EURADOS European Radiation Dosimetry Group

Extremity doses in nuclear medicine – influence of new radionuclides

Robert Kollaard, NRG, Netherlands
Ann McCann, St. Vincent's University Hospital, Ireland
Nicolas Cherbuin , HUG-CHUV, Switzerland
Jérémie Dabin, SCK.CEN, Belgium
Peter Covens, VUB, Belgium
Alessandra Zorz, Istituto Oncologico Veneto IOV - IRCCS, Italy
Lidia Cunha, IsoPor Azores, Portugal

European Alara Network meeting Vienna
3-Oct-2023

EUROPEAN ALARA NETWORK

Introduction

- Exposure of the fingers is a major concern in the protection of nuclear medicin (NM) workers
- Large projects (ORAMED, CONRAD) investigating extremity dose in nuclear medicine
  - ORAMED study: about 20% of the exposed workers in NM might receive a maximum extremity (finger) dose of more than 500 mSv
- Developments since 2011:
  - The introduction/increased use of certain radioisotopes
  - A change in the practices

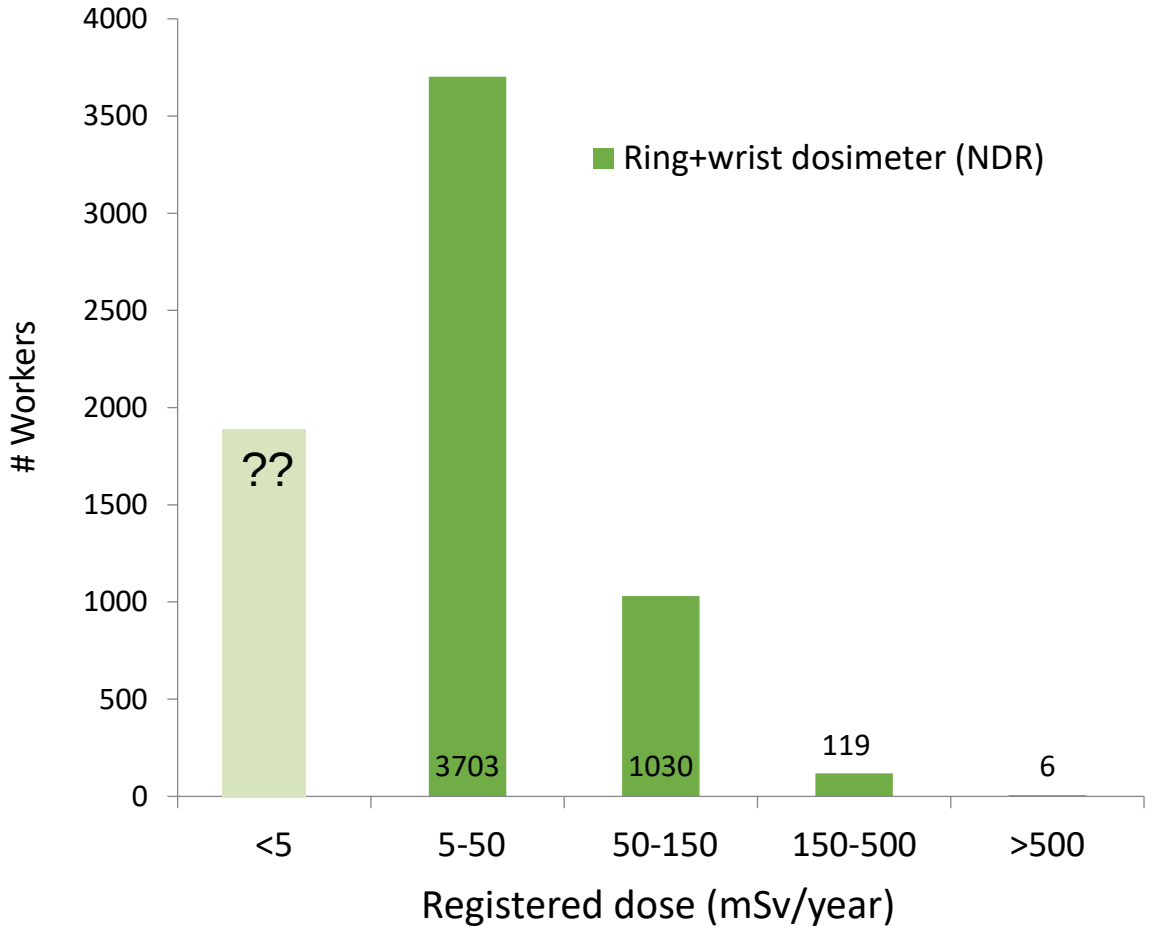
- EURADOS Working Group 12 task (2018) established to:
  - Find out current status of extremity dosimetry in NM
  - Identify and fill in gaps in knowledge – influence of new isotopes

Overview of presentation

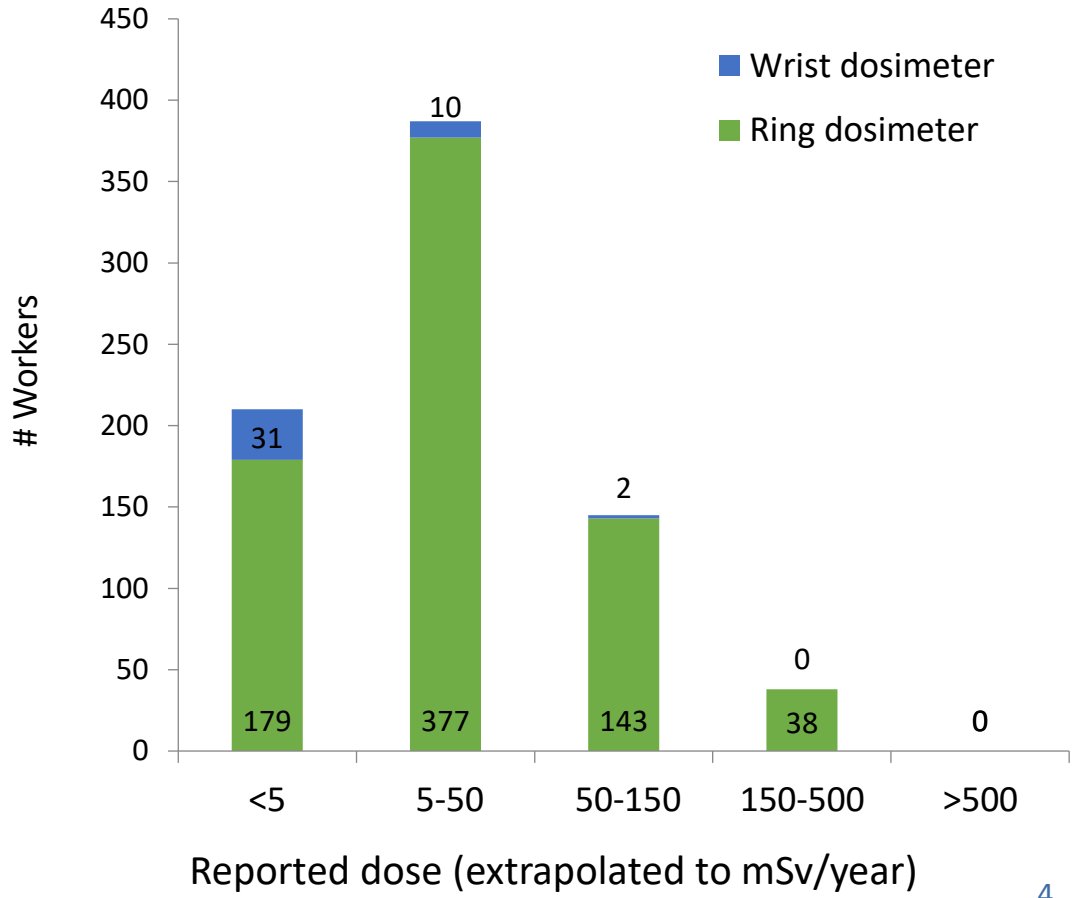
- Overview of extremity doses in Europe
  - Results of 2 surveys
- Extremity doses evaluated in 2 pilots:
  - PET procedures with Ga-68
  - Therapeutic procedures with Lu-177
- Summary and conclusions

Measured extremity doses in Europe - distribution

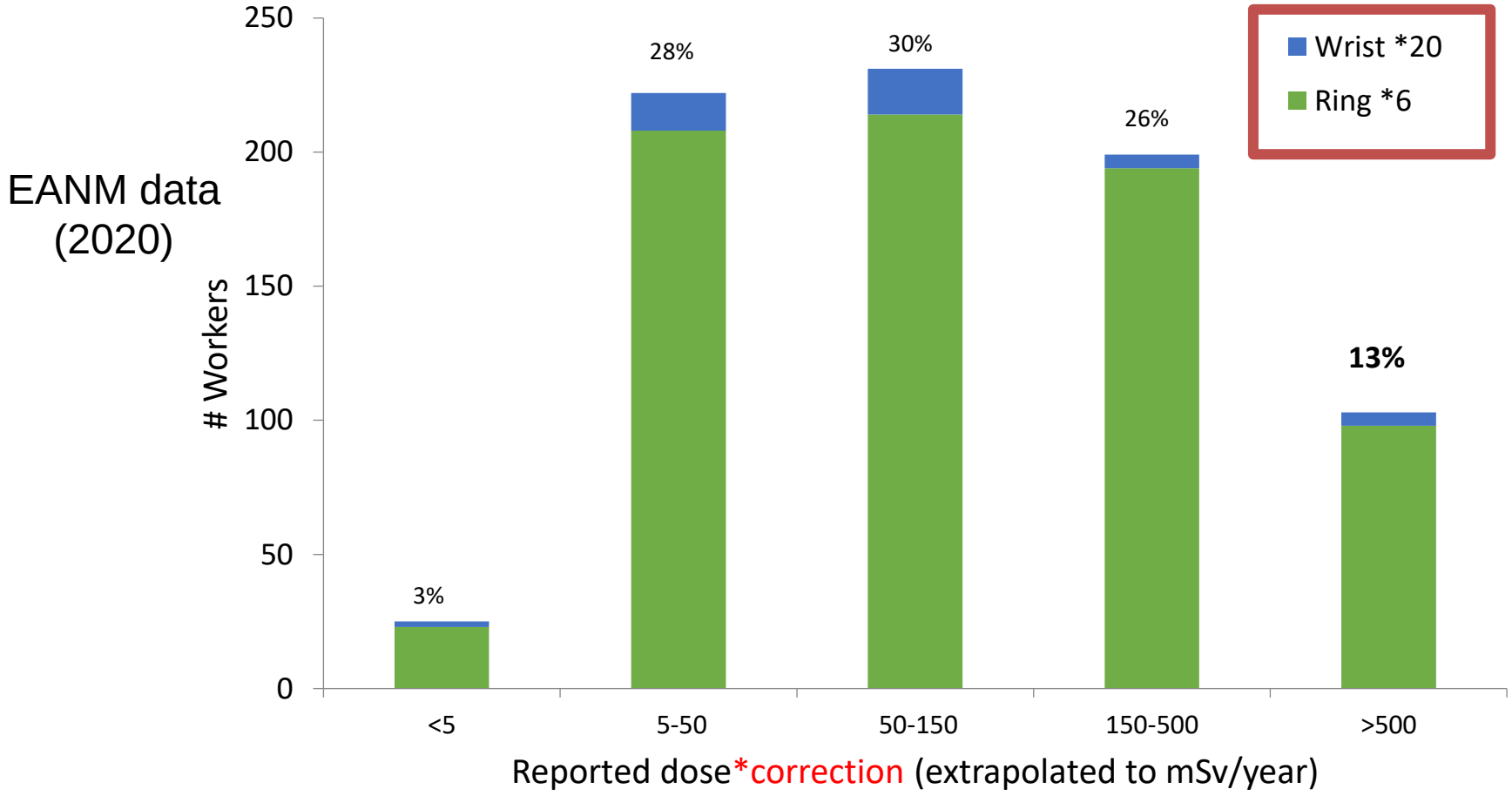
National Dose Registries (2018)
(4938 workers, > 5 mSv)



EANM Survey (2020)
(780 workers)

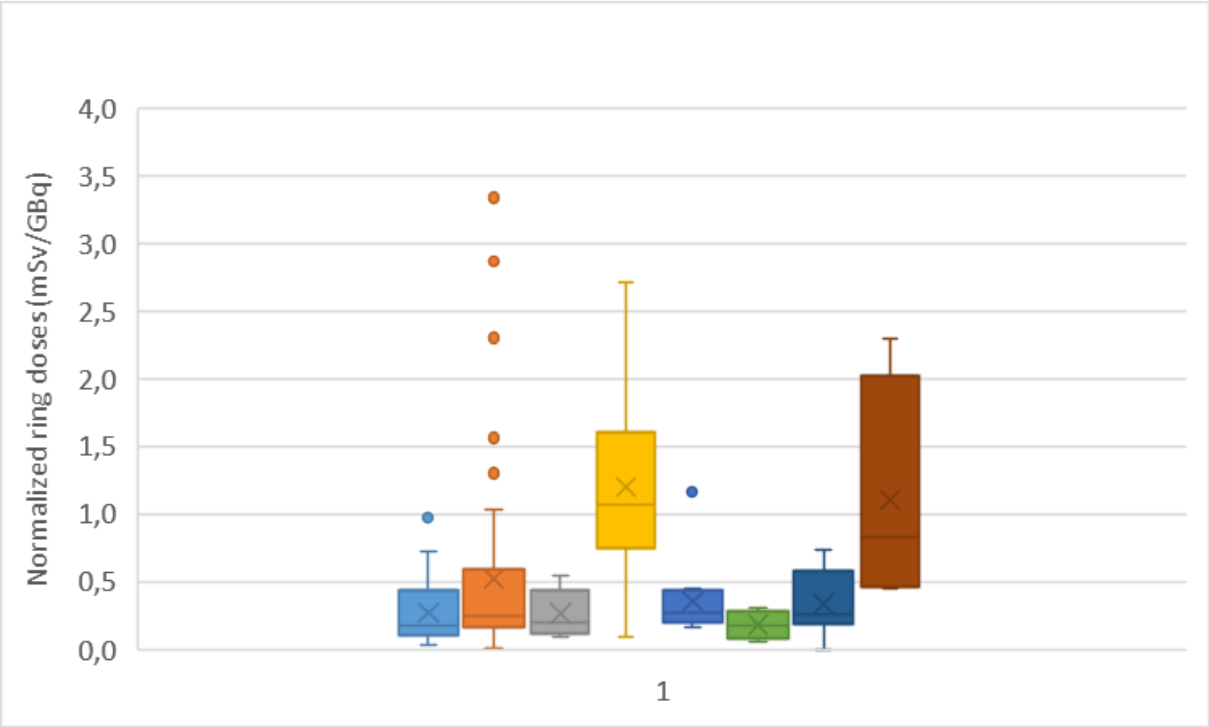


Estimated fingertip doses (EANM survey)



ORAMED (2011): potentially 20% of population > 500 mSv
EANM survey (2018): potentially 13% > 500 mSv

Pilot results- normalized Ga-68 ring dose



- Pilot in 8 centres (122 Ring/TLD dosimeters)
- Index finger of non-dominant hand
- Period of 1 – 3 months
- 61 workers monitored

Task	Normalized ring dose (mSv/GBq)
Prep / dispensing/QC	0.23 (0.01 – 3.34)
Patient administration	0.26 (0.06 – 2.86)
All	0.25 (0.01 – 3.34)

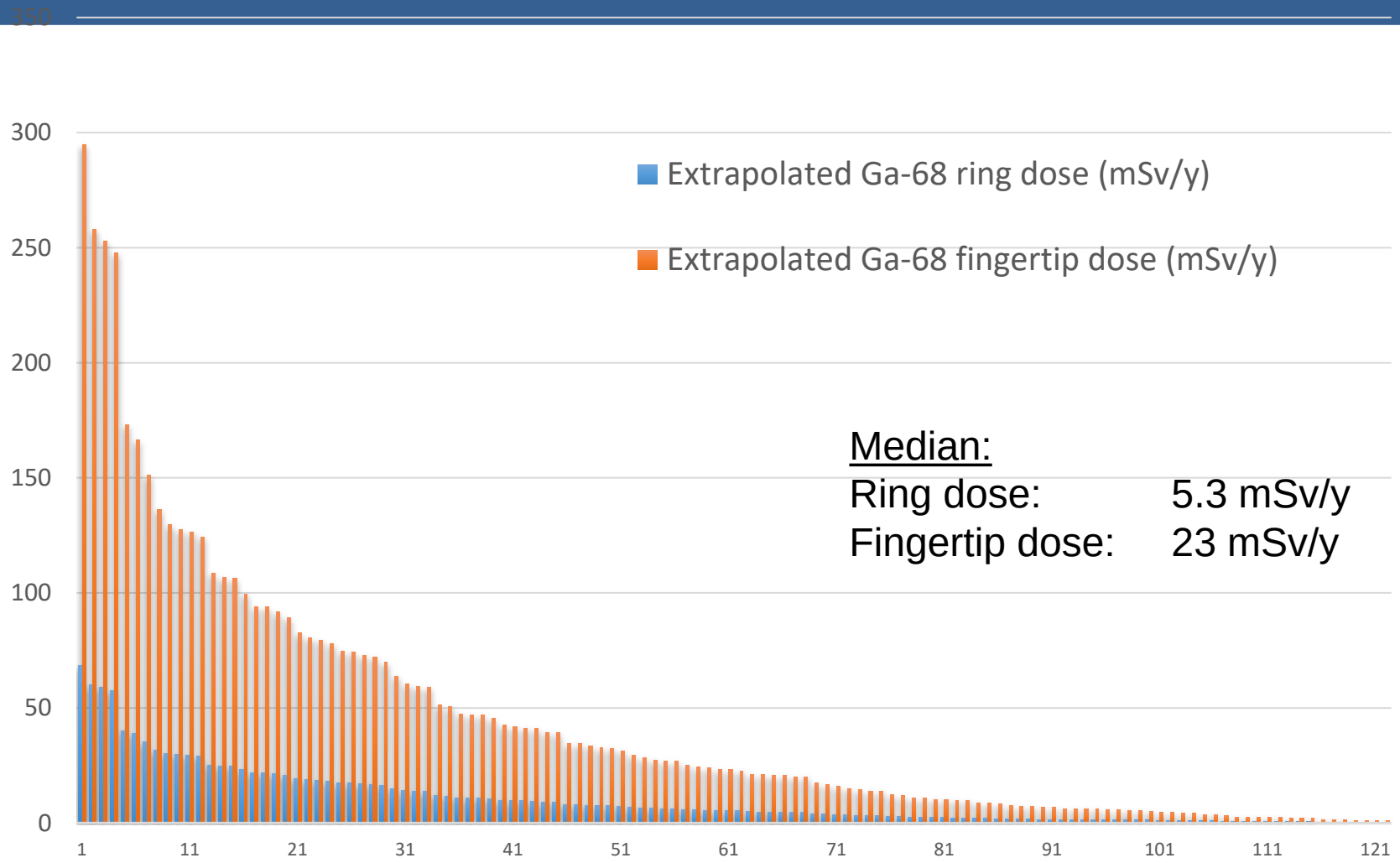
-> Normalised ring dose similar to F-18

Fingertip to base sub-study

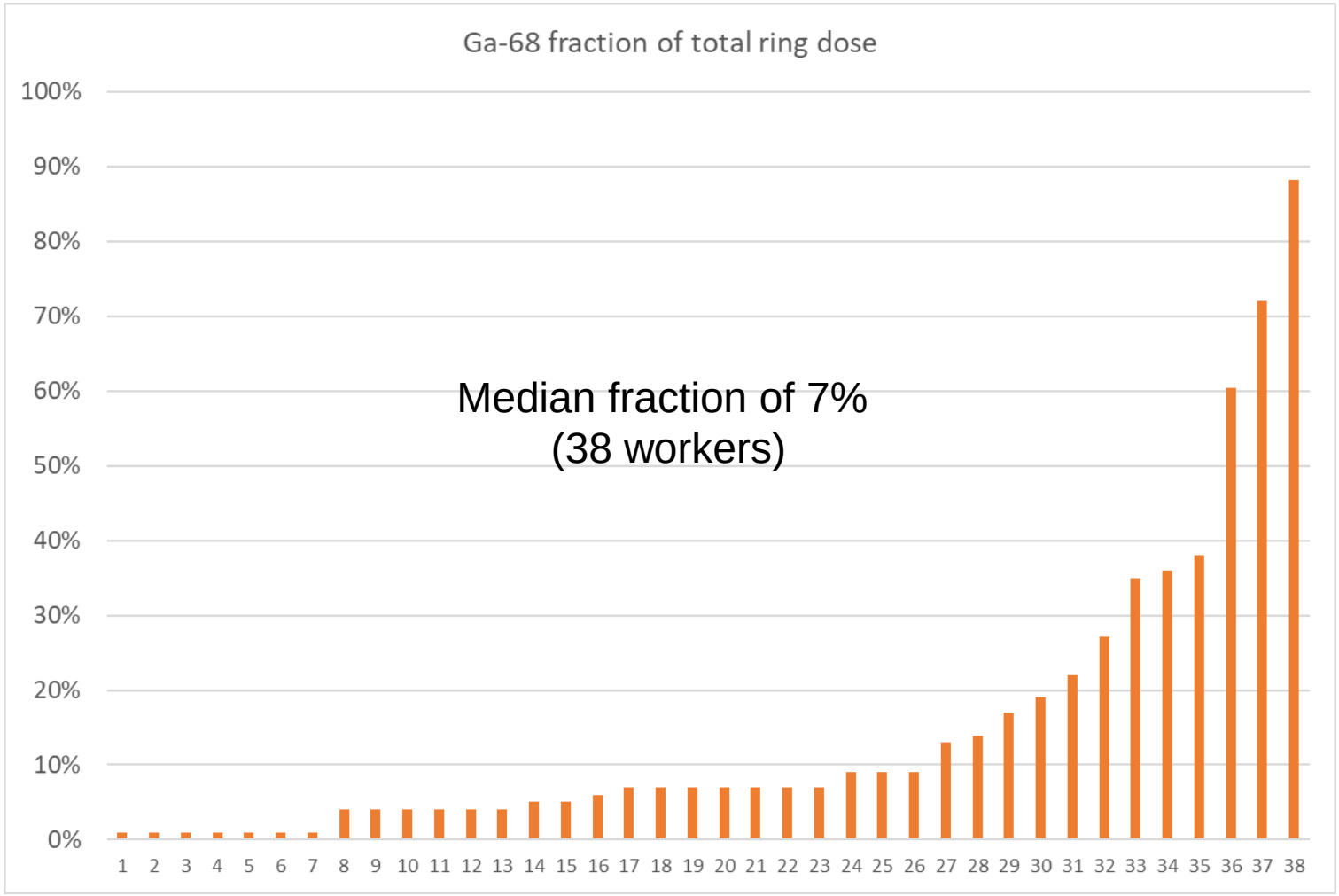
Fingertip to base of the finger data for the index finger of the non-dominant hand (median, range)

	Ring dose (mSv/month)	Fingertip dose (mSv/month)	Dose ratio
Centre 5 (n = 6)	0.5 (0.2 - 0.8)	1.6 (0.7 - 5.0)	4.3 (1.3 - 10.2)
Centre 8 (n = 4)	1.8 (1.5 - 5.7)	6.9 (3.5 - 25.7)	4.0 (2.1 - 4.7)
Total	0.7 (0.2 - 5.7)	3.0 (0.7 - 25.7)	4.3 (1.3 – 10.2)

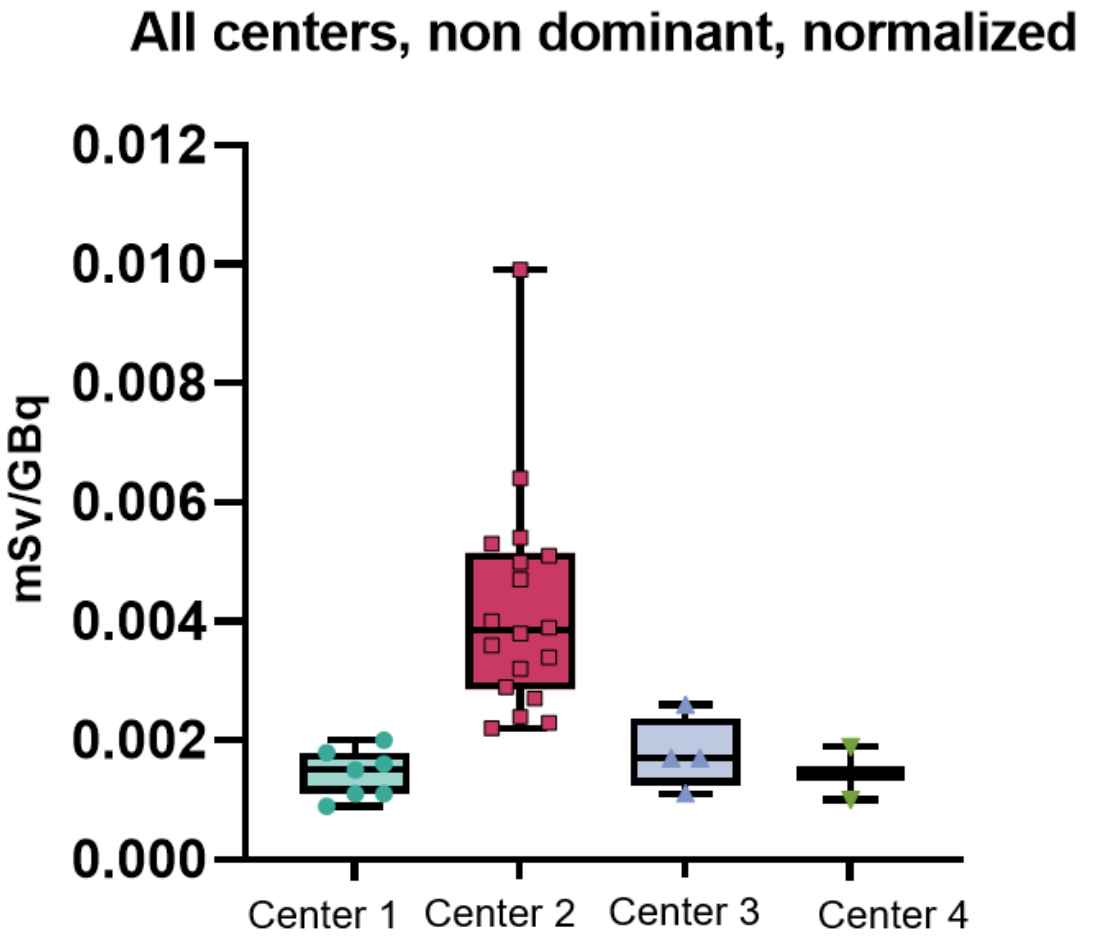
Extrapolated annual Ga-68 dose



Ga-68 fraction of total extremity dose



Pilot results - normalized Lu-177 ring dose



- Ring dose multi center pilot
- Index finger of non-dominant hand
- Currently results from 4/11 centers
- 42 measurements

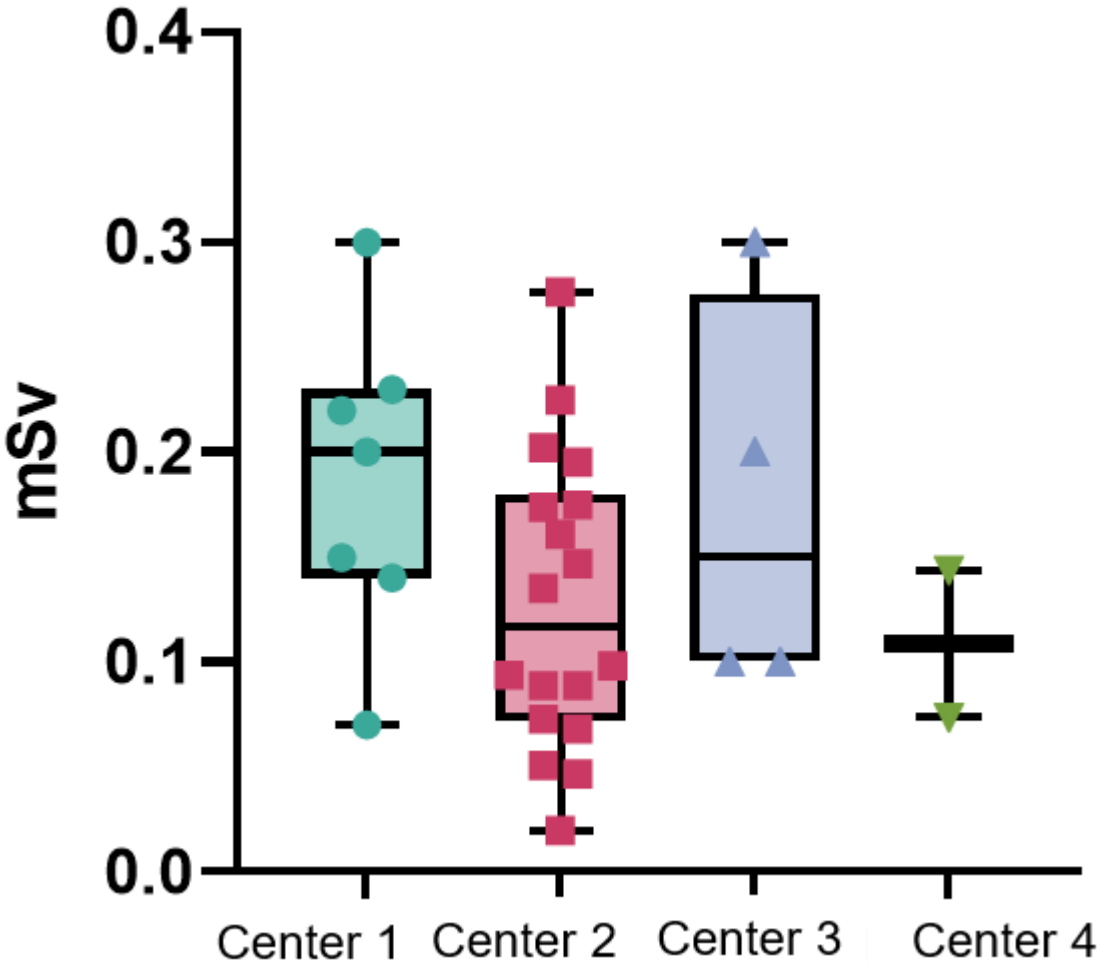
-> Normalised ring dose much lower than Ga-68 or F-18

Lu-177 ring doses (month/year)

Monthly ring doses < 0.4 mSv

Annual ring doses < 5 mSv

=> Fingertip doses < 30 mSv/y?



Next steps for Lu-177 ring dose pilot

- Ring dose data expected from more centers
- Dosimeter intercomparison to validate dosimeters in pilot for Lu-177

Summary of pilot data

	Ga-68	F-18 [ORAMED]	Lu-177	Y-90 [ORAMED]
Application	PET	PET	Therapy	Therapy
Maximum beta energy	1.9 MeV	0.6 MeV	0.5 MeV	2.3 MeV
Number of measurements	122	306	42	147
Number of centers	8	17	4	16
Median ring dose (mSv/GBq)	0.25	~0.2 [0.8 fingertip]	0.003	~0.8 [3-9 fingertip]
Max. ring dose (mSv/y)	69		~5	
Median ring to fingertip ratio	4.3	4		6
Max. fingertip dose (mSv/y)	295	> 500	~30	> 500

Some words about ALARA

- What protection measures can be taken?
- How well are protection measures implemented in practice?

Impact of protection measures on extremity doses – factors in literature

Practice	Distance tools	Gloves	Shielding		Automation	Training
			Syringe and/or vial	Cannula		
	Factor	Factor	Factor	Factor	Factor	Factor
^{99m}Tc			4.3 (P+D) and 1.8 (A), 5-10			
^{18}F			2.3 (D) and 5.0 (A), 1.3		2-5, 11, 17, 37	3
^{124}I	3.0			3.2		
^{90}Y RSO	2.2, 27, 53	2.5	5.8	4.9 (D) and 9.6 (A)		
^{90}Y PRRT		5.9 (0.2 vs 0.1 mm Pb)	3.8 (shield & forceps)		1.6, 2.7	
^{90}Y RIT		1.5-2.7 (3 vs 1 latex)	3.1		2.6-2.8	
^{177}Lu PRRT					3.1	
^{188}Re RE					2.4	

Protection measures in practice – EANM survey

		Frequency of the use of specific protection devices			
Nuclide	Task	Vial shield	Syringe shield	Distance tool	Automated dose dispenser
^{99m}Tc	Preparation	100%	84%	87%	-
	Dispensing	100%	87%	68%	-
	Administration	-	98%	-	-
^{18}F	Dispensing	92%	77%	69%	75%
	Administration	-	81%	-	53%
^{68}Ga	Preparation	88%	86%	81%	-
	Dispensing	88%	70%	79%	21%
	Administration	-	77%	-	21%
^{177}Lu	Administration	-	77%	-	44%
^{90}Y	Administration	-	81%	-	17%

Conclusions

- Surveys (national dose registries, EANM):
  - Current extremity doses lower than estimated by ORAMED study,
  - even with increased workload and new radioisotopes
- Ga-68 procedures
  - Normalized extremity doses and ring to fingertip ratio comparable to F-18
  - Median extrapolated annual dose of 5.3 mSv [ring] and 23 mSv [fingertip]
  - Small group (6%) with estimated fingertip dose > 150 mSv
- Lu-177 procedures
  - Extremity doses are relatively low (< 5 mSv/y) compared to other radionuclides
- Recommendations on protection measures (ICRP and ORAMED) part of daily practice
- Further EURADOS work
  - Complete Lu-177 study
  - Skin dose due to contaminations

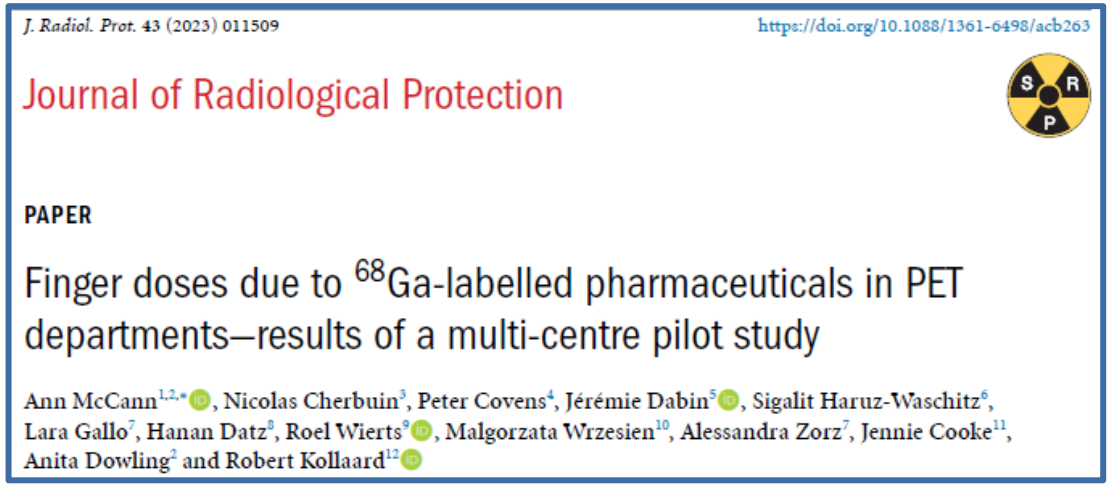
Publications of this EURADOS taskgroup

IOP Publishing | Society for Radiological Protection — Journal of Radiological Protection
J. Radiol. Prot. **41** (2021) 726–738 (13pp) https://doi.org/10.1088/1361-6498/abfff3

Need for harmonisation of extremity dose monitoring in nuclear medicine: results of a survey amongst national dose registries in Europe

Alexandra Kyriakidou[1,*], Jeroen Schlief[2], Merce Ginjaume[3] and Robert Kollaard[2]

https://doi.org/10.1088/1361-6498/abfff3



J. Radiol. Prot. **43** (2023) 011509 https://doi.org/10.1088/1361-6498/acb263

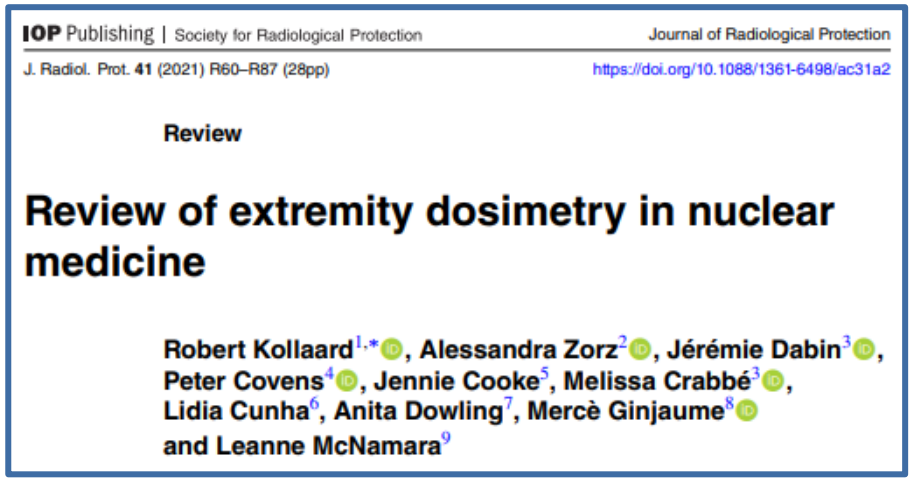
Journal of Radiological Protection

PAPER

Finger doses due to ^{68}Ga-labelled pharmaceuticals in PET departments—results of a multi-centre pilot study

Ann McCann[1,2,*], Nicolas Cherbuin[3], Peter Covens[4], Jérémie Dabin[5], Sigalit Haruz-Waschitz[6], Lara Gallo[7], Hanan Datz[8], Roel Wierts[9], Malgorzata Wrzesien[10], Alessandra Zorz[7], Jennie Cooke[11], Anita Dowling[2] and Robert Kollaard[12]

10.1088/1361-6498/acb263



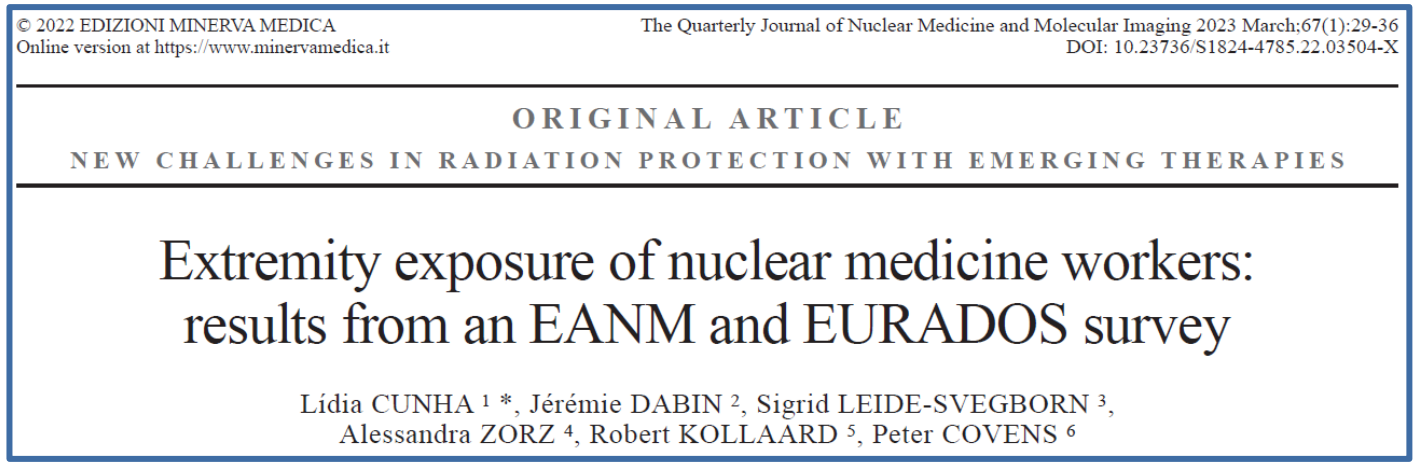
IOP Publishing | Society for Radiological Protection — Journal of Radiological Protection
J. Radiol. Prot. **41** (2021) R60–R87 (28pp) https://doi.org/10.1088/1361-6498/ac31a2

Review

Review of extremity dosimetry in nuclear medicine

Robert Kollaard[1,*], Alessandra Zorz[2], Jérémie Dabin[3], Peter Covens[4], Jennie Cooke[5], Melissa Crabbé[3], Lidia Cunha[6], Anita Dowling[7], Mercè Ginjaume[8] and Leanne McNamara[9]

https://doi.org/10.1088/1361-6498/ac31a2



© 2022 EDIZIONI MINERVA MEDICA
Online version at https://www.minervamedica.it

The Quarterly Journal of Nuclear Medicine and Molecular Imaging 2023 March;67(1):29-36
DOI: 10.23736/S1824-4785.22.03504-X

ORIGINAL ARTICLE

NEW CHALLENGES IN RADIATION PROTECTION WITH EMERGING THERAPIES

Extremity exposure of nuclear medicine workers: results from an EANM and EURADOS survey

Lídia CUNHA [1] *, Jérémie DABIN [2], Sigrid LEIDE-SVEGBORN [3], Alessandra ZORZ [4], Robert KOLLAARD [5], Peter COVENS [6]

10.23736/S1824-4785.22.03504-X

Thanks for your interest

- For more information:
- kollaard@nrg.eu

NRG

Nuclear. For life.

EURADOS

European Radiation Dosimetry Group