

EURADOS Webinar: Release of the nuclear medicine patient in Europe: from basics to a computational approach

A Joint EURADOS-EANM initiative

Clinical experience and needs in radiopharmaceutical therapy

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Release of the nuclear medicine patient in Europe: Clinical experience and needs in radiopharmaceutical therapy

Diagnostic and therapeutic applications in nuclear medicine are inherently related to radiation exposure to health workers, patients and public.

This radiation exposure should be kept as low as reasonably achievable (ALARA) by:

- justification and optimization of the procedures
- Training and education of the health workers
- adapted communication with the patients and their relatives.

However, nuclear medicine covers besides the (radiation) related risks, also other aspects such as:

- the potential clinical benefit
- diagnostic and therapeutic alternatives
- prognosis
- adverse events and quality of life.
- importance to ensure global access to new theranostic approaches.

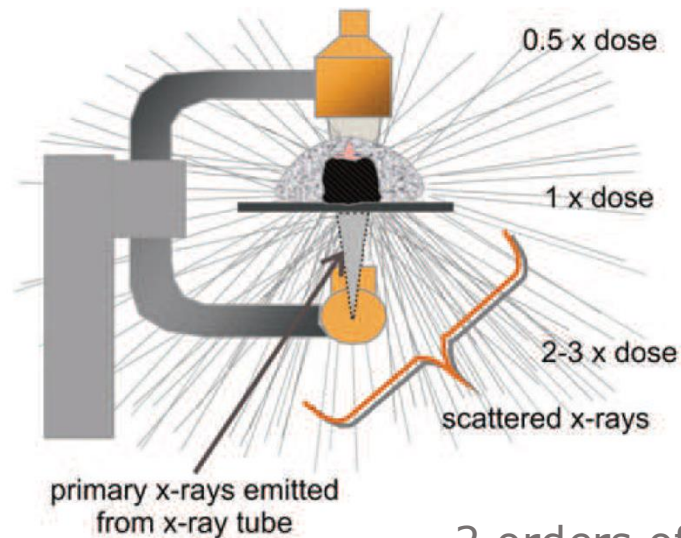
Release of the nuclear medicine patient in Europe: Clinical experience and needs in radiopharmaceutical therapy

Exposure pathways

- External exposure risk (photons)
 - Always present
 - Typically: 5-20 $\mu\text{Sv/h}$ at 1m of patient
 - Order of magnitude cumulated exposure defined by time, distance and frequency
- Contamination risk (electrons, photons)
 - Presence defined by nature of work
 - Should be avoided through hygienic measures

Occupational radiation exposure in nuclear medicine

Radiology

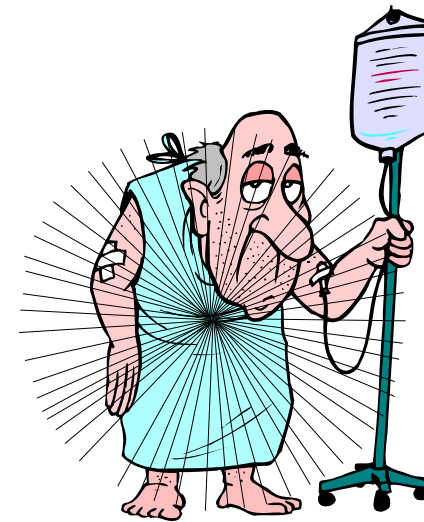


2 orders of magnitude!!

Dose rate 1 m ~ 1 mSv/h

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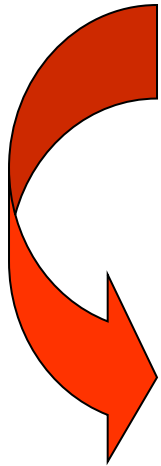
Nuclear Medicine



Dose rate 1 m ~ 10 μ Sv/h

Risk assessment through dosimetry studies

**Radiation exposure caused
by the discharged nuclear
medicine patient?**



Among staff in critical wards

During ultrasonography

Mapping very low level occupational exposure in medical imaging: A useful tool in risk communication and decision making

P. Covens et al, Eur J Radiol. 2012 Sep;81(9):e962-6.

Objectives:

The residual exposure through shielding or the exposure of discharged nuclear medicine patients are often questioned by health workers.

The aim is to provide detailed assessment that should give more information about the impact on the individual radiation dose.

Methods:

Cumulated radiation exposure was measured in a university hospital during a period of 6 months by means of thermoluminescent dosimeters at background locations and at locations where enhanced exposure levels are expected but where the impact on the individual exposure is unclear.



**Radiation exposure caused
by the discharged nuclear
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Among staff in critical wards

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Mapping very low level occupational exposure in medical imaging: A useful tool in risk communication and decision making

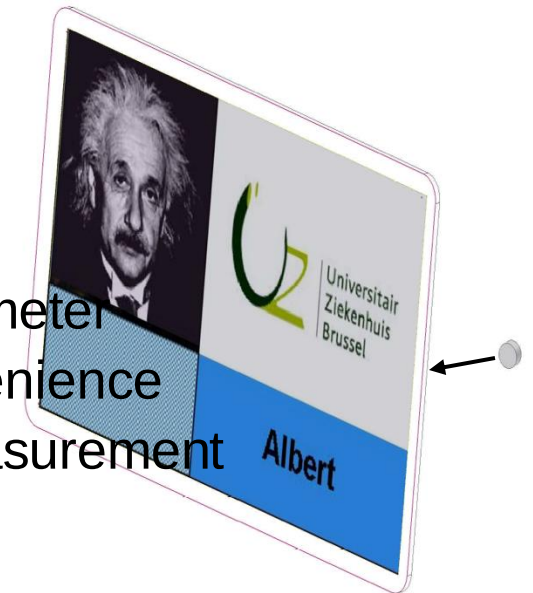
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General concept of the dosimetry study

- Measure the cumulated radiation dose
- Long measuring period of 6 months (increase statistics)
- Measure representative background
- Record patient data (nuclear medicine procedure, specific ward, complementary examination)

Ward staff radiation dose assessment

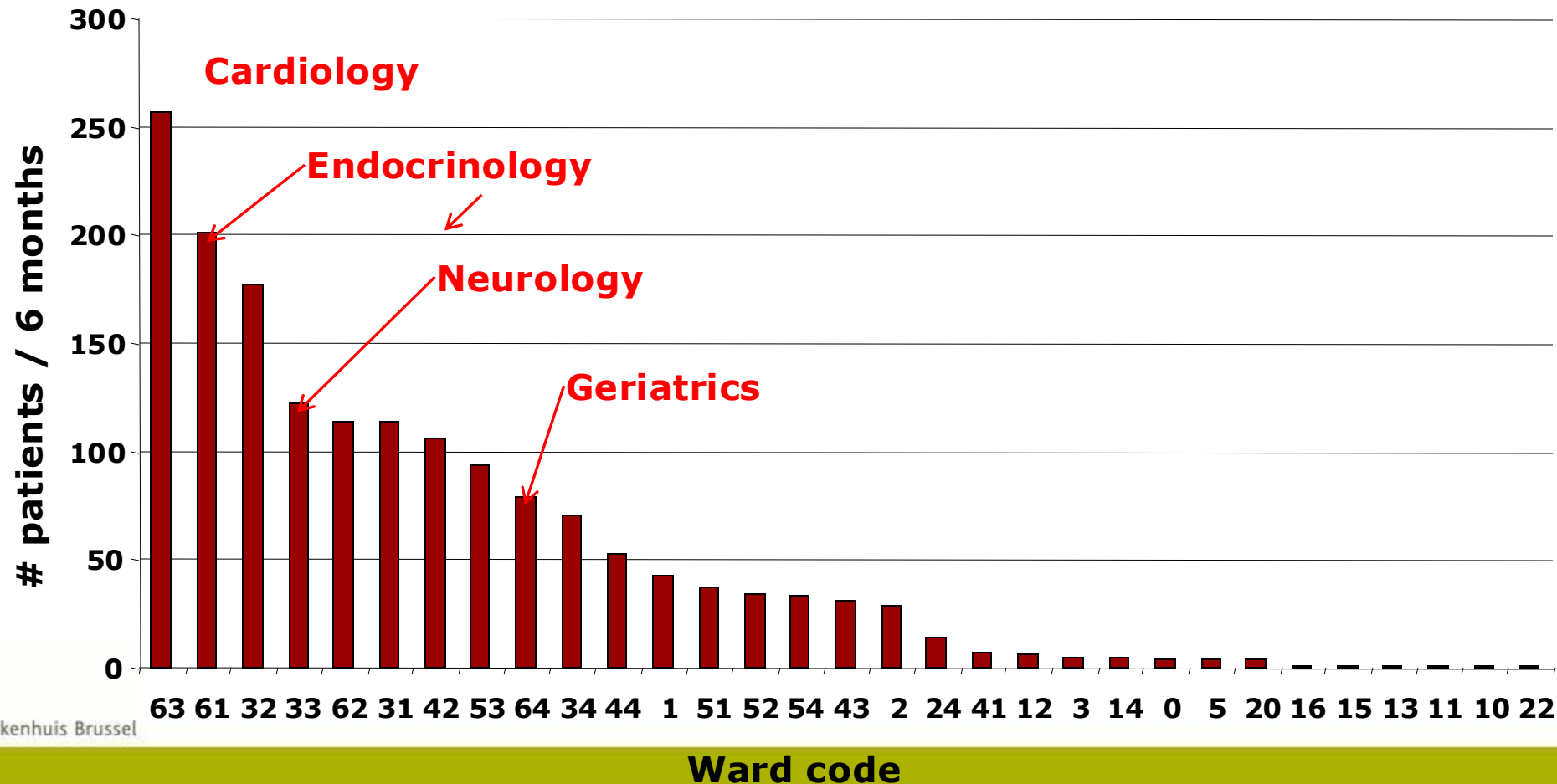
- Direct measurement of radiation dose 70 staff members (nurses, logistic staff, paramedics,...)
- Transformed hospital badge
 - Integrated dosimeter
 - No extra inconvenience
 - Sustainable measurement



Mapping very low level occupational exposure in medical imaging: A useful tool in risk communication and decision making

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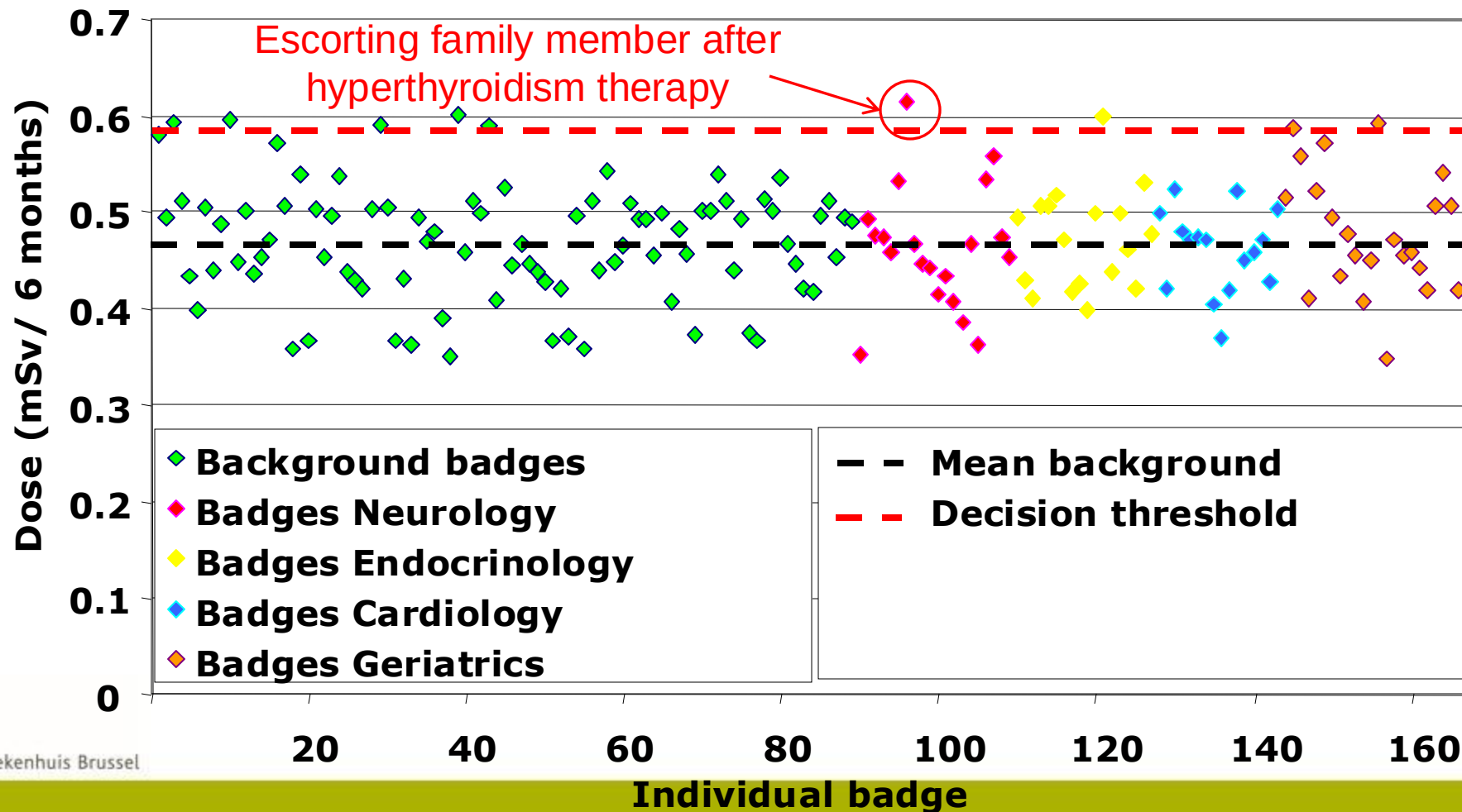
Results: number of nuclear medicine patients / ward



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Results: radiation dose measurements ward staff



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Ultrasonographers radiation exposure
from discharged nuclear medicine
patients

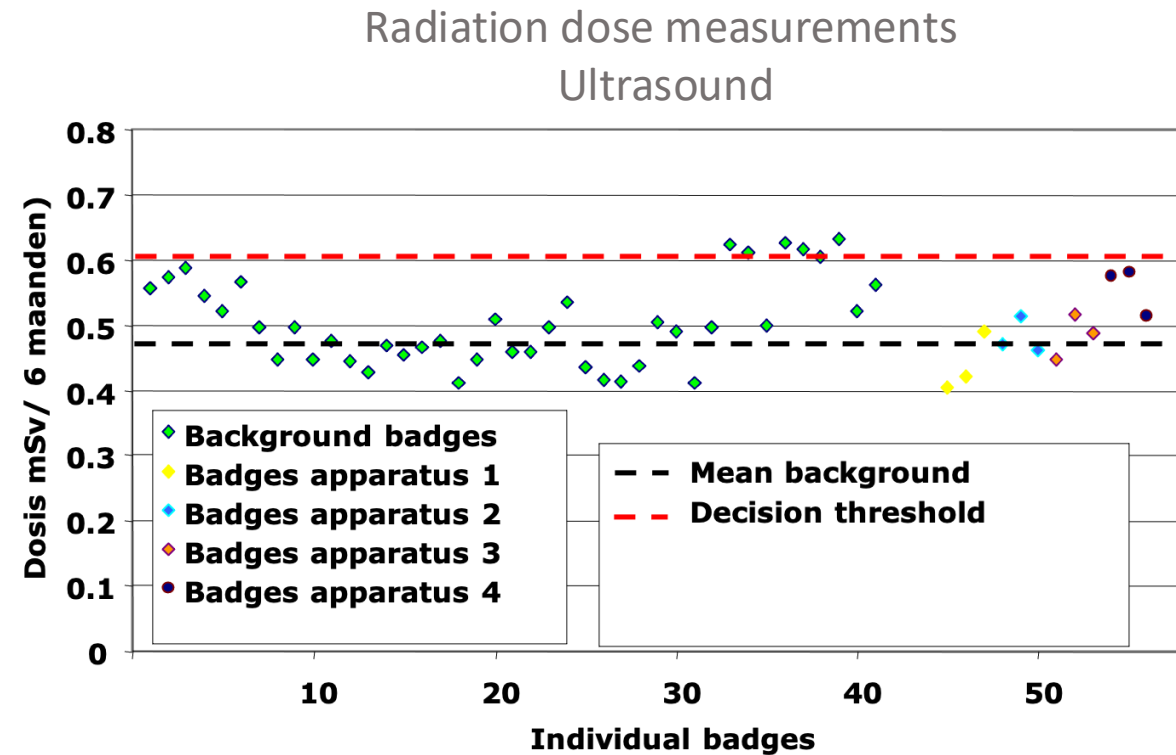
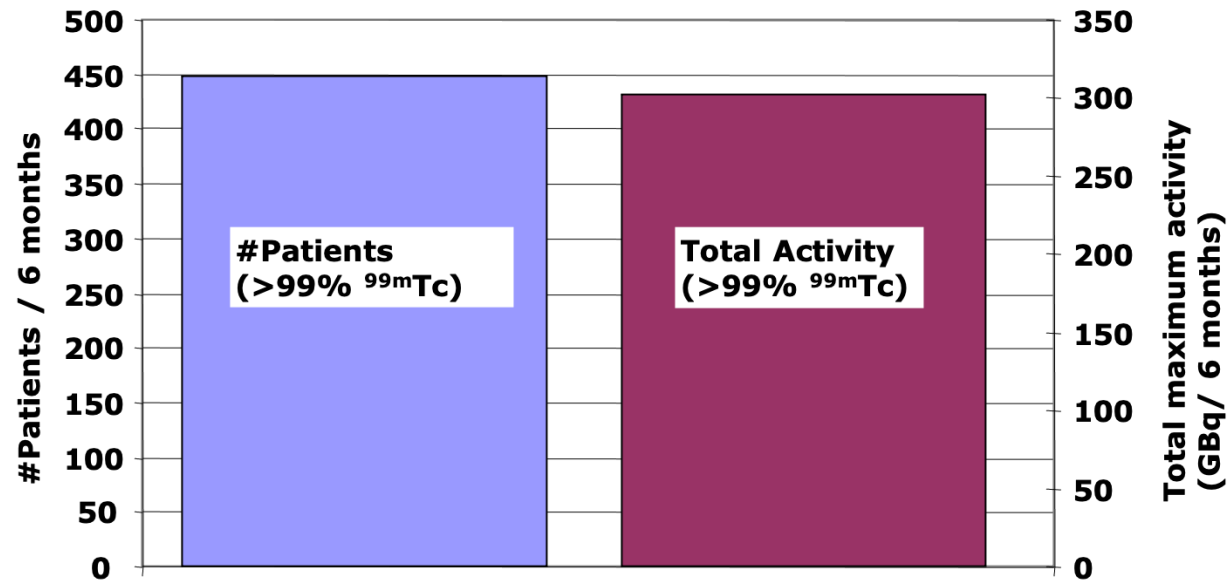
- No Individual measurement of radiation dose
- Dosimeters on apparatus
 - Set of 3 pieces
 - Close to bed
 - Overestimation individual workload!
- 4 ultrasonography apparatus



Mapping very low level occupational exposure in medical imaging: A useful tool in risk communication and decision making

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Only patients undergoing a nuclear medicine procedure and ultrasonography procedure during the same day!



- No enhanced cumulated radiation exposure which significantly differs from this background level could be found during ultrasonography procedures among nuclear medicine patients.
- Example on how translational/observational research can be helpful in both risk communication and decision making.

Mapping very low level occupational exposure in medical imaging: A useful tool in risk communication and decision making

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Caveats... & Pitfalls...

- Contaminations?
 - Not assessed in these studies
- Should be limited by hygienic measures
- Therapeutic procedures?
 - Not present during patient follow-up in wards/ultrasonography
 - Should have separate attention!

Occupational radiation exposure in radionuclide therapy

Dose rates for ^{177}Lu -PSMA & -DOTATATE

- Against transportation packaging / container: $< 1 \mu\text{Sv/h}$
- Against vial (7,4 GBq) in beta-shielding:
 - Side: $10 \mu\text{Sv/h}$
 - Upper side: $35 \mu\text{Sv/h}$
- Behind the screen: $< 1 \mu\text{Sv/h}$ (place of the operator)
- Against the lead shielded syringe:
 - Side: $150 - 200 \mu\text{Sv/h}$
- Against transport case with shielded syringe: $2 \mu\text{Sv/h}$
- During administration behind an automatic syringe pump:
 - Behind a lead screen: $1-2 \mu\text{Sv/h}$
- Immediately after administration:
 - 1 m from the patient: $50 \mu\text{Sv/h}$
 - 2 m from the patient: $2-3 \mu\text{Sv/h}$
- The next day at discharge: $3-20 \mu\text{Sv/h}$ at 1 m



Dosimetry of nurses radionuclide therapy rooms (^{131}I & ^{177}Lu)

2-4 patients / week

dosimeter	hp10	hp0.07	5/2024	4/2024	3/2024	2/2024	12+1/2024	11/2023	10/2023	9/2023	7+8/2023	6/2023	5/2023
G03	0.19	0.23		0.08	0	0	0	0	0	0	(0.11)	0	0
G06	0.18	0.19		0	0.05	0	0.08	0	0.05	0	0	0	0
G15	0.17	0.17		0	0	0	0	0	0	0	0.08	0	0.09
G24	0.14	0.15		M	0	0	0	0	0	0.08	0.06	0	0
G05	0.11	0.13		0	0	0	0.11	0	0	0	0	0	0
G11	0.1	0.1		0	0	0	0	0	0	0.1	0	0	0
G17	0.1	0.1		0	0	0	0	0	0.1	0			
G02	0.08	0.08		0	0	0.08	0	0	0	0	0	0	0
G08	0.06	0.06		0	0.06	0	0	0	0	0	0	0	0
G22	0.06	0.06		0	0	0	0	0	0	0.06	0	0	0
G10	0.06	0.06		0	0	0	0	0	0.06	0			
G21	0.06	0.06		M	0	0	0	0	0	0	0	0	0.06
G13	0.05	0.05		M	0	0	0	0.05	0	0	0	0	0
G14	0.05	0.05		M	0	0	0.05	0	0	0	0	0	0
G26	0	0		0	0								
G09	0	0		0	0	0	0	0	0	0	0	0	0
G25	0	0		0	0	0	0						
G12	0	0		0	0	0	0	0	0	0	0	0	0
G23	0	0		0	0	0	0	0	0	0	0	0	0
G20	0	0		0	0	0	0	0	0	0	0	0	0
G07	0	0		0	0	0	0	0	0	0			
G04				0	0	0	0	0	0	0	0	0	0

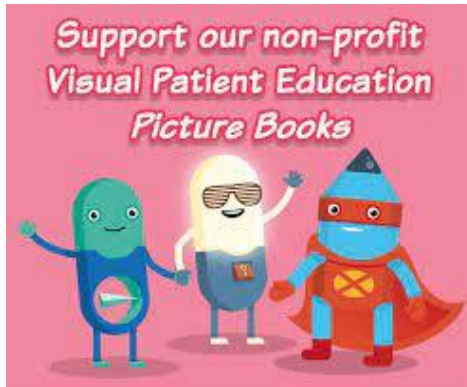
0.20 mSv = **1%** of the legal dose limit / year (20 mSv)

It's all about (risk) communication

Different approaches in function of:

Patient population:

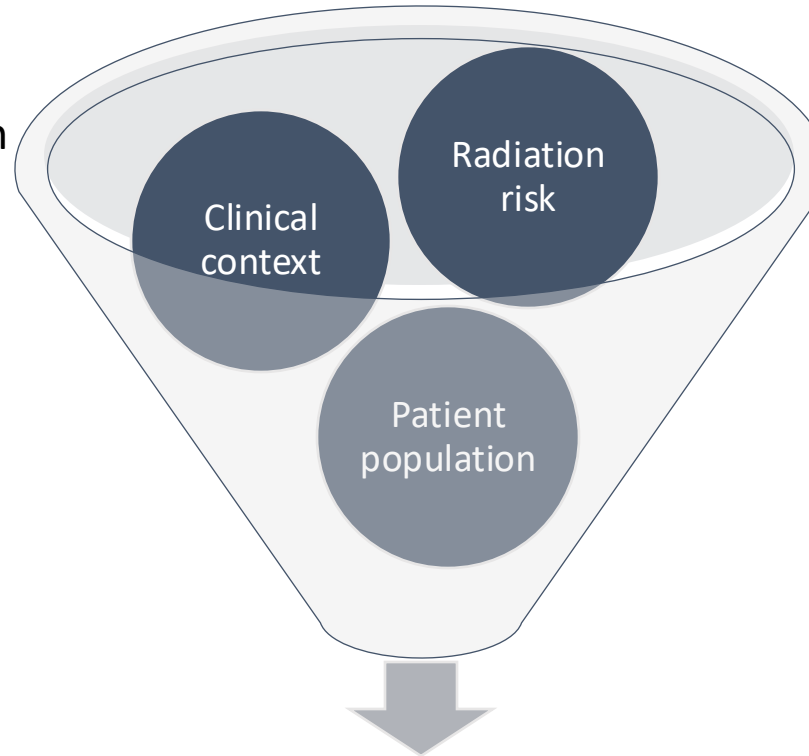
- ✓ patient background
- ✓ education
- ✓ general misinformation about radiation
- ✓ age



Ronald van Rheenen, UMCG
<https://www.facebook.com/sunnyandtim/>

Clinical context:

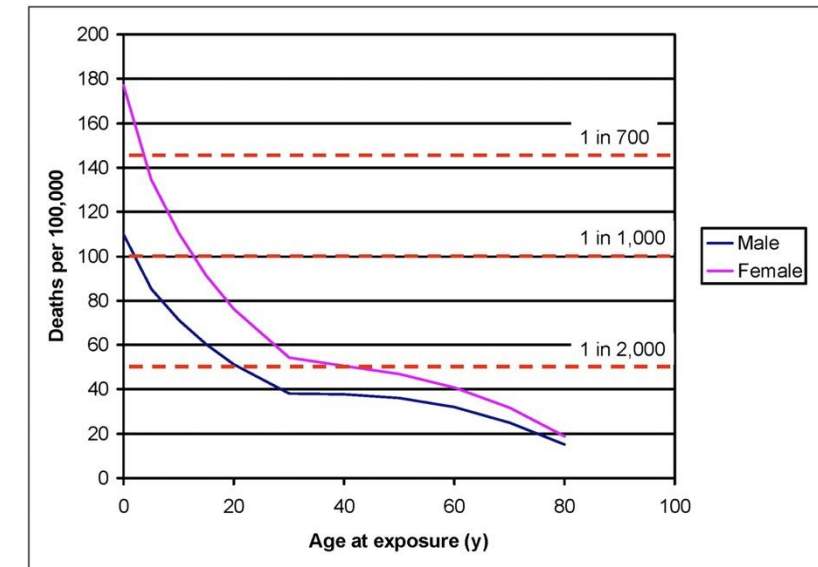
- risk versus benefit
- risk of not performing the examination



Adapted communication
Combination of written & verbal information

Radiation risk:

- Radiation dose
- Gender
- Age



Lifetime attributable risk of cancer death as function of age at time of exposure and sex resulting from 10-mSv exposure.

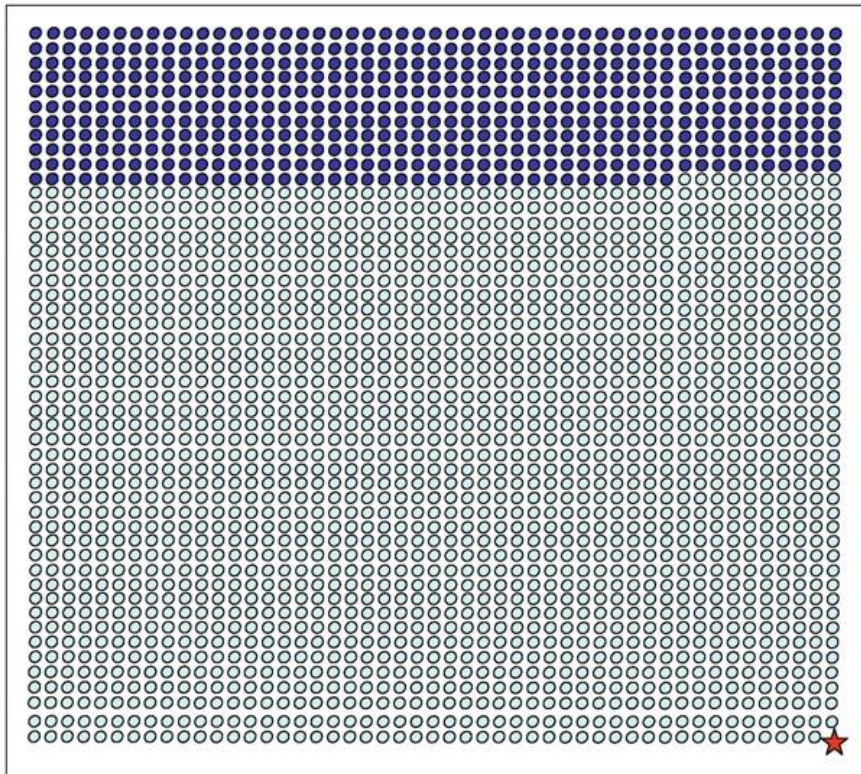


Patient-tailored communication in Nuclear Medicine

Different ways to communicate the same message

- Non-quantitative approach: e.g. comparison with other radiologic tests and natural background radiation.
- Relative risk: e.g. comparison of the cancer risk associated with radiation exposure to the natural risk of cancer.
- Lifetime risk: e.g. the risk associated with radiation from medical imaging to other lifetime risks.

Demonstration of 1 in 2,500 risk in comparison to 550 in 2,500.



Lifetime Risk of Death from Everyday Activities in the U.S.

Activity	Lifetime risk
Assault	214
Accident while riding in car	304
Accident as pedestrian	652
Choking	894
Accidental poisoning	1,030
Drowning	1,127
Exposure to fire or smoke	1,181
Cancer from ^{18}F -FDG PET scan (10-y-old)	1,515
Falling down stairs	2,024
Cancer from $^{99\text{m}}\text{Tc}$ -MDP bone scan (10-y-old)	2,560
Cancer from ^{18}F -FDG PET scan (40-y-old)	2,700

Release of the nuclear medicine patient in Europe: Guidelines

EANM Technologist's Guides:

- Radiation Protection and Dose optimisation (2016)
- Radionuclide Therapy Management (2022)

Radionuclide therapy procedure guidelines:

Joint EANM/SNMMI procedure guideline for the use of ^{177}Lu -labeled PSMA-targeted radioligand-therapy (^{177}Lu -PSMA-RLT)

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