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## **Radiation Protection of Undertakers and Crematorium Staff in Case of a Patient Death Shortly After Radionuclide Therapy**

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# RADIATION PROTECTION OF UNDERTAKERS AND CREMATORIUM STAFF IN CASE OF A PATIENT DEATH SHORTLY AFTER RADIONUCLIDE THERAPY

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Cutting Edge Science Track - TROP Session: Current Issues of Radiation Protection (Session #1105)  
Presentation #OP-495

# EANM Disclosure of Interest Statement

My co-authors and I have nothing to disclose

# Context

- Strong development of new radionuclide therapies : Lutetium-177, Actinium-225, etc.
- French Nuclear Safety Authority asked IRSN in 2020 to perform studies on these new radionuclides
  - most promising new radionuclides
  - patient RP
  - workers RP from different fields
- Today's worker RP topic: case where a patient dies shortly after radionuclide therapy with new radiopharmaceuticals

# Objectives

- Assessment of the doses which could be received:
  - by undertakers : transport and embalming of the body
  - by crematorium staff

# Transport and embalming : Method

Most promising therapeutic radionuclides considered: Lu-177, Ra-223, Ho-166 et Ac-225

$$H^*(10) = \dot{H}^*(10) \cdot \Delta t = \frac{\Gamma \cdot A \cdot d_{réf}^2}{d^2} \cdot \underbrace{e^{\frac{-\ln(2) \cdot t_1}{T_{eff}}}}_{\text{before death}} \cdot \underbrace{e^{\frac{-\ln(2) \cdot t_2}{T_{phy}}}}_{\text{after death}} \cdot \Delta t \leq 300 \mu\text{Sv}$$

*Hyp : 3 deceased patients/year (< 1 mSv/year)*

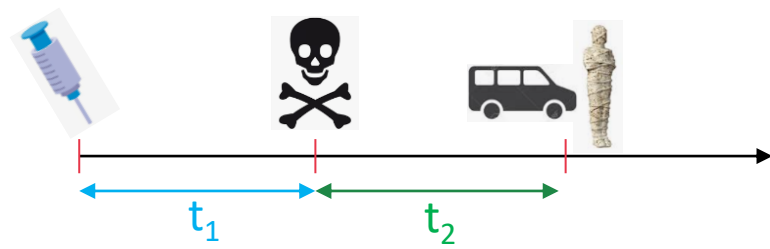
Hypothesis for time and distance :

- Transport : 1 h at 50 cm
- Embalming : 2 h at 50 cm

✓ Hypothesis validated by funeral personnel

Administered activities, equivalent dose rate constant et effective half-lives : values from literature with conservative approach

# Results (embalming/transport)



$$\frac{\Gamma \cdot A \cdot d_{réf}^2}{d^2} \cdot e^{-\frac{\ln(2) \cdot t_1}{T_{eff}}} \cdot e^{-\frac{\ln(2) \cdot t_2}{T_{phy}}} \cdot \Delta t \leq 300 \mu Sv$$

	Immediate death after administration $t_1=0$		No constraints after death $t_2=0$
	$t_2 \text{ min} = ?$		$t_1 \text{ min} = ?$
	transport	embalming	
Ra-223-dichloride	-	-	-
Ac-225-PSMA	-	-	-
Lu-177-DOTATATE	-	4 days	0,5 day
Lu-177-PSMA	-	4 days	1 day
Ho-166 microspheres	1 days	2 days	1,3 day
I-131 iodide (3,7 GBq)	11 days	19 days	2,1 days
I-131 MIBG (7,4 GBq)	19 days	27 days	6,6 days

**Regulation** ✓

# Method to assess crematorium staff exposure

- Therapeutic RN considered: Cu-67, Y-90, In-111, I-131, Sm-153, Ho-166, Er-169, Lu-177, Re-186, Re-188, At-211, Pb-212, Bi-212, Bi-213, Ra-223, Ac-225
- Visits in 3 crematoria to understand the operations carried out according to the type of fume filtration system (small vs. large container)
- Staff:
  - technical (in charge of cremation)
  - administrative (office)
  - external technician (large container maintenance)
- Protection considered: walls + PPE
- Activity considered : Activity administered to the patient without any decay (most conservative assumption)



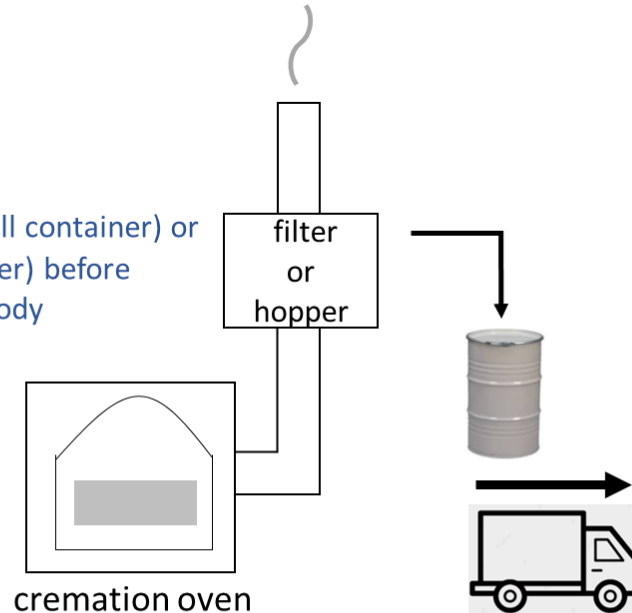
## Results and recommendations (1/2)

- Only a few cases lead to more than 300  $\mu\text{Sv}$  for I-131, Ac-225 and In-111 (therapeutic application) in some scenarii (e.g. external technician)
- To reduce exposure, IRSN recommends:
  - for I-131, to increase the time between death and cremation as much as possible, in compliance with national regulations and with the family's agreement
  - every effort should be made to inform the crematorium of the radioactive nature of the body, so that recommendations can be applied

## Results and recommendations (2/2)

Even in the worst-case scenario, application of the 3 recommendations below will drastically reduce worker exposure to below 300  $\mu\text{Sv}$  :

① : empty the filter (small container) or the hopper (large container) before cremating a radioactive body



② : evacuate the drum containing the contaminated dust as quickly as possible

③ : If ① and ② not possible, increase the distance between the contaminated filter storage area and the other rooms in the crematorium (in particular the administrative rooms)

# Take-home messages

- For transport/embalming operators, there is a lower risk associated with the new radionuclides than I-131
- For crematorium staff, except for some particular cases, the risks associated with the new radionuclides are low
- And application of IRSN recommendations can further reduce their exposure

Thank you for your attention.

Questions ?

Report available on:

<https://www.irsn.fr/sites/default/files/2023-02/Avis-IRSN-2023-00004.pdf> (in French)