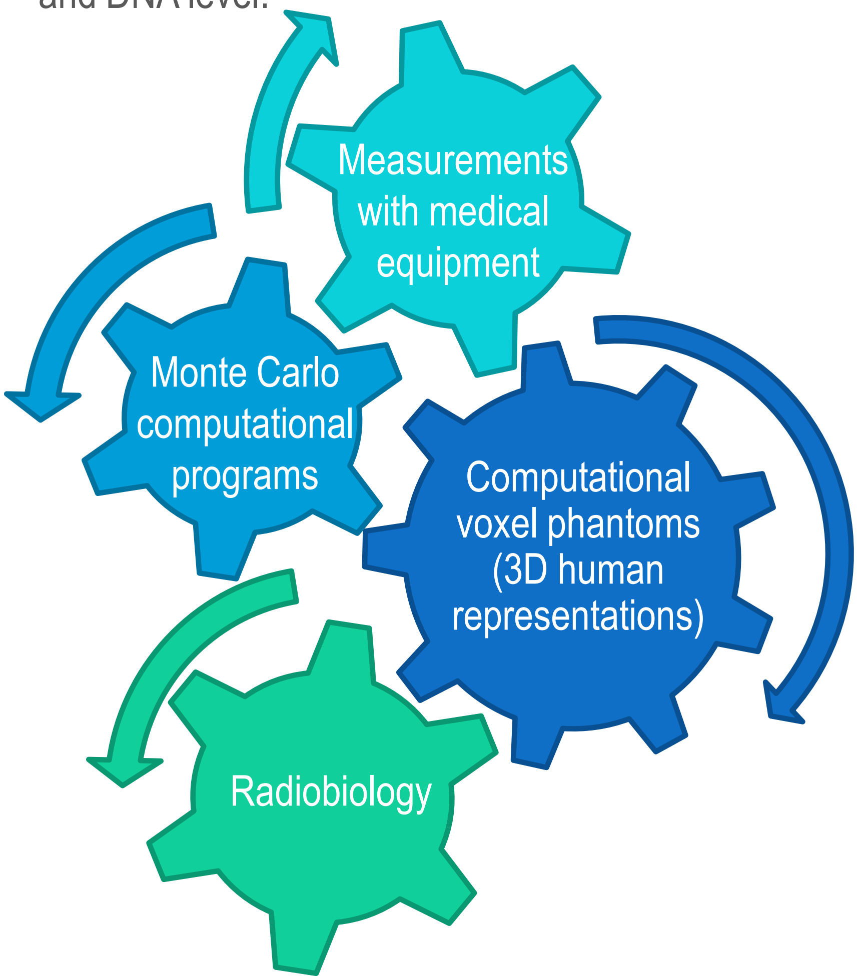
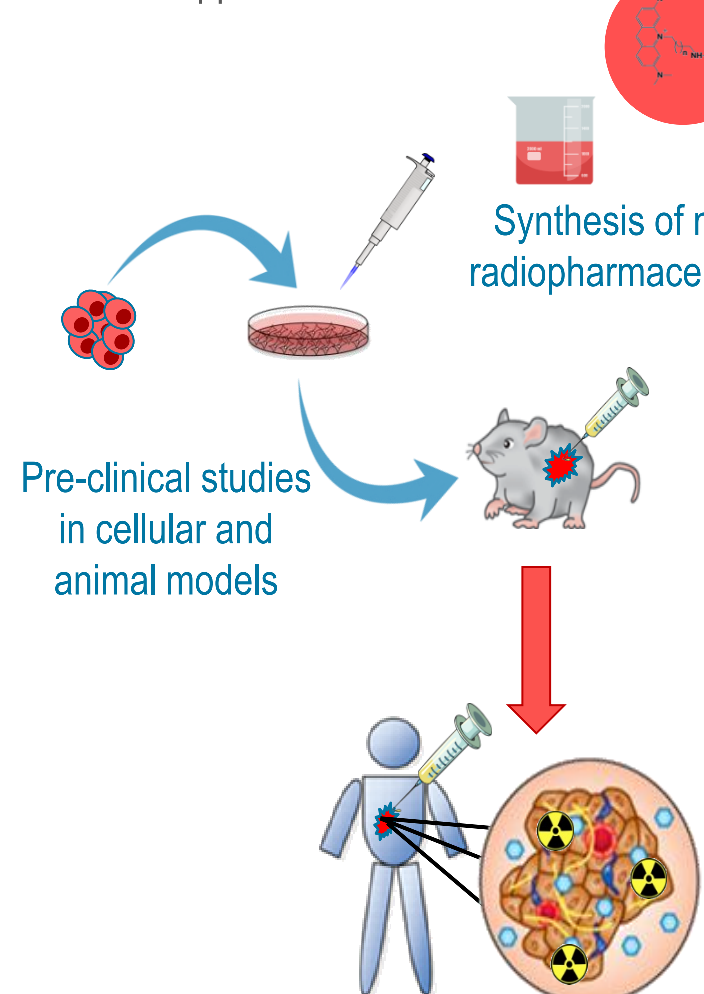
- Dosimetry of medical applications of IR.
- Studies of the implementation of the Justification and Optimization principles (radiation protection of the patient).
- Assessment of the biological effects of IR at the cell and DNA level.



- Development and pre-clinical evaluation of radiopharmaceuticals for nuclear imaging by SPECT or PET or targeted therapy with radionuclides.
- Development of innovative radiopharmaceuticals for theranostic applications.



Radiation protection of the patient and medical staff

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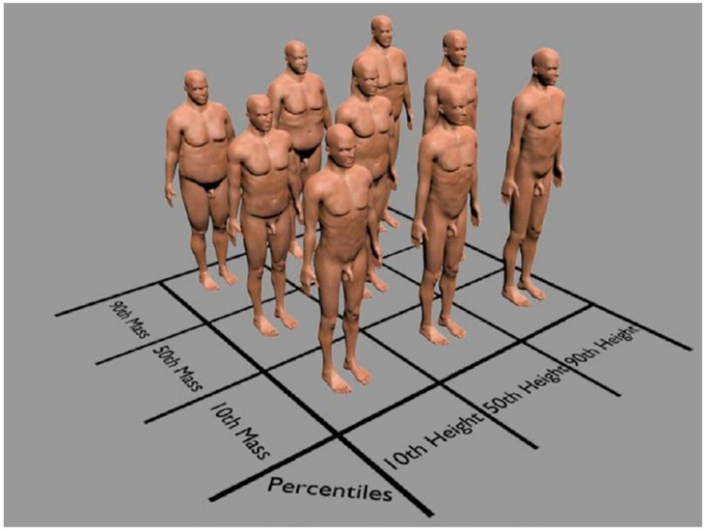
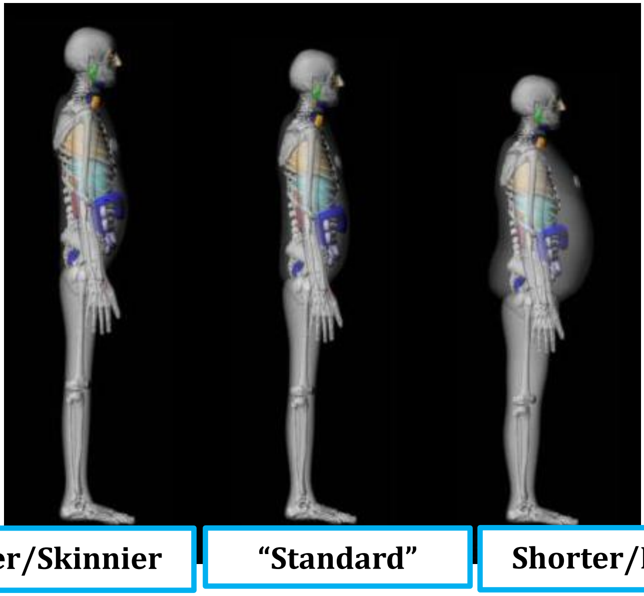
- Dose is calculated for reference individuals, with volumes / organs / masses "standard"
  → Anatomic variability does not exist
- **Patient-dependent Dosimetry**

Accurate assessment of individual organ doses



Patient-dependent (different BMI and morphometries) and patient-specific phantoms



Future: Individual dose and risk assessment for all medical applications (diagnostic and therapy)

- **Interventional cardiology and radiology**
  - The staff (MDs, technicians, nurses, etc.)
    - Assessment of the exposure of the: Lens of the eye, thyroid, extremities
    - Optimization of the protection: Effectiveness of the protective equipment (shields, lead aprons, goggles, thyroid collars, etc.) in dose reduction
  - The patient (tissue reactions due to overexposures)

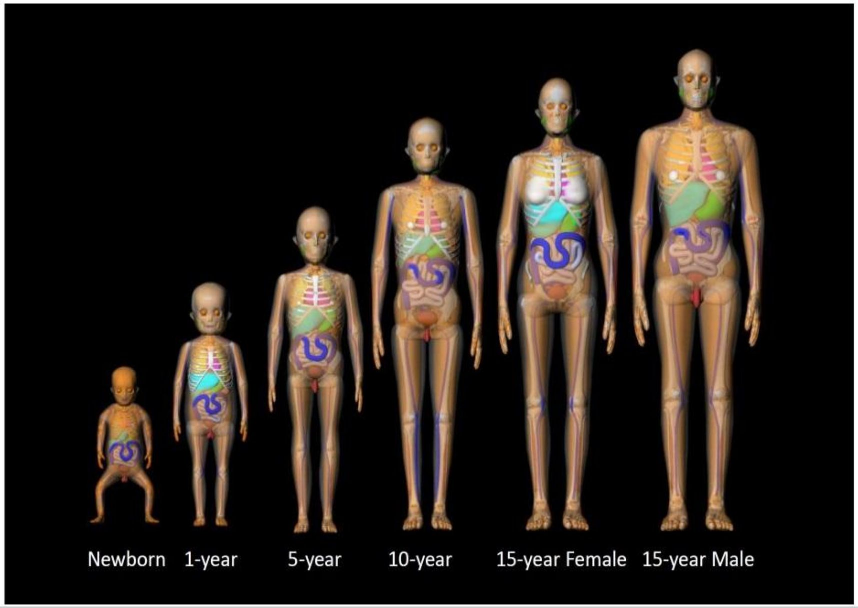
Pediatric Exposures

Children are of special concern in radiation protection:

- Higher radiation sensitivity.
- Longer life expectancy.
- Identical settings provide higher organ doses than in adults – need to optimize acquisition protocols.

High organ doses may increase the risk of radiation-induced cancer in later life.

Risk assessment of pediatric CT exposures:



Use of pediatric phantoms (ICRP family)

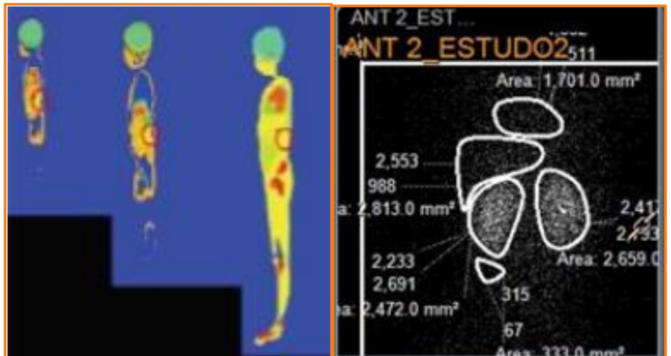
Improve the estimates of amount of radiopharmaceuticals to be administered in Nuclear Medicine procedures:

Mathematical modeling of radiopharmaceutical's behavior within the human body - bio-distribution of in the different organs (biokinetic models).

Need to development of new biokinetic models adapted for pediatric patients taking into account different weight and height

Summary

- C2TN contribution for the improvement of the Quality and Safety of patient health care:

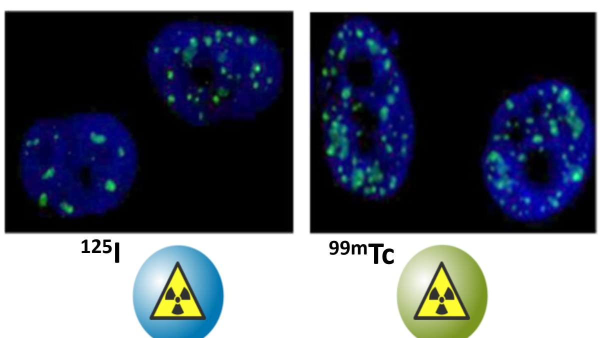


Develop individualized medical diagnostic methodologies with patient dependent and patient specific exams and protocols (personalized medicine)

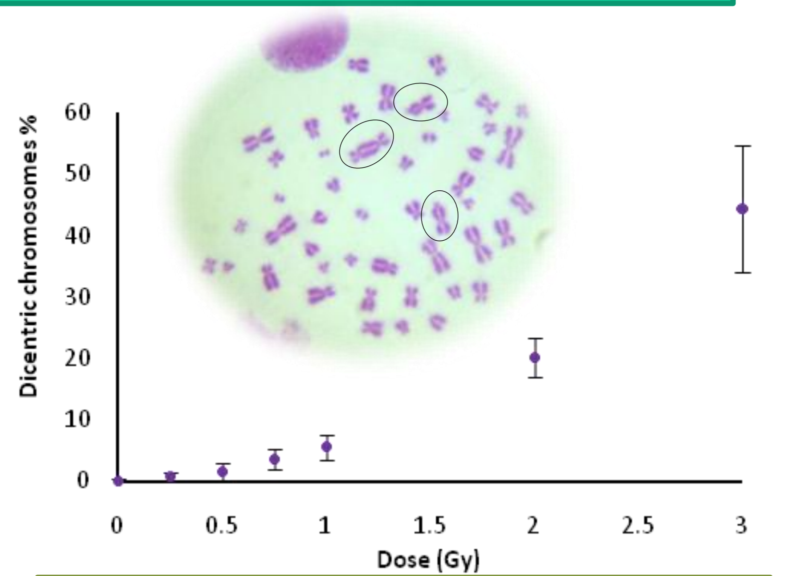
Determine patient's exposure to radiation during medical procedures improving the radiation protection of patient and medical staff.

Quantify the risks associated to low dose and repeated radiation exposures.

Reduce and better deliver the radiation dose involved in medical procedures, decreasing patient morbidity.



Perform the radiobiological evaluation of targeted radiopharmaceuticals for imaging or theranostic applications, including the potential side effects in healthy tissues.



Estimate the biological dose that people have been accidentally exposed

- Some references:

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Thank you for the attention!