IAEA programs for medical imaging physics in the member states

Peter Knoll
Dosimetry and Medical Radiation Physics Section
International Atomic Energy Agency

International Atomic Energy Agency (IAEA)

world's central intergovernmental forum for scientific and technical co-operation in the nuclear field.

IAEA's Organizational Structure

- Director General
- Director General's Office for Coordination
- Secretariat of the Policy-Making Organs
- Offices of Legal Affairs; Public Information and Communicatio Internal Oversight Services, and
- 6 Department

Part of the United Nations, an independent organization

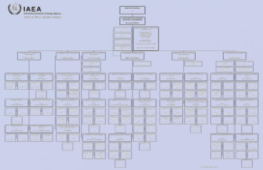
2,500+ staff

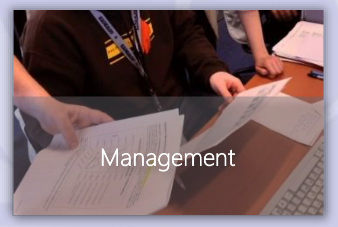
HQ in Vienna

Offices in Toronto, Tokyo, New York, Geneva

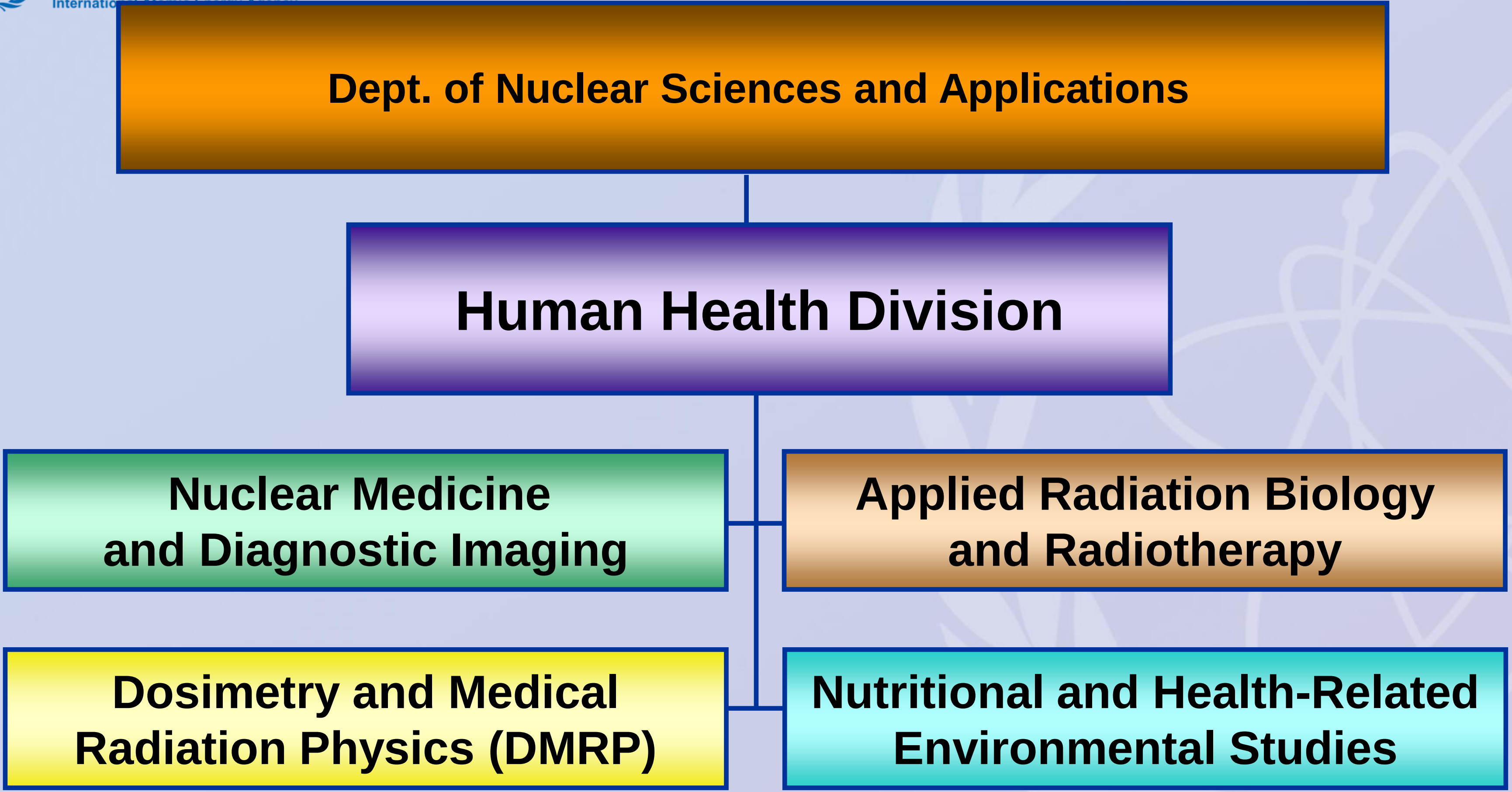
Laboratories in Seibersdorf and Monaco

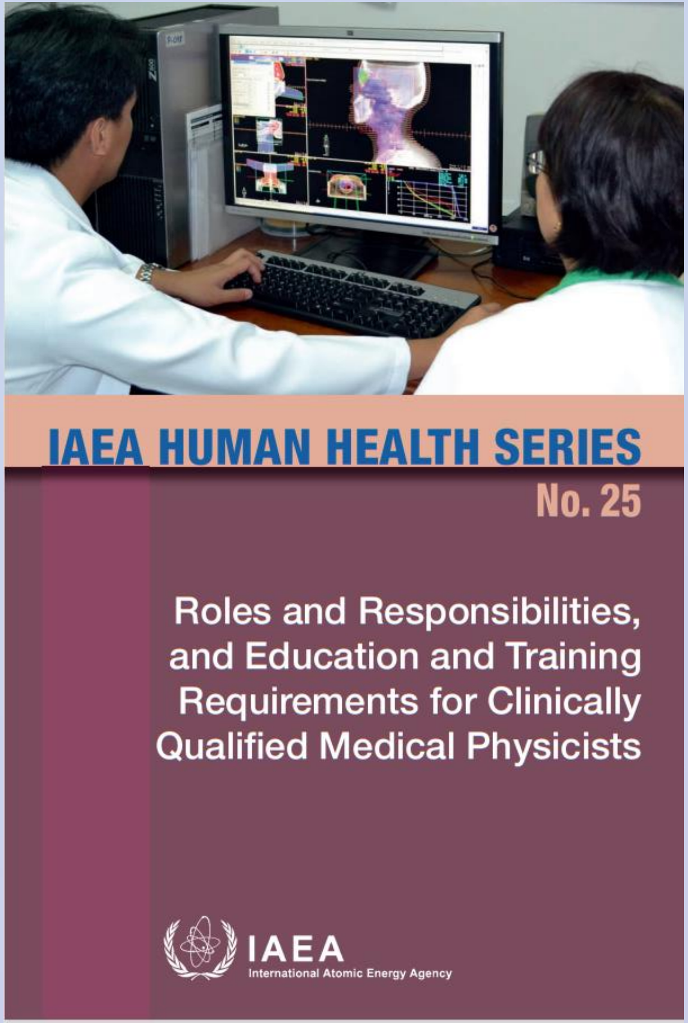
175 Member States





SUSTAINABLE DEVELOPMENT GOALS


Dept. of Nuclear Sciences and Applications
Human Health Division
Nuclear Medicine and Diagnostic Imaging
Applied Radiation Biology and Radiotherapy
Dosimetry and Medical Radiation Physics (DMRP)
Nutritional and Health-Related Environmental Studies

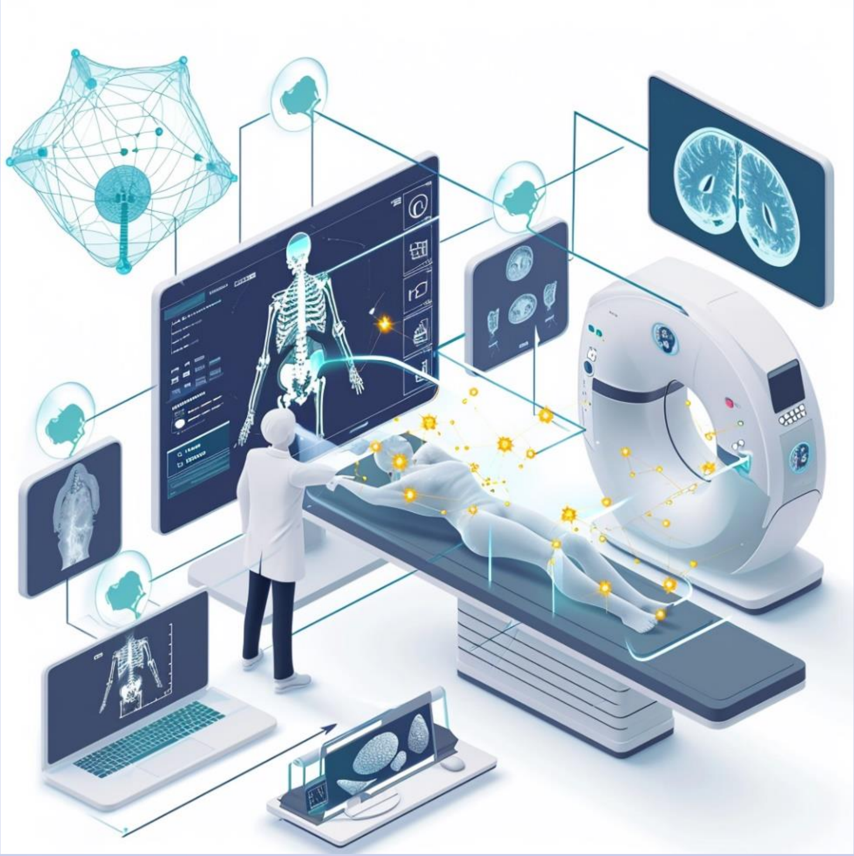


This publication addresses the shortfall of well trained and clinically qualified medical physicists working in radiation medicine.

The roles, responsibilities and clinical training requirements of medical physicists have not always been well defined or well understood by health care professionals, health authorities and regulatory agencies.

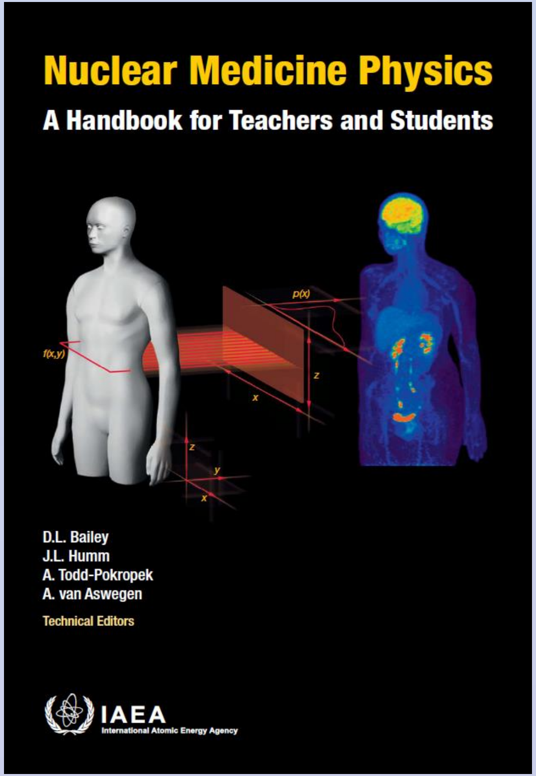
To fill this gap, this publication provides recommendations for the academic education and clinical training of clinically qualified medical physicists, including recommendations for their accreditation, certification and registration, along with continuous professional development.

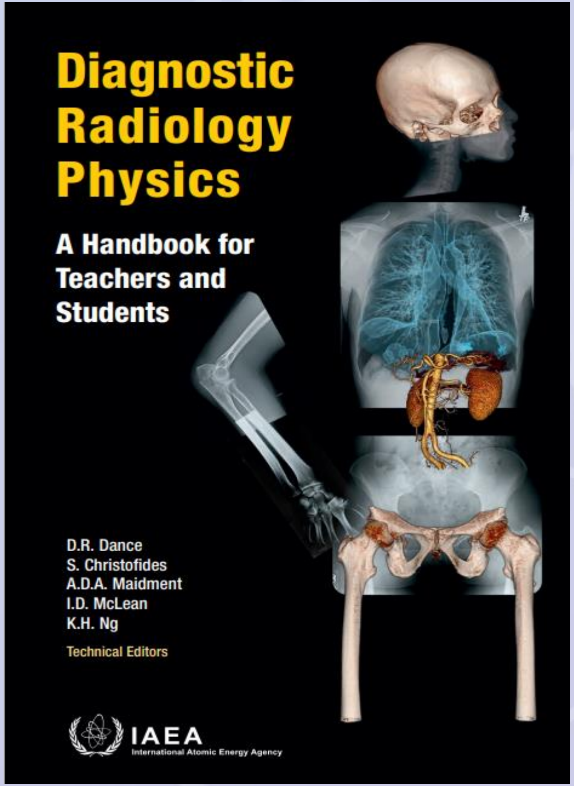
The goal is to establish criteria that support the harmonization of education and clinical training worldwide.



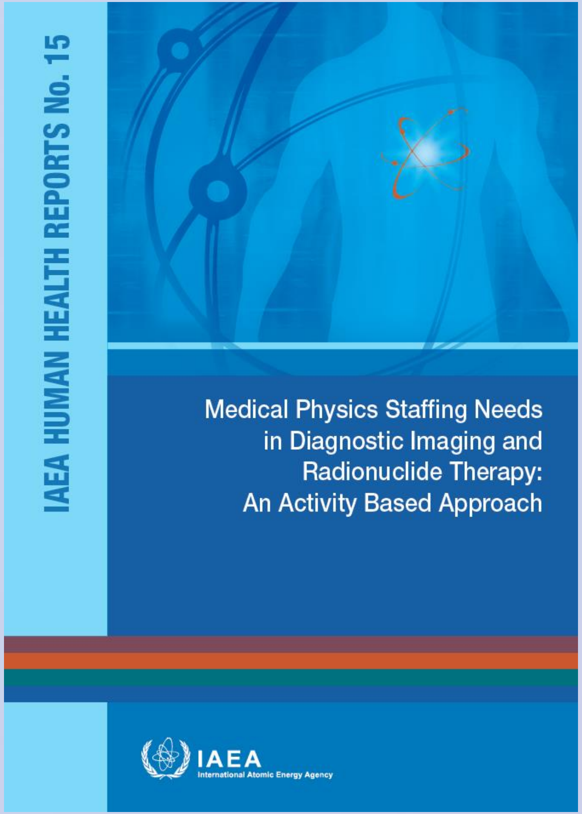
- Installation design (workflow)
- Procurement of the equipment
- Acceptance test of equipment.
- Ensuring radiation safety for patients, staff, and the public.
- Calibration and verification of instruments.
- Technical supervision of equipment.
- Clinical computing and networking.
- Research and development initiatives.
- Providing education and training.
- Quality management and QC procedures
- Collaboration with other professionals
- Optimization of physical aspects of diagnostic and therapeutic procedures

Advancing Medical Physics Education: IAEA's Guideline Development Initiative





IAEA
International Atomic Energy Agency



Recommended Medical Physicist Staffing Levels for Medical Imaging based on Roles and Responsibilities.

D. McLean (Australia)

S. Holm (Denmark)

M. Brambilla (Italy)

M.C. Martin (USA)

H. Delis and GL Poli (IAEA)

Assessing the Demand for Medical Physics Services in Imaging

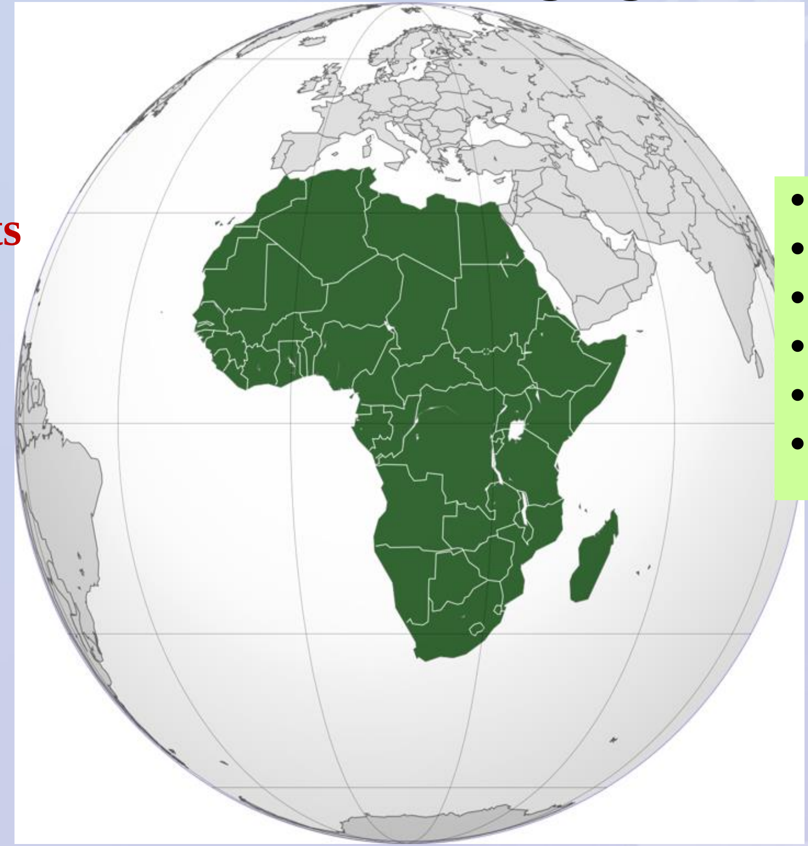
82 institutions

21 countries

97 Diagnostic Radiology Depts

40 Nuclear Medicine Depts

75 Interventional Radiology



- 1.414.752 planar X-rays
- 604.597 CTs
- 70.366 IR, ICs
- 268.240 NM
- 19.481 non-imaging
- 9351 radionuclide therapy

Current Appointments of Imaging Medical Physicists Fall Short by a Factor of 20

Health and Technology
https://doi.org/10.1007/s12553-022-00663-w

ORIGINAL PAPER

Medical physics services in radiology and nuclear medicine in Africa: challenges and opportunities identified through workforce and infrastructure surveys

Christoph Trauernicht[1] · Francis Hasford[2] · Nadia Khelassi-Toutaoui[3] · Imen Bentouhami[4] · Peter Knoll[4] · Virginia Tsapaki[4]

Received: 4 March 2022 / Accepted: 24 March 2022

Abstract
The International Atomic Energy Agency (IAEA) developed a staffing model to estimate the number of clinically qualified medical physicists (CQMP) that are required in an imaging facility, including diagnostic radiology and nuclear medicine. For the first time this staffing model was applied on a large scale across Africa. Within the framework of the IAEA African Regional Agreement (AFRA) Technical Cooperation (TC) project RAF6/053 entitled "Enhancing Capacity Building of Medical Physics to Improve Safety and Effectiveness of Medical Imaging (AFRA)", a survey based on the IAEA staffing model was used to investigate the current CQMP workforce needs in imaging and radionuclide therapy in Africa in order to establish a baseline, identify gaps and suggest steps for improvement. The survey was open for five months, after which data verification was performed. 82 responses were received from 21 countries, including data from 97 diagnostic radiology and 40 nuclear medicine departments, as well as 75 interventional radiology departments and/or catheterization laboratories. Only 26·8% of centres employed an adequate number of CQMPs. The staffing model indicated that 134·3 CQMPs were required for these centres, but only 63 are currently employed in medical imaging and/or nuclear medicine at these centres. At least 11 countries do not have a single institution with an adequate number of CQMPs. Data analysis indicated that the number of radiology and nuclear medicine CQMPs is largely inadequate, at least by a factor of 20 in almost all countries in the region.

Keywords Medical physics · Nuclear medicine · Radiology · Imaging · Workforce

1 Strengths and limitations of the study

– The study applied a well-established imaging medical physics staffing model on a large scale across Africa.
– This is the first study to broadly investigate the staffing model across a whole region.
– The severe shortage of medical physicists in Africa was partially quantified.
– Results of the study will be biased towards centres that actually employ medical physicists, as these were the main respondents of the staffing survey.

2 Introduction

Medical imaging is technologically advanced, and the wide availability of services has resulted in a significant increase in applications and in global utilization [1, 2]. Medical physics deals with the application of physics principles to medicine and plays an important role in the prevention, diagnosis, and treatment of disease [3]. According to the International Labour Organisation, medical physicists are considered an integral part of the health workforce, with one of the listed tasks being "ensuring the

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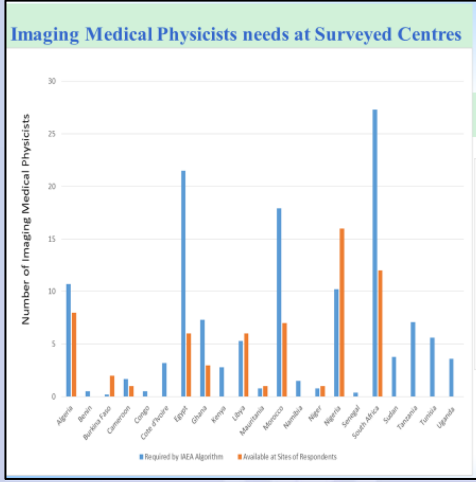
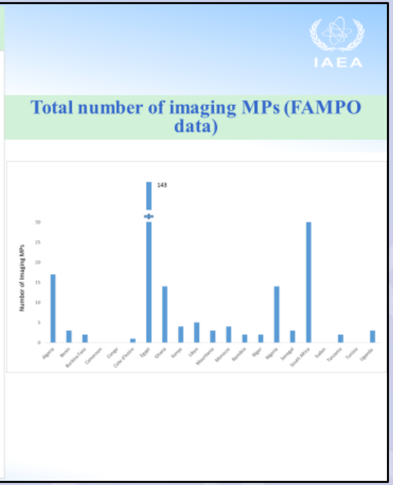
2 Medical Physics Department, School of Nuclear and Allied Sciences, University of Ghana, Accra, Ghana

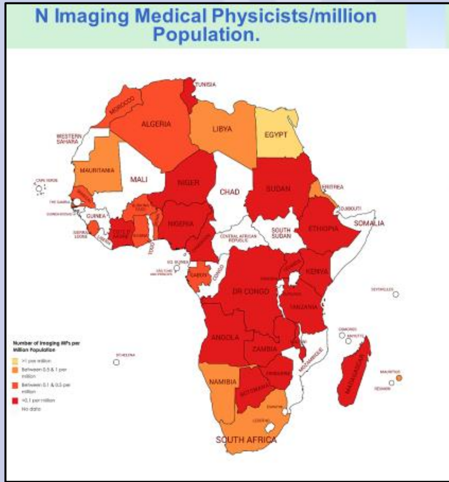
3 Medical Physics Department, Nuclear Research Centre of Algiers, Algiers, Algeria

4 International Atomic Energy Agency, Vienna, Austria

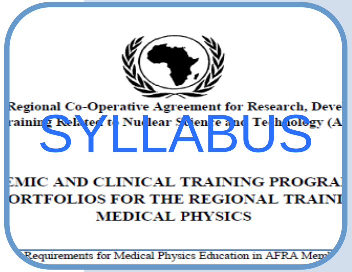
Published online: 31 March 2022







Harmonized Clinical training program in imaging in Africa


Regional Co-Operative Agreement for Research, Deve...
...raining Related to Nuclear Science and Technology (A...
...EMIC AND CLINICAL TRAINING PROGRA...
...ORTFOLIOS FOR THE REGIONAL TRAINI...
MEDICAL PHYSICS
...Requirements for Medical Physics Education in AFRA Mem...

SYLLABUS

Radiology program

Nuclear Medicine Program

Medical physicists clinical training in imaging in 2021

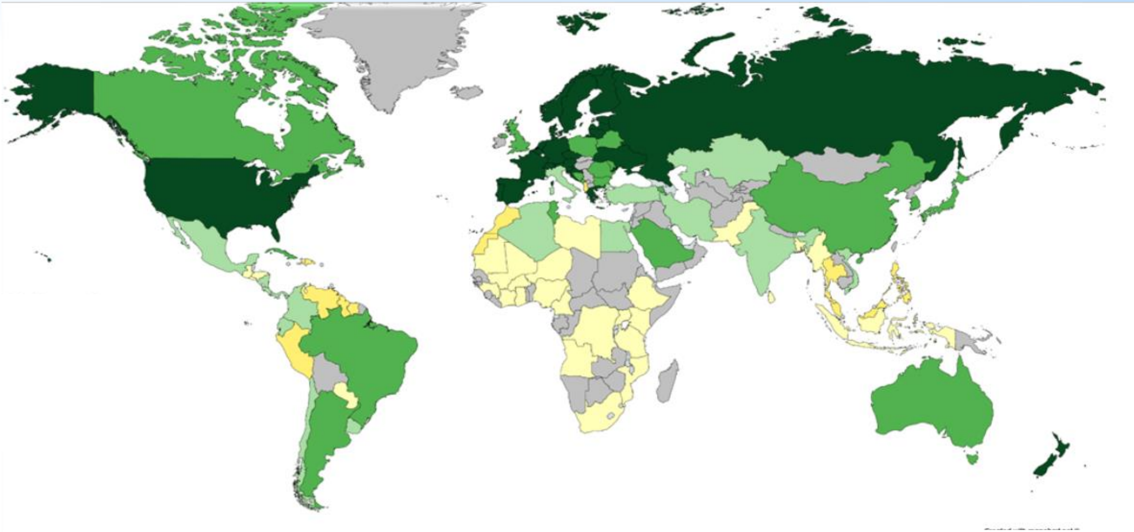
(more countries to be involved in the near future)

Algeria

19 long term groups fellowship for clinical training on quality assurance, dosimetry, safety, quality management systems, etc

Human resources

IAEA



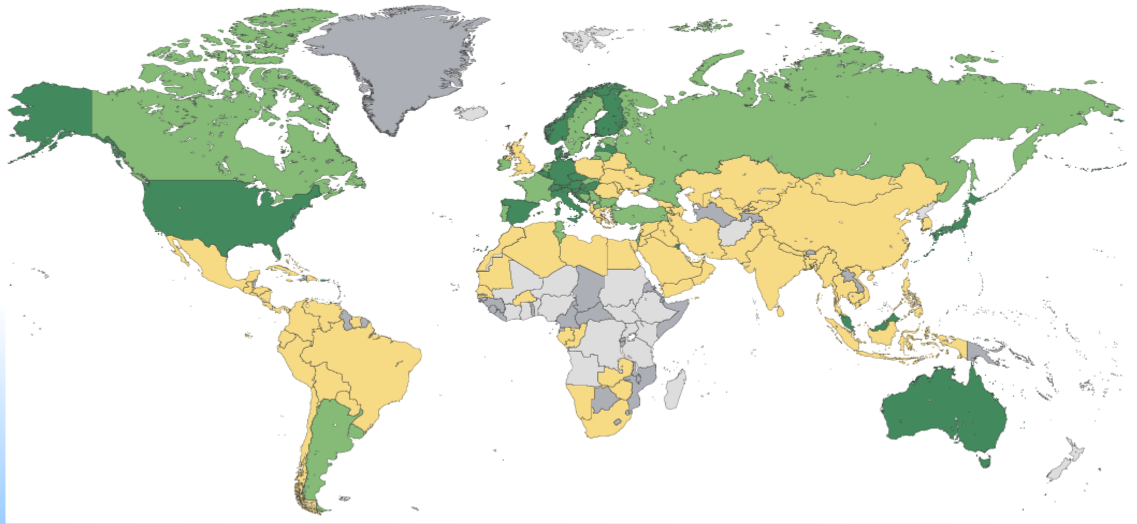
Radiologists ranges

- More than 100
- Between 50 and 100 (inc)
- Between 25 and 50 (inc)
- Between 10 and 25 (inc)
- Between 0 and 10 (inc)
- Data not available

iMAGiNE

IAEA Medical Imaging and Nuclear Medicine Global Resources Database

IAEA



NM Physicians ranges

- More than 10
- Between 5.1 and 10 (inc)
- Between 0.1 and 5 (inc)
- No NM Physicians
- Data not available

IAEA

Rays of Hope

Cancer care for all

Rays of Hope aims to improve cancer outcomes by providing comprehensive access to *radiation medicine* where it is needed.

What is an Anchor centre?

A regional leader who contributes to best practices in radiation medicine while enhancing professional development

Integrated cancer services

Employment of various technologies from diagnosis to treatment

Research projects

A proven record of research, including participation in coordinated research projects

Fellows

Training of fellows in conjunction with the IAEA

Training & education programmes

Provision of Master and/or Doctorate prog, related to radiation medicine

In cooperation with nationally recognized universities

Experts

Provision of experts for IAEA training courses and missions

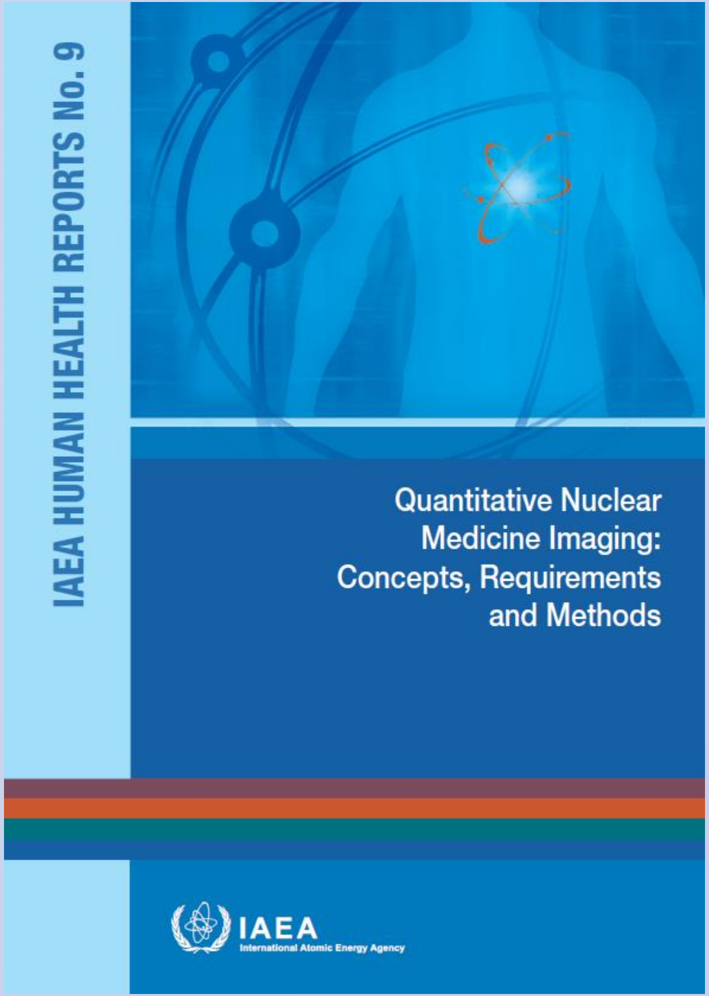
IAEA
International Atomic Energy Agency

Introduction of IAEA's Initial Five Anchor Centres at the 67th General Conference

- the University Hospital Centre of Bab El-Oued and Pierre and Marie Curie Cancer Centre (Algeria)
- King Hussein Cancer Center (Jordan)
- Institut National d'Oncologie (Morocco)
- Atomic Energy Cancer Hospital, Nuclear Medicine, Oncology and Radiotherapy Institute, Islamabad (Pakistan)
- and Ege University Faculty of Medicine (Türkiye).

Anchor Centres (as of Jan 2024)

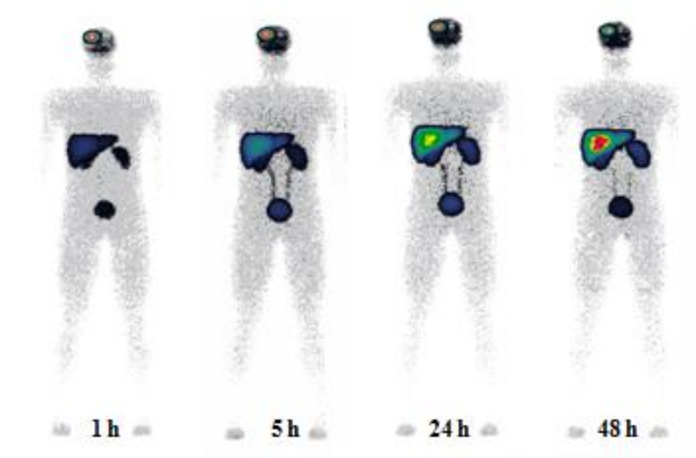
Anchor Centre applications: 20
Approved centres: 8
Anchor Centres: 5

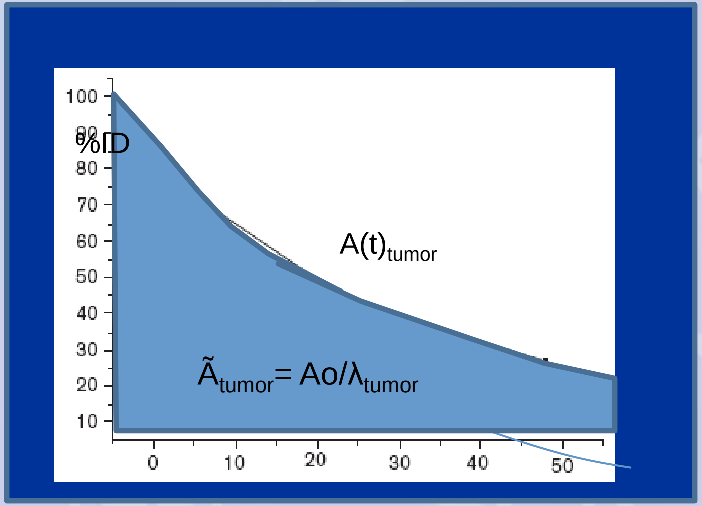


- Published in February 2014
- Addressed to Medical Physicists working in a clinical environment in establishing proper procedures for quantification of nuclear medicine images and for internal dosimetry

Irene Buvat (France)
Eric C Frey (USA)
Alan J Green (UK)
Michael Ljungberg (Sweden)
S. Palm, GL Poli (IAEA)

CRP E23005 "Radiopharmaceutical Therapy (RPT): Dosimetry-Driven Treatment Planning and Global Research Collaboration"



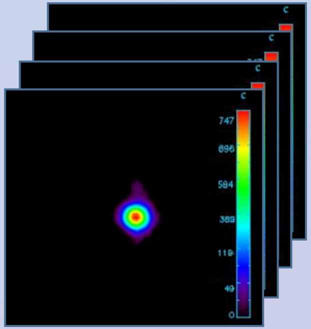


t(h)

$$\frac{\tilde{A}_{tumor}}{C_{T\ tumor}} = \frac{\tilde{A}_{x,y,z}}{C_{x,y,z}}$$

$$\tilde{A}_{x,y,z} = \frac{\tilde{A}_{tumor}}{C_{T\ tumor}} * C_{x,y,z}$$

T_{adq}=3h



Tomographic Slices

Bolch, W.E., et al. MIRD Pamphlet No. 17: "The dosimetry of …." J Nucl Med, 1999. ***40: p. 11S-36S.***

CRP E23005 "Radiopharmaceutical Therapy (RPT): Dosimetry-Driven Treatment Planning and Global Research Collaboration"

Dosimetry-Driven Approach: Emphasizes patient-specific pharmacokinetics, tumour, and organ radioactivity localization via imaging. Considers differences in absorbed dose estimates, accounting for individual patient factors and radionuclide properties.

Impact:

Develop capabilities in state-of-the-art dosimetry research in RPT, impacting clinical services and research potential in member states.

JNM
The Journal of Nuclear Medicine

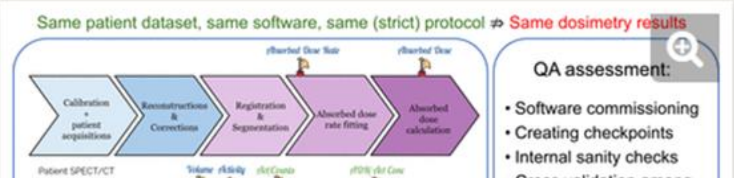
Research Article | Clinical Investigation

Quality Assurance Considerations in Radiopharmaceutical Therapy Dosimetry Using PLANETDose: An International Atomic Energy Agency Study

Gunjan Kayal, Nathaly Barbosa, Carlos Calderón Marín, Ludovic Ferrer, José-Alejandro Fragoso-Negrín, Darko Grosev, Santosh Kumar Gupta, Nur Rahmah Hidayati, Tumelo C.G. Moalosi, Gian Luca Poli, Parul Thakral, Virginia Tsapaki, Sébastien Vauclin, Alex Vergara-Gil, Peter Knoll, Robert F. Hobbs and Manuel Bardiès

Journal of Nuclear Medicine October 2023, jnumed.122.265340; DOI: https://doi.org/10.2967/jnumed.122.265340

Visual Abstract



In this issue

Journal of Nuclear Medicine
Vol. 64, Issue 10
October 1, 2023
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Complete Issue (PDF)

Outcome of E2.30.05

Joint IAAE-AAPM seminar "New IAEA Programs and Projects On Radiopharmaceutical Therapy" at the AAPM Meeting 2022

Gunjan Kayal, Maxime Chauvin, Alex Vergara-Gil, Naomi Clayton, Ludovic Ferrer, Tumelo Moalosi, Peter Knoll, Lara Struelens, Manuel Bardiès "Generation of clinical 177Lu SPECT/CT images based on Monte Carlo simulation with GATE" Physica Medica, Volume 85, 2021,Pages 24-31

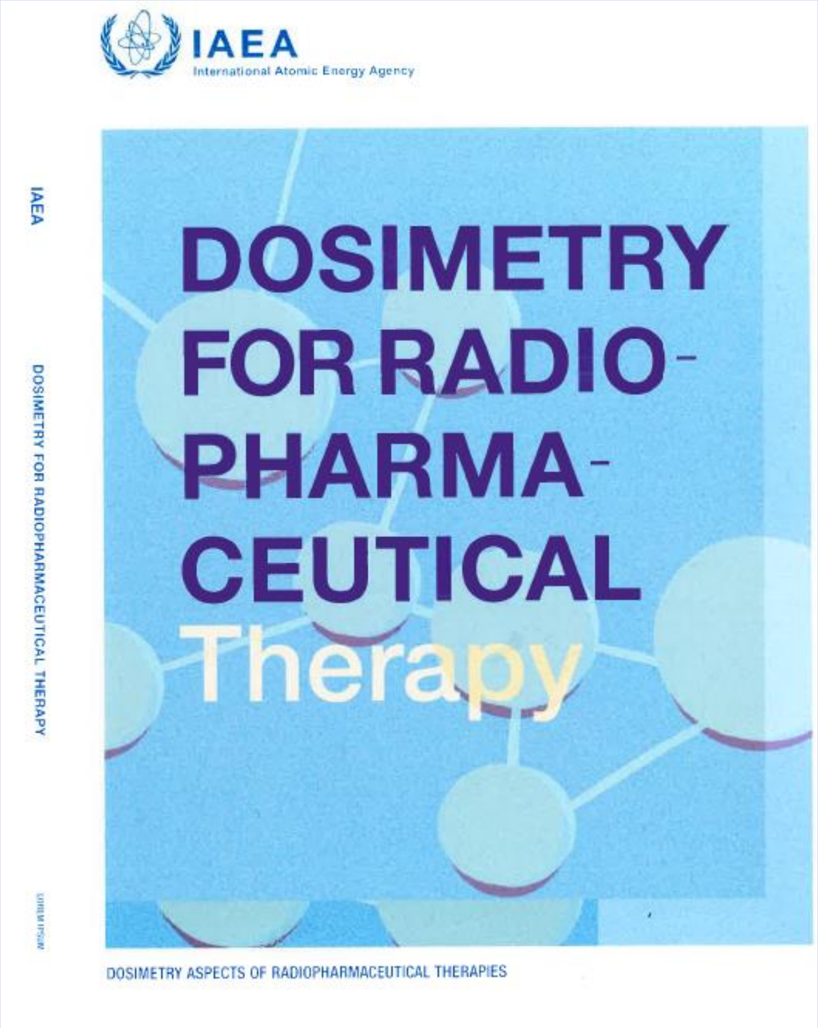
Poster presentation: I131 quantification and accuracy and precision using imaging and non-imaging techniques. XXXV Congresso brasileiro de medicina nuclear, Alasbimn

Indonesia marked a significant milestone by performing its first Lu-177 therapies, indicating a notable advancement in the field of Radiopharmaceutical Therapy (RPT) within the country.

Consultancy Meeting to Develop a CRP for an Evaluation on the Minimal Standard of Requirements of Medical Physicists Working on Radiopharmaceutical Therapies (RPT)

External Participants

Leonel Torres (Cuba), M. Bardies (France), K. Chuamsaamarkekee (Thailand), Y. Dewaraja (USA), R. Hobbs (USA)



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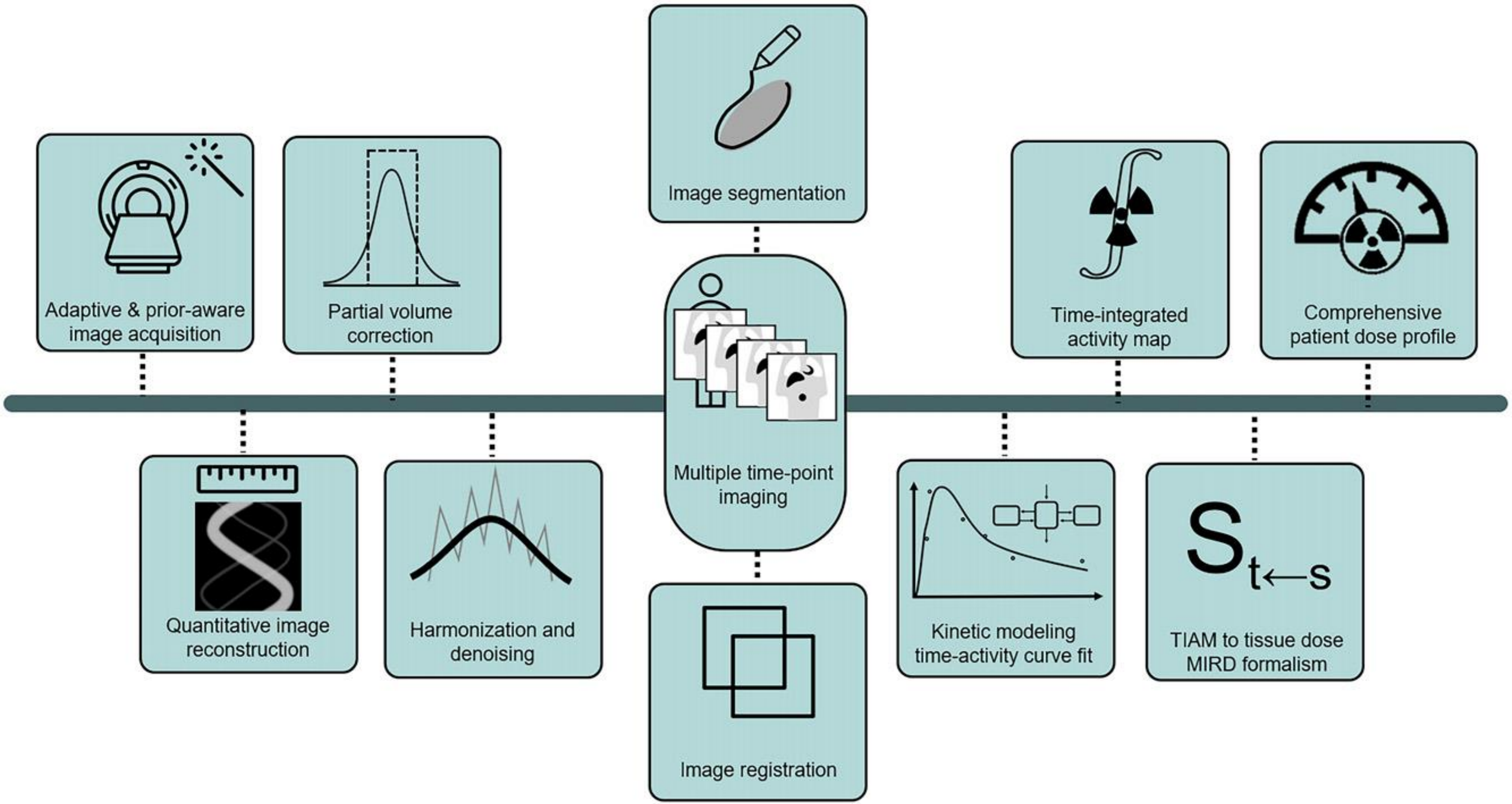
F.A. Verburg	Würzburg University, Germany
B. Zimmerman	National Institute of Standards and Technology, United States of America

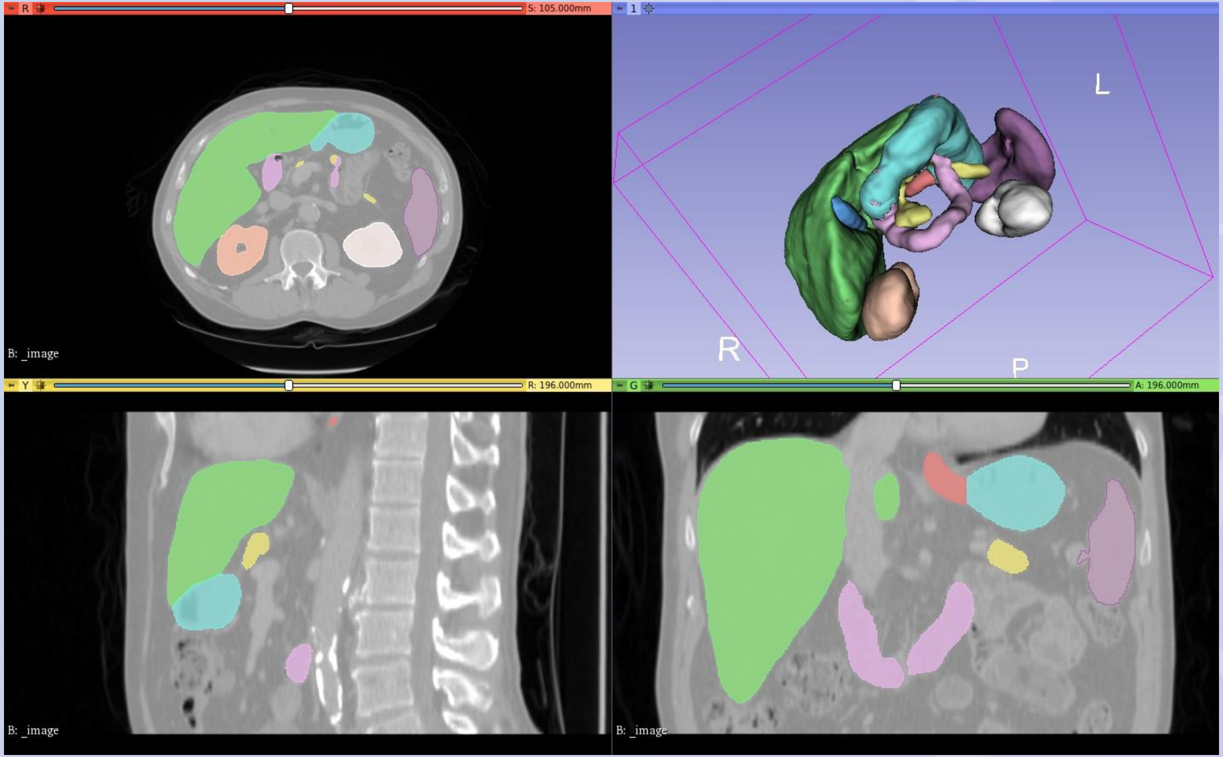
1. AI Integration Healthcare
2. Advances in Medical Technology
3. **Impact on Healthcare Delivery**
4. **Faster development of Clinical Software prototypes**
5. Navigating Implementation Obstacles
6. **Role of Medical Physicists (CQMPs)**

   Essential in safe AI implementation and need updated training in AI.
7. **Education and Training Needed**
8. **IAEA Guidance**



Saboury B. et al. Artificial Intelligence in Nuclear Medicine: Opportunities, Challenges, and Responsibilities Toward a Trustworthy Ecosystem.
J Nucl Med 2023; 64:188–196

AI-assisted annotation (AIAA) for 3D Slicer



[ai-assisted-annotation-client/slicer-plugin/README.md at master · NVIDIA/ai-assisted-annotation-client · GitHub]

IAEA Transthyretin Amyloid Cardiomyopathy Study – The I-TAC study

CRP, Start 2021, duration: 4 years , NMDI Diana Paez, Anita Brink

Participating countries: Argentina, Australia, Brazil, Croatia, Cuba, Greece, India, Italy, Latvia, Malaysia, Mexico, Serbia, South Africa, Spain, Sweden, Türkiye, United States of America, Uruguay

Heart Failure with Preserved Ejection Fraction (HFpEF): Major health issue, commonly undiagnosed.

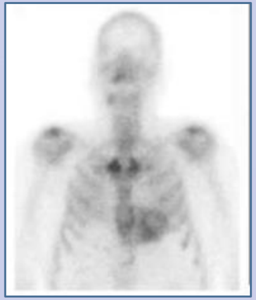
Transthyretin Amyloid Cardiomyopathy (ATTR-CMP): Affects 13-18% of adults >65 with HFpEF, median survival 25-41 months.

Challenge: Underdiagnosis of ATTR-CMP limits treatment effectiveness.

Underdiagnosis Factors: Lack of knowledge about amyloidosis, Lack of expertise in Tc-99m-PYP imaging.

Solution: Tc-99m-PYP SPECT test—non-invasive, accurate diagnosis, avoids biopsy.

Perugini 1



Perugini 2

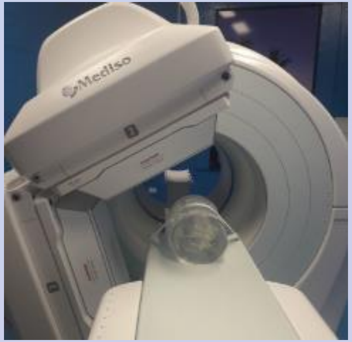
Perugini 3

Grigoratos C. et al. IJC 2020

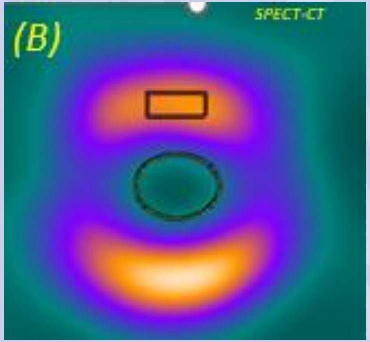
IAEA Transthyretin Amyloid Cardiomyopathy Study – The I-TAC study

IMPLEMENTING QUANTITATIVE EVALUATION OF ATTR-CMP
USING ABSOLUTE METRICS FROM Tc-99m-PYP STUDIES.

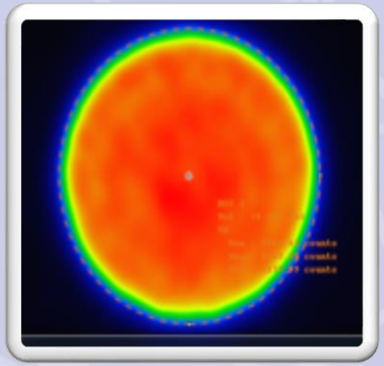
Data Collection:



Data Processing:



Result Analysis:



Joint ICTP-IAEA Workshop on Dosimetry in Radionuclide Therapy and Diagnostic Nuclear Medicine

20 September - 1 October 2021
An ICTP - IAEA Virtual Meeting
Trieste, Italy

Further information:
http://indico.ictp.it/event/9593/
smr3570@ictp.it

In recent years, there has been an increase of therapeutic applications using radiopharmaceuticals. This workshop, which is intended for clinically qualified medical physicists with experience in radionuclide therapy, will provide the participants with a comprehensive review of the developments in the field of nuclear medicine image quantification and practical internal dosimetry.

Description:

The purpose of this workshop is to contribute to the knowledge of clinically qualified medical physicists in nuclear medicine by providing theoretical and practical tools for internal dosimetry. Molecular radiotherapy has demonstrated unique therapeutic advantages in the treatment of an increasing number of cancer types. Such treatments can deliver high absorbed doses to specific targets (tumour lesions) and healthy organs (organs at risk) and, thus, require a patient specific dose assessment. These calculations would help to optimize the amount of radioactivity to be administered and to reduce the risk of under- or over-dosing patients, otherwise observed when using empirical approaches to activity determination. As part of the selection, candidates will be requested to undertake a written test.

The workshop is under the umbrella of ICTP and IAEA and is expected to strengthen the knowledge of clinically qualified medical physicists working in nuclear medicine. The expected audience are clinically qualified medical physicists working in a hospital, with at least 5 years' experience in the field of nuclear medicine medical physics including radionuclide therapy.

Topics:

- Introduction to radiopharmaceutical dosimetry and MIRD formalism
- Time integrated activity coefficient calculation
- Radiation transport and energy deposition
- ICRP internal dose coefficient for radiological protection
- Y-90 microspheres dosimetry
- Bone seeking radiopharmaceuticals (including Ra223 therapy)
- Peptide receptor radionuclide therapy
- I131 therapy
- Radiation safety for staff and the public in therapeutic nuclear medicine

The workshop will be conducted in English.

Director:

P. KNOLL, IAEA, Austria

Local Organiser:

R. PADOVANI, ICTP, Italy

Lecturers:

M. BARDIES (France)
W. BOLCH (USA)
C. CHIESA (Italy)
M. CREMONESI (Italy)
L. FERRER (France)
G. GLATTING (Germany)
R. HOBBS (USA)
M. LASSMANN (Germany)
L. STRIGARI (Italy)
A. VERGARA-GIL (France)

How to apply:

Online application:
http://indico.ictp.it/event/9593/

Female scientists are encouraged to apply.

Registration:

There is no registration fee.

Deadline:

30 June 2021

IAEA

ICTP The Abdus Salam International Centre for Theoretical Physics
www.ictp.it
Trieste, Italy

Joint ICTP-IAEA Workshop on Quantitative Imaging and Analysis Methods in Modern Nuclear Medicine

Description:

An advanced workshop for medical physicists working in nuclear medicine departments, diving deep into advanced nuclear medicine imaging, emphasizing quantitative methods, rigorous quality control, and emerging trends.

29 April - 3 May 2024

Trieste, Italy

International Conference on Hybrid Imaging (IPET 2024)

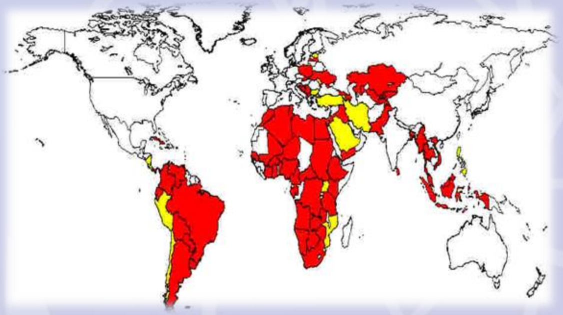
7–11 October 2024, Vienna, Austria

The IPET 2024 conference will provide clinicians and imaging specialists with an international forum to critically examine the pivotal role of multimodality imaging techniques and their streamlined and emerging clinical applications, with special emphasis on SPECT-CT, PET-CT, and PET-MR for cancer management within adult and paediatric populations. As well, it will critically assess current clinical indications of radiopharmaceutical therapies in cancer management, using an evidence-based approach.

Abstract deadline: 11 March 2024

https://www.iaea.org/events/ipet-2024

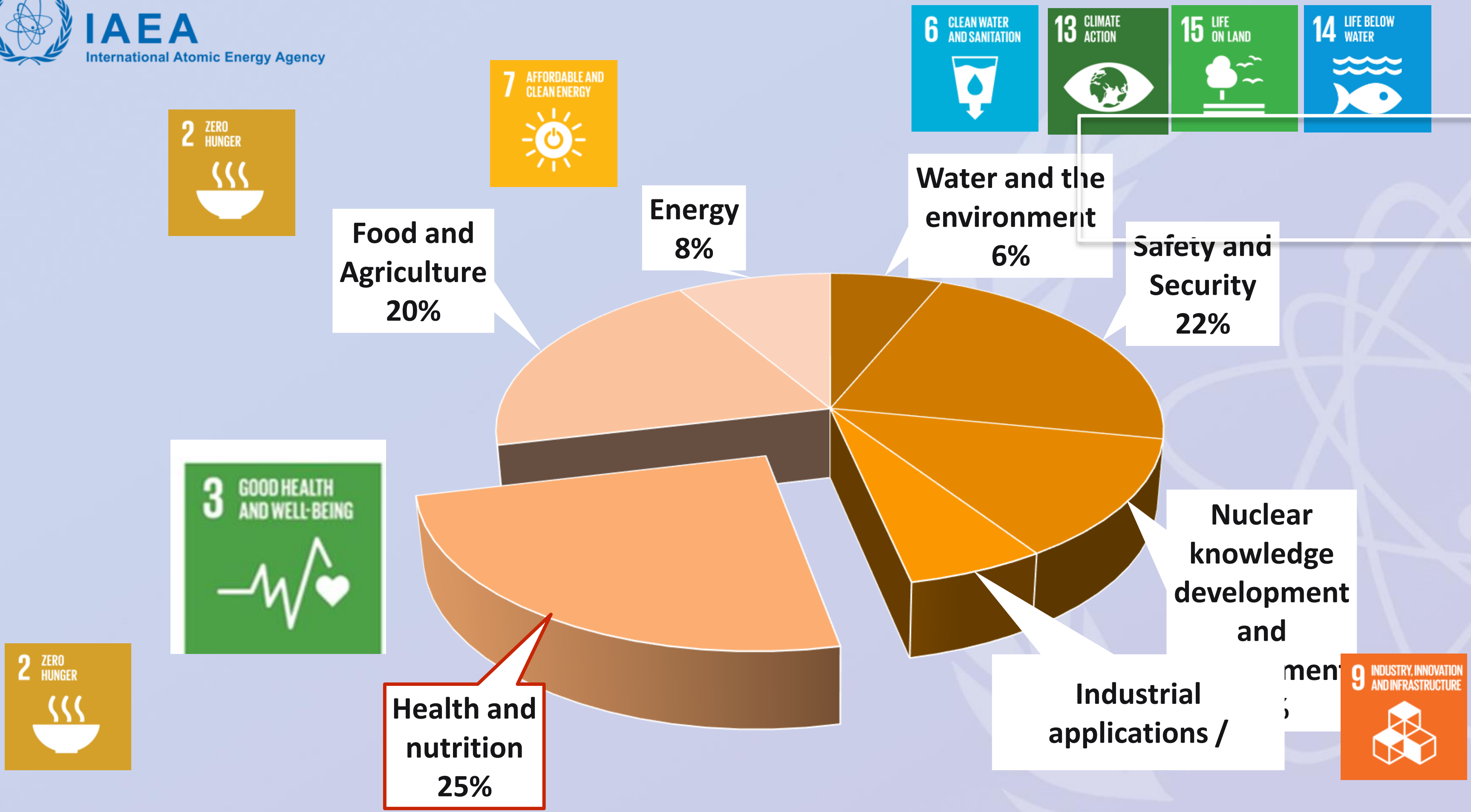
Technical Cooperation Programmes



IAEA's primary mechanism for transferring nuclear technology to the member states:

- Fellowships
- Expert missions
- Training Courses
- Procurement

IAEA
International Atomic Energy Agency

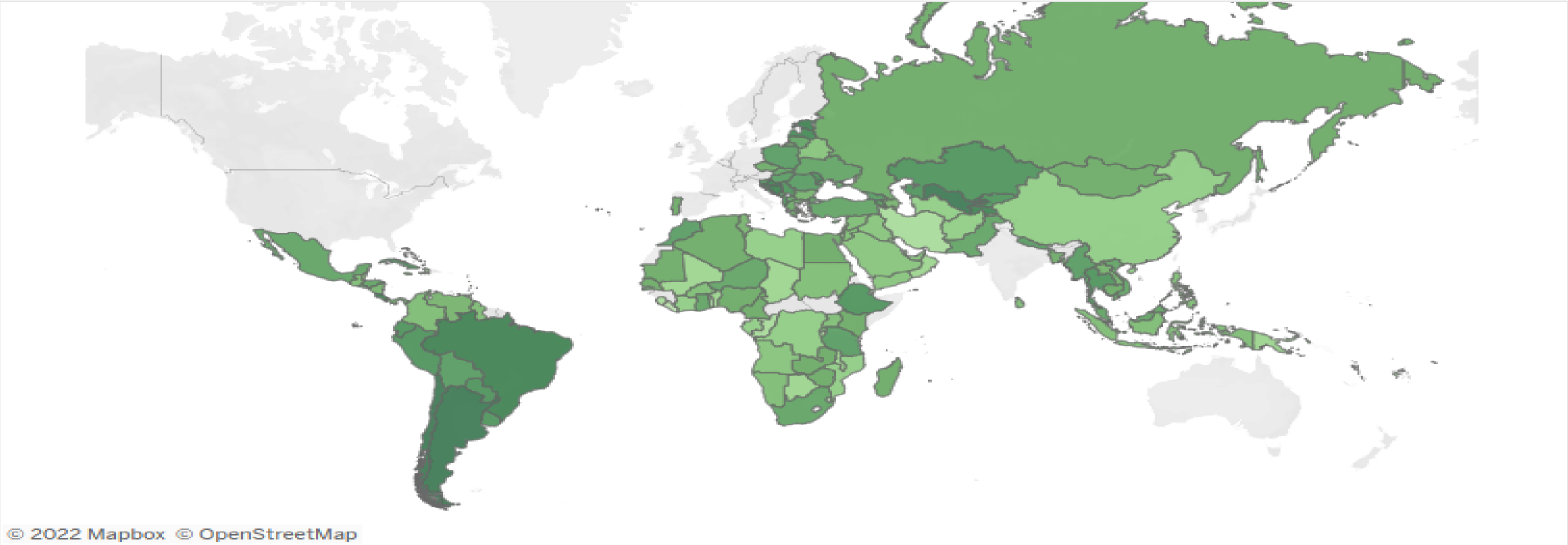


242 Projects | **143** Countries | **24** Staff | **2021** Since

5 Interregional | **31** Regional | **206** National

TC Projects

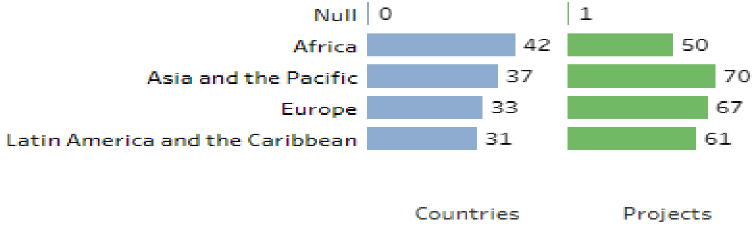
Last Update: 01/02/2022 10:15:22



TC projects by section

TO is a part of the project team

TC projects by region



Project Type
(All)

Sections
- [ ] (All)
- [ ] Division of Human H...
- [x] Dosimetry
- [x] Nuclear Medicine
- [ ] Nutrition
- [ ] Radiation Oncology

TO Name
(All)

Closure Status
- [ ] (All)
- [ ] Cancelled
- [ ] Closed
- [ ] On-hold
- [x] Open
- [ ] Pending Closure

TC Project Year
(Multiple values)

Project Number

Country

Regions
(All)

ProjectType
- Interregional
- Regional
- National

CountProjectNumber
1 14

SUNRISE

Under the umbrella of Rays of Hope Initiative and Innovation in Low resourced setting

We are aiming to measure the impact of interventions in radiation medicine for cancer patients.

By Establishing a global radiation medicine database for collecting meaningful data from centres and member states in the relevant field of expertise within NAHU to support research in the field.

Sustainable Unified Network for Radiation Medicine Innovation and Scientific Excellence

Medical Physicists: Essential Catalysts in Advancing Data-Driven Healthcare


Many thanks for your attention!