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# Information and radiation protection for all healthcare practitioners, to some extent involved in the care for nuclear medicine patients - Superior Health Council, publication 8277

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Continuing education, FANC, Nov 10, 2017

<https://www.health.belgium.be/fr/conseil-superieur-de-la-sante?keyword=8277>

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# Objectives of the report

- To provide comprehensive and simple guidance to all health care practitioners involved to some extent with the care of Nuclear Medicine patients
- To propose scientific background for reasonable behaviours with those patients
- To stimulate the use of standardized approaches through work packages dedicated to every interest group (fiches)

# Nuclear Medicine for what?



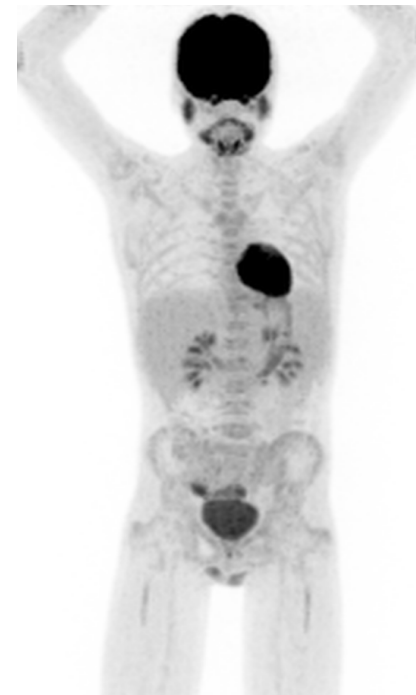
baseline

→  
LMB 2001



iPET

→  
R-CYVE



iPET\*

# Legal framework

- RD 2001
  - Art. 53.2: aims at protection of the patient
  - Art. 25: more important here, aims at the protection of the worker
    - Protection at work
    - Protection of pregnant staff (declaration)
    - Yearly training and education
  - However, remains vague as to what has to be implemented and by whom: EXPLOITANT
  - The role of the occupational physician is essential, in cooperation with local responsible(s) and physical control

# Concerned groups

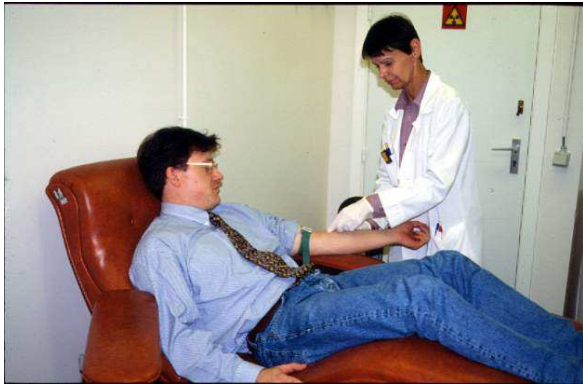
- Staff in Nuclear Medicine
  - Physician
  - Nurses and technologists
  - Other staff (administration, front office, physicists, **radiopharmacists**...)
- Staff on wards
- Staff in other medico-technical departments (eg. radiology, cardiology, endoscopy, laboratory,...)
- Patient transport (carts or volunteers)
- Cleaning services
- External workers: electricians, plumbers, maintenance technicians, controllers....

# Definition and nature of the risk(s)

- External exposure
  - Contact with unsealed sources for preparation of radiopharmaceuticals
  - Contact with unsealed sources for administration to patients (mainly iv.)
  - Contact with injected patients for performing imaging
  - Contact with wastes and patients' excreta
  - All other contacts with patients
- Internal exposure (contamination)
  - Internal contamination
  - External contamination (radiopharmacy, patient handling, excreta,...)

New exposures: CT-scan with hybrid imaging, therapy with high  $\beta^-$  activities or alphas

# Definition and nature of the risk(s)





# Definition and nature of the risk(s)



# Risk probability

- Within NM Depts, risks remain very low, ie.
  - Minor skin contaminations (gloves!)
  - Unexpected prolonged contact with therapy patient (accident, resuscitation,...)
  - Room contamination and closure/exclusion....
- Incidents/accidents may occur but are very rare eg.
  - Major external contamination (skin, eyes, ...)
  - Inhalation of  $^{125}\text{I}$  (only in research laboratories nowadays)
  - Exception for cyclotrons and reactors workers (out of the scope)

# Pillars of radiation protection for HCP/patients

- Justification
  - *What has not to be done should not be done*
- Optimization (ALARA)
  - *What has to be done should be done properly and with the lowest radiation dose to all involved*
- Dose limits
  - Must be respected (staff vs public; no limits for patients)

# Practicals of radiation protection for HCP

- **T**ime
  - **D**istance
  - **S**hielding
- Common to all procedures, shielding vs patients unrealistic
- **Contamination: specific to unsealed sources**
    - Handling of sources
    - Handling of injectables
    - Handling of wastes

# Basic training – NM professionals

- Education about radiation for the patient (art. 53.2)
  - Pertains to general education of physicians, nurses and technologists – accreditation required (visa + validation of curriculum)
- Education about self-protection (art. 25)
  - Responsibility of the ‘exploitant’, usually covered by
    - Internal RP Dept (Physical Control)
    - External providers
    - Departments self
  - Usually well **understood** but no actual control of what is provided

# Training in radioprotection for staff

- How to protect oneself?
  - Keep in mind distance/time, with highly radioactive patients (therapy)
  - Keep in mind the caring role for the low radioactive patient
  - Avoid any risk of external or internal contamination (gloves for single-use, protective clothes if needed, overshoes, 'do not eat, drink, smoke, make-up' while taking care of patients)
  - Use protective measures such as syringe shielding, lead apron (?), appropriate use of waste sorting, in selected cases, instant-reading dosimeter

# Information for three target groups

- Referring physician
  - Justification and shared responsibility
- Helper
  - *Knowingly* and *willingly* and beyond a professional relationship
- Patient
  - Cost/benefit analysis

Not the responsibility of the occupational physician

Although in multidisciplinary contacts, her/his advice might be useful

# Practical information – external exposure

- Gamma rays: **continuous exposure**
  - From gamma emitters,  $\beta^+$  (annihilation) and  $\beta^-$  emitters (bremsstrahlung)
  - Main sources of whole-body exposure

**Time and distance**

- $\beta^+$  and  $\beta^-$  emitters: main sources of extremity (+eye of lens?) exposure: **intermittent exposure**

**Time and shielding**

- X-rays: **intermittent exposure**
  - New source of exposure due to hybrid imaging (PET-CT and SPECT-CT)

**Distance and shielding**



# Practical information – external exposure

- Dose rate in NM (from patients and sources)

<b>Examen (immédiatement après l'injection)</b>	<b>Activité injectée (MBq)</b>	<b>Débit de dose à 1m au moment de quitter le service (µSv/h)</b>
Scintigraphie osseuse	740	7.5
Examen thyroïdien (Tc-99m)	110	2
Examen rénal (dynamique)	150-185.	4
PET (F-18)	260	21

# Practical information – external exposure

- Dose rate in NM (from patients and sources)

	Débit de dose (mSv/h)
En contact direct avec une seringue contenant 740 MBq (20mCi)	260
En contact direct avec une seringue contenant 740MBq (20mCi avec blindage de 2 mm)	2.6
En contact direct avec une fiole contenant un éluat de 30GBq (810mCi)	2300
A 30cm d'une fiole contenant un éluat de 30GBq (810 mCi)	7.5

(calculé grâce au manuel Delacroix, 2002 [11])

# Practical information – internal exposure

- Remains exceptional but potentially dangerous
  - Contamination with  $^{99m}\text{Tc}$  or  $^{18}\text{F}$  is most probably without consequences
  - Contamination with  $^{125}\text{I}$  and  $^{131}\text{I}$  may lead to significant absorbed doses (up to Grays in the thyroid gland)
  - Minute contamination with  $^{223}\text{Ra}$  can lead to high absorbed doses (L20 200 kBq/ingestion) ie. 2.000 times more than  $^{99m}\text{Tc}$

**Respect rules: use gloves and change them, no food or drinks, no smoking, no make up**

# Practical information – protection measures



# Practical information – protection measures



# Practical information – protection of pregnancy and lactating mothers

- Inconsistency of the Belgian legislation

- RD 20/07/2001 may tolerate 1 mSv/yr including pregnancy to the mother and by extension to the fetus
- RD of 02/05/1995 does not allow a pregnant women to be exposed to chemical, biological and physical risks
- In NM, the whole-body dose may be irrelevant as **contamination may occur!**
- **Therefore prophylactic protection from work is compulsory for pregnant women**
- Max 5-mo breastfeeding period is foreseen (exception for multiple births)

# Practical information – orderly (brancardiers)

- External exposure:  $\sim 0$  (reduce length of transport path)
- Contamination: minimal risk with urine, wounds, vomiting – patient preparation by nursing staff is essential
- Dosimeter: optional
- If anticipated risk: gloves
- If incident: call/ask Nuc med Department

# Practical information –technical services

- External exposure: limited except for US (should ideally be performed before, ALARA!)
- Contamination: minimal risk with urine, wounds, vomiting – patient preparation by nursing staff is essential
- Always wear work clothes
- Gloves for invasive techniques (endoscopy, biopsy, catheterism)
- Collect wastes if appropriate (call NM)
- NM should warn (if possible) the staff for patients with higher risk ( $^{131}\text{I}$ ,  $^{223}\text{Ra}$ )



# Practical information – staff on wards

- Specific instructions for shielded rooms
- Usually staff on wards is not considered professionally exposed
- External exposure: negligible
- Contamination: may be more frequent by direct contact with patient's biological secretions (blood, urine, wounds, burns, vomit,...)
- Usually biological protection is sufficient
  
- Collect wastes: avoid large volumes of contaminated wastes!

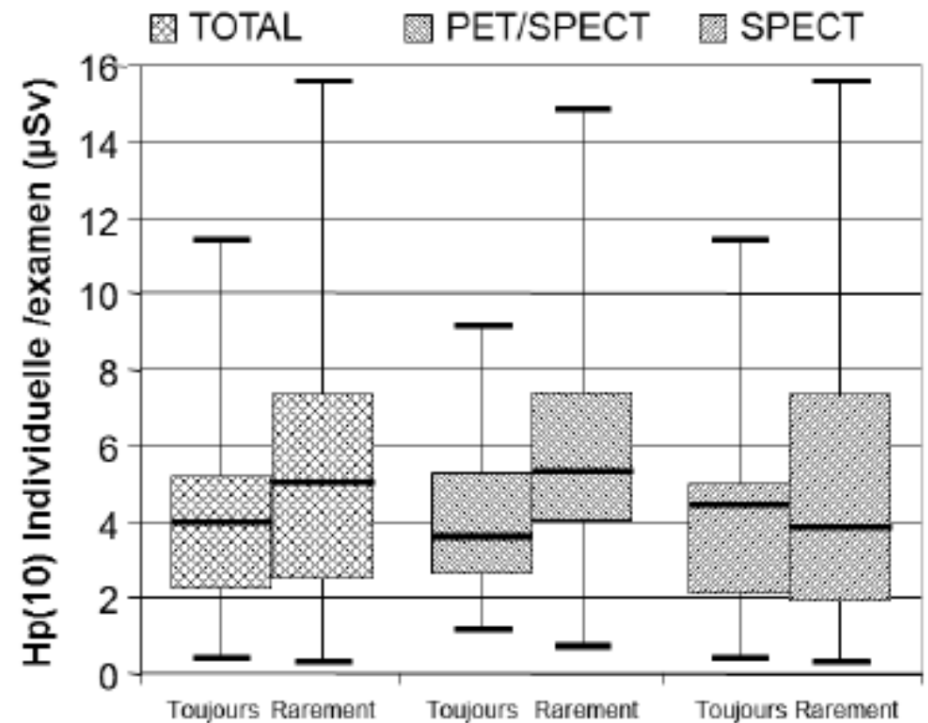
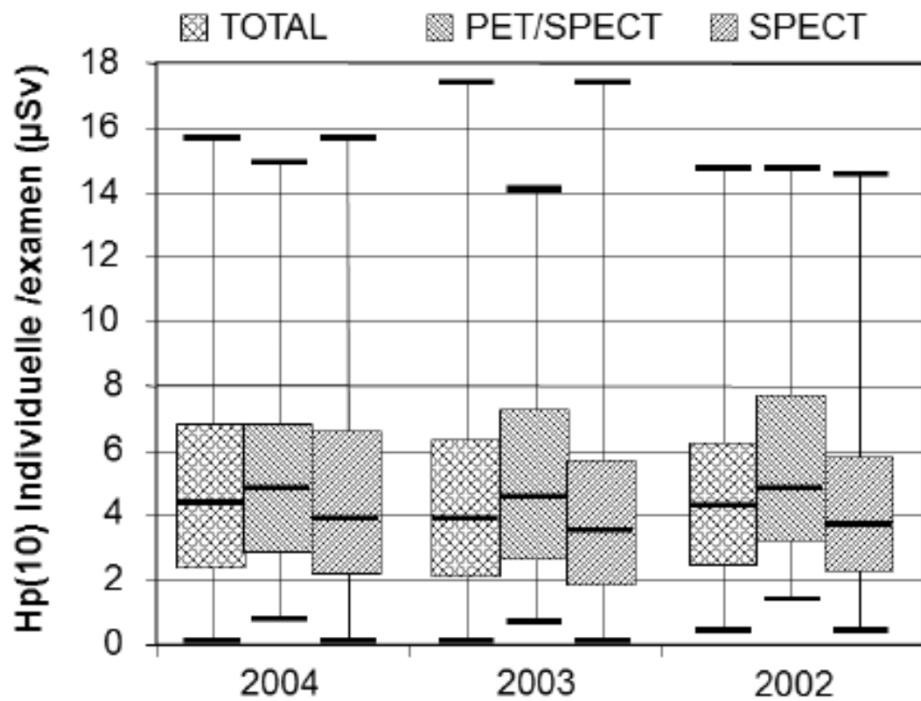
# Practical information – external workers

- Technicians for specific maintenance are usually well trained
- Others (electricians, painters, plumbers,...) are not aware:
  - Supervision by local staff, preparation of tasks
  - Dosimeter if controlled zone
  - CAVE: lavatories, waste zone
  - Never operate X-ray equipment without supervision

# Practical information – cleaning staff

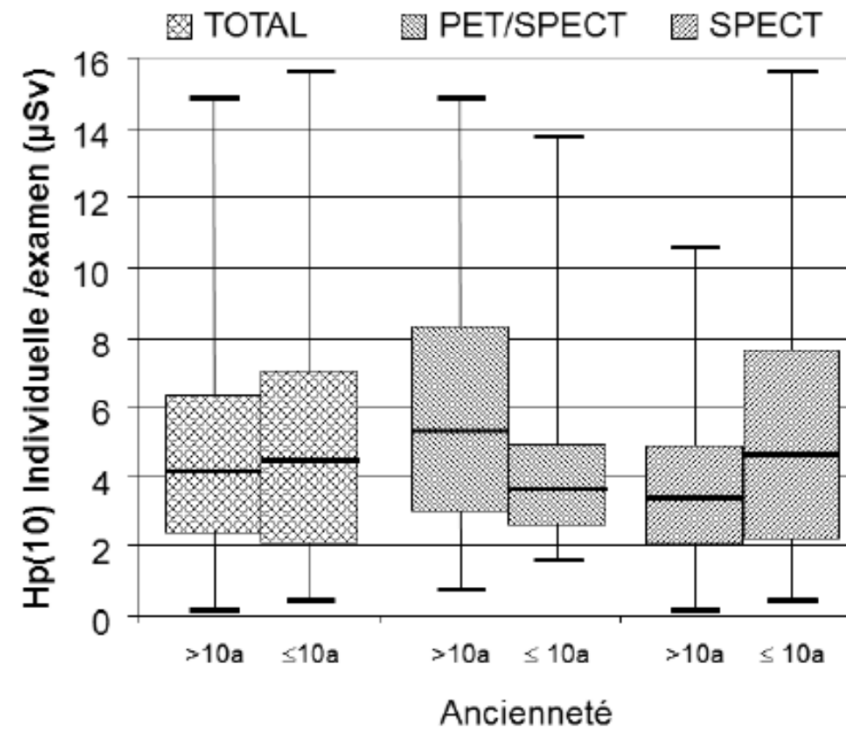
- The major issue is the training because of:
  - Low level of education
  - Language issues
  - Frequent rotation (internal/external companies)
- Dosimeter is compulsory
- Instruct well about sorting wastes!!!

# Doses to staff – a Belgian exploratory survey



Use of syringe shielding

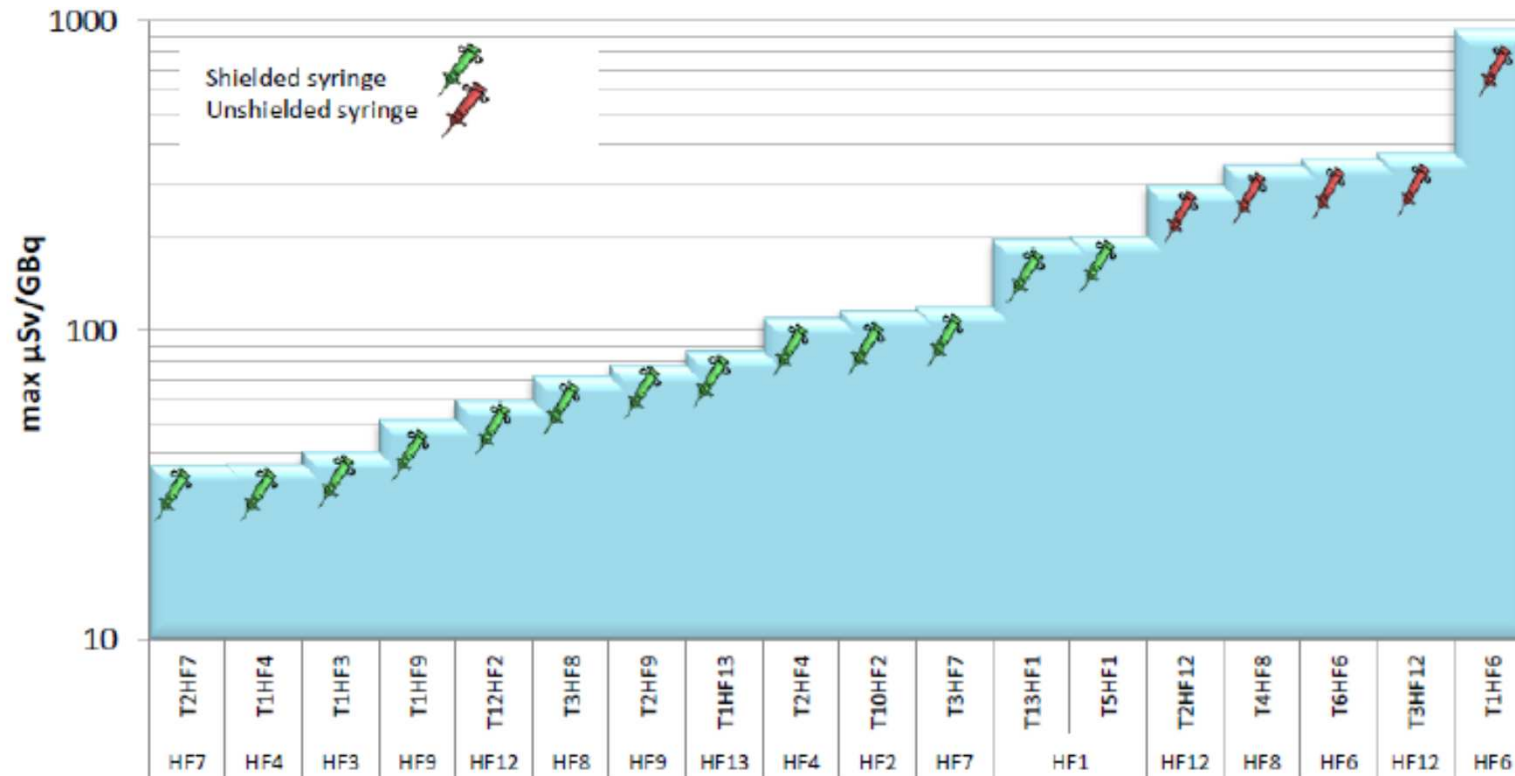
# Doses to staff – a Belgian exploratory survey



# Doses to staff – a Belgian exploratory survey

- Introduction of PET has not lead to an increase in yearly individual or collective doses (corrected for volumes and staff)
- Use of protection measures (lead shielding, lead apron) is useful
- Experience is not a guarantee for reducing doses, nor was, at that time, training
- A repeat study is mandatory to look at >ten years of experience

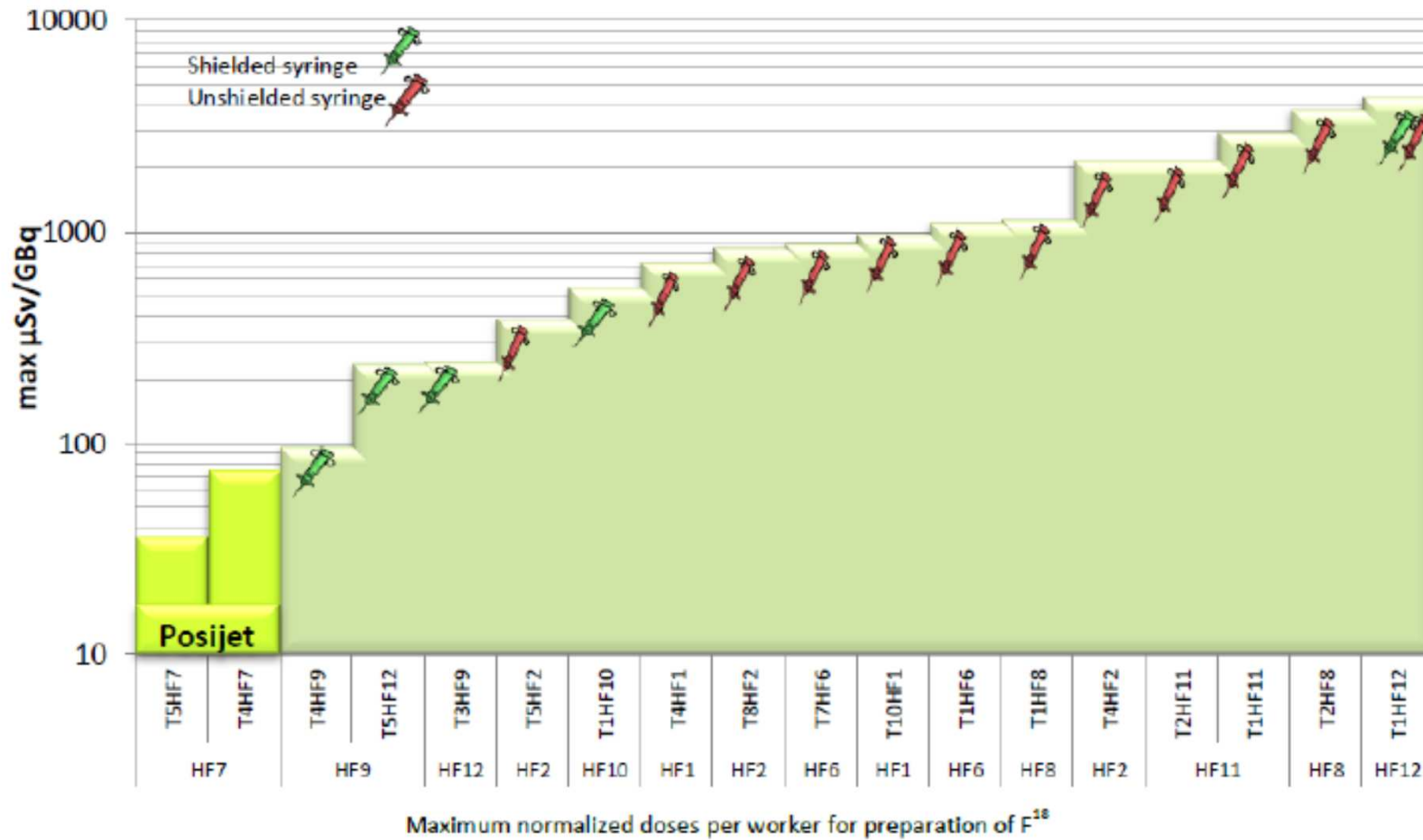
# Doses to staff – EXDOS



Maximum normalized doses per worker for administration of  $Tc^{99m}$

\*: [www.oramed-fp7.eu](http://www.oramed-fp7.eu)

# Doses to staff – EXDOS





# Practical approach: dedicated fiches

## ANNEXE 4 : FICHE D'INFORMATION POUR LE PERSONEL CHARGE DU TRANSPORT DES PATIENTS EN MEDECINE NUCLEAIRE

<b>Groupe cible</b>	Toute personne chargée du transport de patients du service de médecine nucléaire vers d'autres services.
<b>Objet</b>	Résumé d'informations concernant la protection et les risques éventuels à proximité d'un patient porteur de substances radioactives.
<b>Fréquence et durée de l'exposition</b>	Occasionnelle
<b>Voies d'exposition</b>	<u>Exposition externe</u> : A proximité des patients ayant reçu une injection et des déchets éventuels. <u>Contamination</u> : lors d'un incident, par contact avec les liquides biologiques de patients ayant reçu une injection (sang, urine, vomissures...).
<b>Mesures de protection</b>	Limiter le temps auprès de patients ayant reçu une injection, garder les distances (>1m) par rapport au patient si possible et prendre des mesures d'hygiène en cas d'incident (perte d'urine, vomissures...). Dans ce cas, toujours prendre contact avec le service de médecine nucléaire.
<b>Moyens de protection</b>	Vêtements de travail distincts et en cas d'incident : gants.
<b>Déchets</b>	Maintenir les déchets découlant d'un incident éventuel (perte d'urine, vomissures,...) dans un sac à déchets séparé et prendre contact avec un responsable du service de médecine nucléaire.
<b>Grossesse et allaitement</b>	Eviter tout contact prolongé avec le patient à courte distance.
<b>Port d'un dosimètre</b>	En fonction de la charge de travail
<b>Contrôle médical</b>	examen médical ciblé (rayonnement ionisant) uniquement si considéré comme nécessaire par le médecin du travail.
<b>Contact (Médecine nucléaire)</b>	Dr X tél :
<b>Contact (hors médecine nucléaire )</b>	Dr Y, médecin du travail, tél CPPT : M./Mme, tél :
<b>En cas d'urgence radiologique</b>	Service de Contrôle physique interne, externe, tél Service de prévention, tél Service de garde, tél
<b>Référence interne</b>	SOP xyz                      Validation Approbation
<b>Référence externe</b>	CSS

# Conclusions for the occupational physician

- Nuclear Medicine is rapidly evolving
  - PET and high energy annihilation photons
  - Introduction of hybrid imaging with X-rays from which doses to staff can remain almost 0
  - Therapy with beta ( $^{90}\text{Y}$ ) and high finger doses
  - Therapy with alpha ( $^{223}\text{Ra}$ ) with high radiotoxicity and risk of internal contamination
- Staff surveillance is needed as well as training and continuous education
- The probability of risk is very low, but risks may be substantial
- A workplace visit is desirable especially in small departments