AAPM 2013 International Medical Physics Symposium

Making a Difference in the World: Are you willing to be part?

Madan M. Rehani, PhD

Currently with European Society of Radiology, Work reported pertains to International Atomic Energy Agency, Vienna, Austria

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We are all interested in making a difference

Global Scenario

- **3.6 billion medical X ray procedures/year**
- **About 35 million nuclear medicine examinations**
- **About 5 million patients radiotherapy treatments**

Challenge!!!!!

Early 2000's

Are children undergoing x-ray examinations in developing countries getting higher radiation dose than necessary?

Our recent study- Pediatric CT

Armenia (1), Belarus (1), Bosnia & Herz (3) Brazil (5), Bulgaria (12), China (3), Costa Rica (1), Croatia (3), Czech Republic (6), Estonia (2), Indonesia (1),	Iran (10), Israel (7), Kuwait (5), Lebanon (6), Lithuania (3), Malaysia (5), Malta (1), Mexico (2), Montenegro (1), Moldova (5), Myanmar (1),	Oman (1), Pakistan (5), Paraguay (3), Peru (1), Poland (1), Qatar (1), Serbia (3), Singapore (1), Slovakia (4), Slovenia (1), Sri Lanka (2)	Sudan (3), Syria (8), Tanzania (3), Thailand (2), The Former Yugoslavia Republic (FYR) of Macedonia (5), United Arab Emirates UAE (15).

40 Less resourced countries

AJR FOCUS ON:

IAEA Survey of Pediatric CT Practice in 40 Countries in Asia, Europe, Latin America, and Africa: Part I, Frequency and Appropriateness

Jenia Vassileva[1]
Madan M. Rehani[2]
See end of article for complete author list

OBJECTIVE. The purpose of this study was to assess the frequency of pediatric CT in 40 less-resourced countries and to determine the level of appropriateness in CT use.

MATERIALS AND METHODS. Data on the increase in the number of CT examinations during 2007 and 2009 and appropriate use of CT examinations were collected, using standard forms, from 146 CT facilities at 126 hospitals.

Eur Radiol
DOI 10.1007/s00330-012-2639-3

COMPUTED TOMOGRAPHY

IAEA survey of paediatric computed tomography practice in 40 countries in Asia, Europe, Latin America and Africa: procedures and protocols

Jenia Vassileva · Madan M. Rehani · Kimberly Applegate · Nada A. Ahmed · Humoud Al-Dhuhli · Huda M. Al-Naemi

First ever study of this kind

Findings from these papers

- **Dedicated CT protocols in 94%**
- **Protocols for some age groups not available 50%**
- **Indication based protocols used in 57%**
- **$CTDI_{vol}$ for head, chest in some facilities 2-5 times adults**
- **Up to 100 times variation in radiation dose**

Results: Typical exposure parameters

Protocols for **chest examination** of infant (<1 y) in 8 CT facilities with the same 64-detector scanner model (Light Speed VCT, GE)

Scanner number	mode	Tube voltage, kV	Tube current, mA	t rot, s	Pitch value	$CTDI_{vol}$, mGy
39	helical	80	129	0.5	1.3	1.89
40	helical	120	120	0.5	0.984	10.21
102	helical	80	240	0.5	0.984	2.64
26	helical	80	100-250	0.5	0.96	4.35
29	helical	100	180	0.4	0.98	13.2
8	helical	120	80	0.4	1.375	4.5
124	helical	80	25	0.5	0.9	0.71
119	helical	120	80	0.6	0.9	10

14.5-fold variation

Head CT

- $CTDI_w$ values were higher than the latest UK DRL values for children by,
  - 62% for age group <1y,
  - 27% for (1-5) y,
  - 22% for (5-10) y.
- The third quartile $CTDI_{vol}$ values are lower by 3 to 16% than the DRLs in UK, Germany and France, depending on the age group, but they are higher than corresponding values in Switzerland by up to 45%.
- **Gantry tilt or patient head repositioning was applied by more than 75% of operators**

Impact of Optimization

Appropriateness Issues

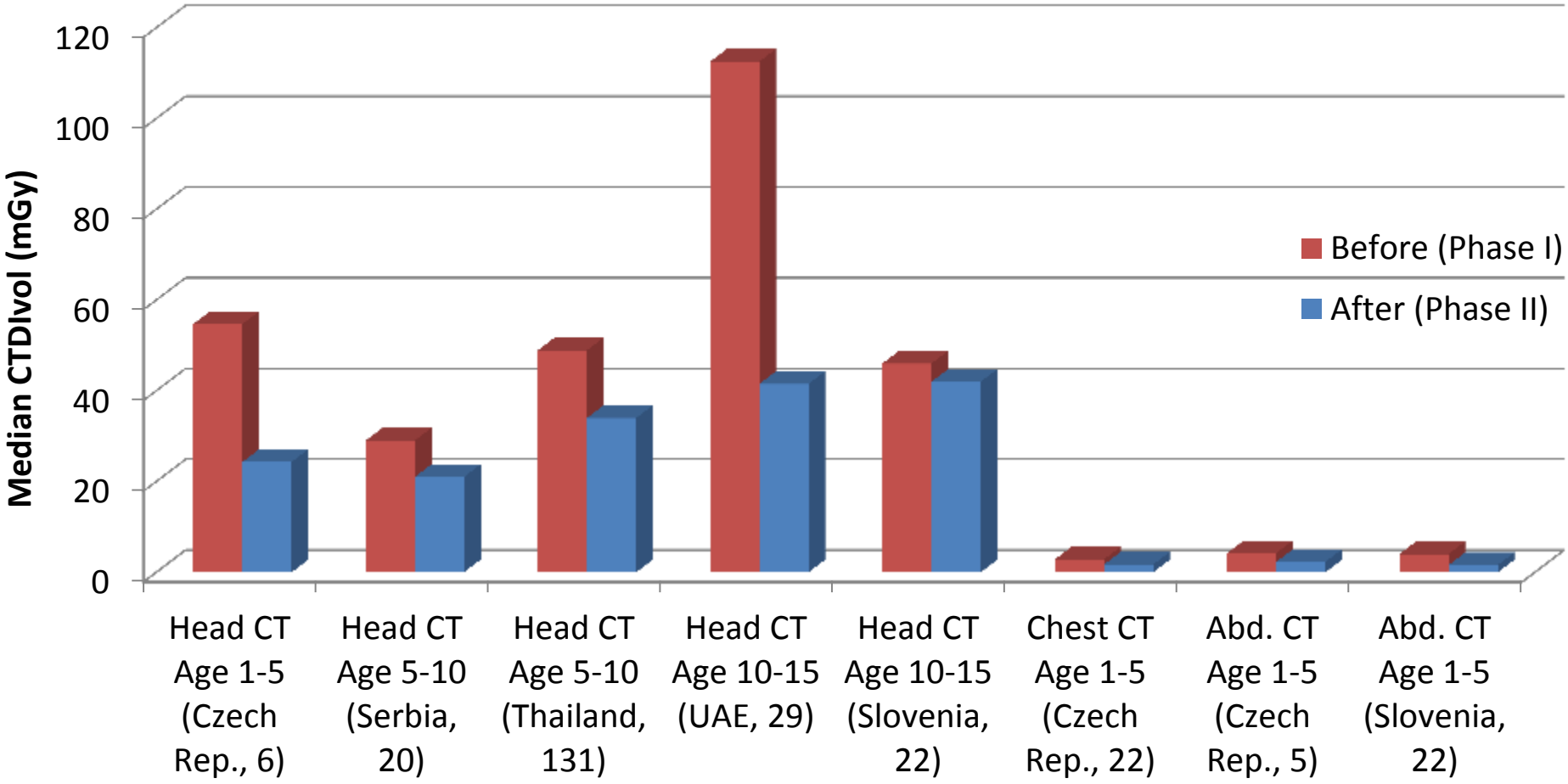
Not according to available guidelines in

- Accidental head trauma, (not in about 50%. Minor trauma and suspected abuse)
- Infants with congenital torticollis;
- Children with possible ventriculo-peritoneal shunt malfunction and
- Young children (<5 years old) with acute sinusitis.
- _____

Mostly according to guidelines

- Infant with hydrocephalus (76% use other than CT)
- Child with indication for appendicitis (acute abdominal pain)
- Child with persistent headache

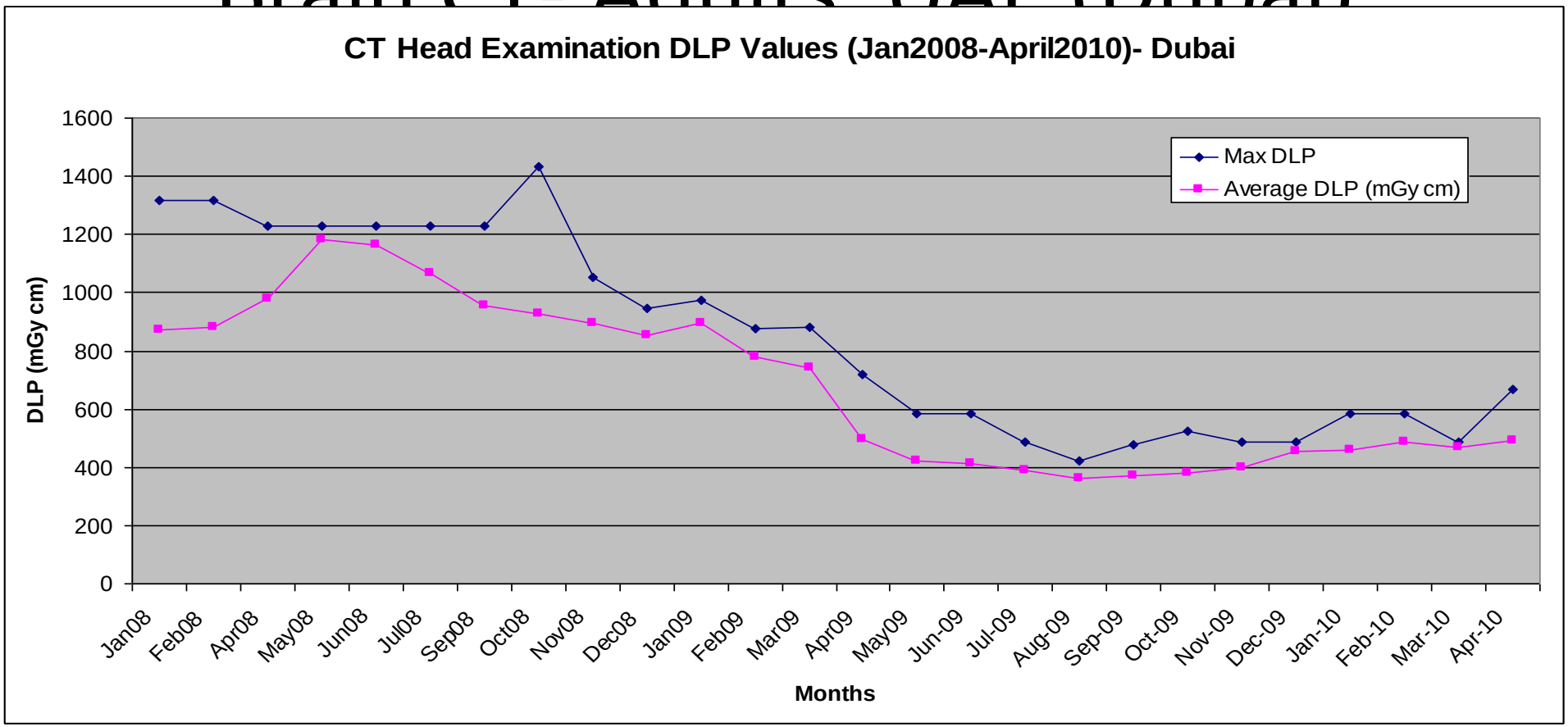
Impact of optimization



How many have experience in documenting impact of optimization

WITH TIME???

Brain CT- Adults UAE (Dubai)



How CT Dose has changed over period

Dose management actions following awareness, review of DLP values and analysis of causes when values are high and management in following patients thus increasing awareness among staff on regular basis

Radiation Protection Dosimetry Advance Access published August 17, 2009

Radiation Protection Dosimetry (2009), pp. 1–9 doi:10.1093/rpd/ncp144

PATIENT DOSES IN CT EXAMINATIONS IN 18 COUNTRIES: INITIAL RESULTS FROM INTERNATIONAL ATOMIC ENERGY AGENCY PROJECTS

W. E. Muhogora[1], N. A. Ahmed[2], A. Beganovic[3], A. Benider[4], O. Ciraj-Bjelac[5], V. Gershan[6], E. Gershkevitsh[7], E. Grupetta[8], M. H. Kharita[9], N. Manatrakul[10], M. Milakovic[11], K. Ohno[12], L. Ben Omrane[13], J. Ptacek[14], C. Schandorf[15], M. S. Shabaan[16], D. Stoyanov[17], N. Toutaoui[18], J. S. Wambani[19] and M. M. Rehani[20,*]

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[14]Department of Medical Physics and Radiation Protection, University Hospital Olomouc, I.P. Pavlova 6,

Radiation Protection Dosimetry Advance Access published February 11, 2010

Radiation Protection Dosimetry (2010), pp. 1–10 doi:10.1093/rpd/ncq015

PAEDIATRIC CT EXAMINATIONS IN 19 DEVELOPING COUNTRIES: FREQUENCY AND RADIATION DOSE

W. E. Muhogora[1], N. A. Ahmed[2], J. S. AlSuwaidi[3], A. Beganovic[4], O. Ciraj-Bjelac[5], V. Gershan[6], E. Gershkevitsh[7], E. Grupetta[8], M. H. Kharita[9], N. Manatrakul[10], B. Maroufi[11], M. Milakovic[12], K. Ohno[13], L. Ben Omrane[14], J. Ptacek[15], C. Schandorf[16], M. S. Shaaban[17], N. Toutaoui[18], D. Sakkas[19], J. S. Wambani[20] and M. M. Rehani[21,*]

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[11]Centre National de Radioprotection, Rabat, Agdal, Morocco
[12]Clinical Centre Banja Luka, 12 Beba 6, 7800 Banja Luka, Republic of Srpska, Bosnia & Herzegovina
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Some participants in projects

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

Image quality and dose in mammography in 17 countries in Africa, Asia and Eastern Europe: Results from IAEA projects

Olivera Ciraj-Bjelac[a,1], Simona Avramova-Cholakova[b,2], Adnan Beganovic[c,3], Sotirios Economides[d,4], Dario Faj[e,5], Vesna Gershan[f,6], Edward Grupetta[g,7], M.H. Kharita[h,8], Milomir Milakovic[i,9], Constantin Milu[j,10], Wilbroad E. Muhogora[k,11], Pirunthavany Muthuvelu[l,12], Samuel Oola[m,13], Saeid Setayeshi[n,14], Cyril Schandorf[o,15], Ion Ursulean[p,16], Ivan R. Videnovic[q,17], Areesha Zaman[r,18], Julius Ziliukas[s,19], Madan M. Rehani[t,*]

European Journal of Radiology
Article in Press, Corrected Proof - Note to users

doi:10.1016/j.ejrad.2011.03.075 | How to Cite or Link Using DOI
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Radiation protection of patients in diagnostic radiology: Status of practice in five Eastern-European countries, based on IAEA project

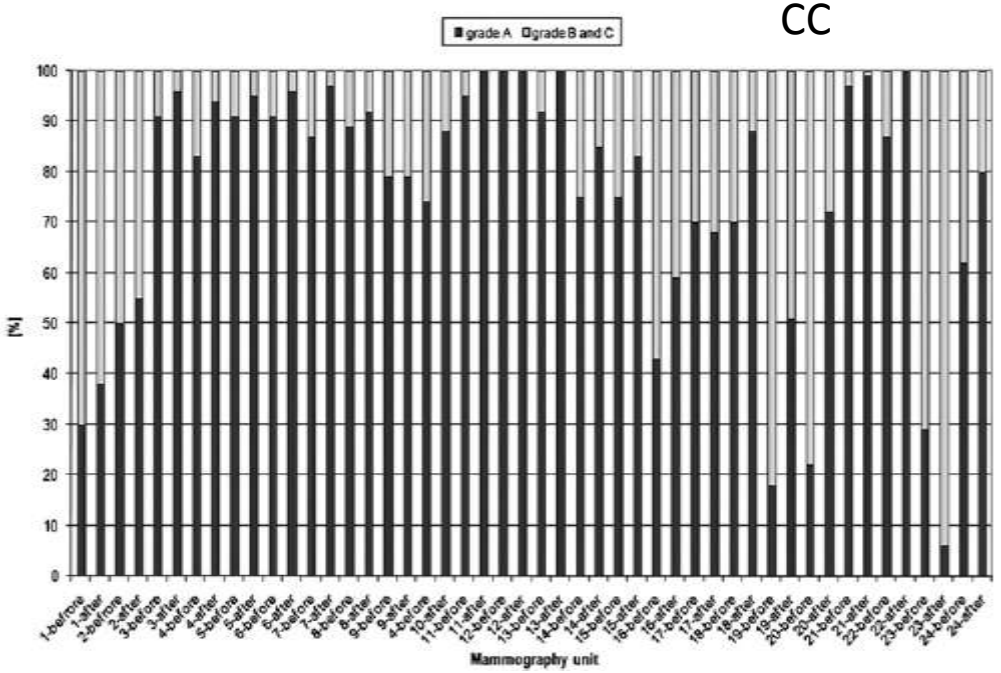
Olivera Ciraj-Bjelac[a, 1], Adnan Beganovic[b, 2], Dario Faj[c, 3], Vesna Gershan[d, 4], Sonja Ivanovic[e, 5], Ivan R. Videnovic[f, 6] and Madan M. Rehani[g,]

Image quality improvement

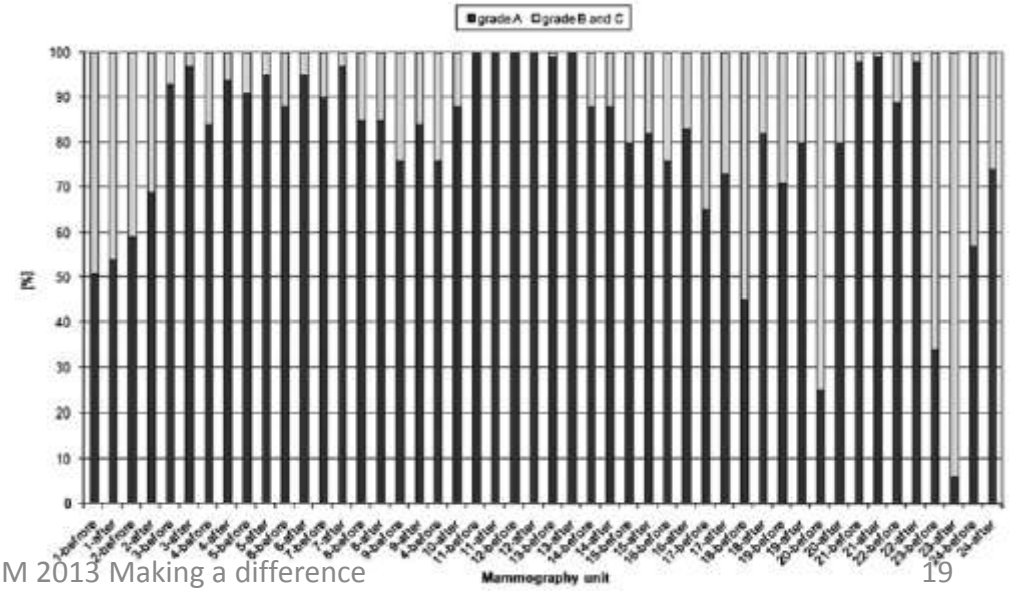
- Image quality improved by:
  - ***9 percentage for CC***
  - ***7 percentage points for MLO***

- Range: from a few percentage points to **more than 50 percentage points** in participating centres

CC



MLO



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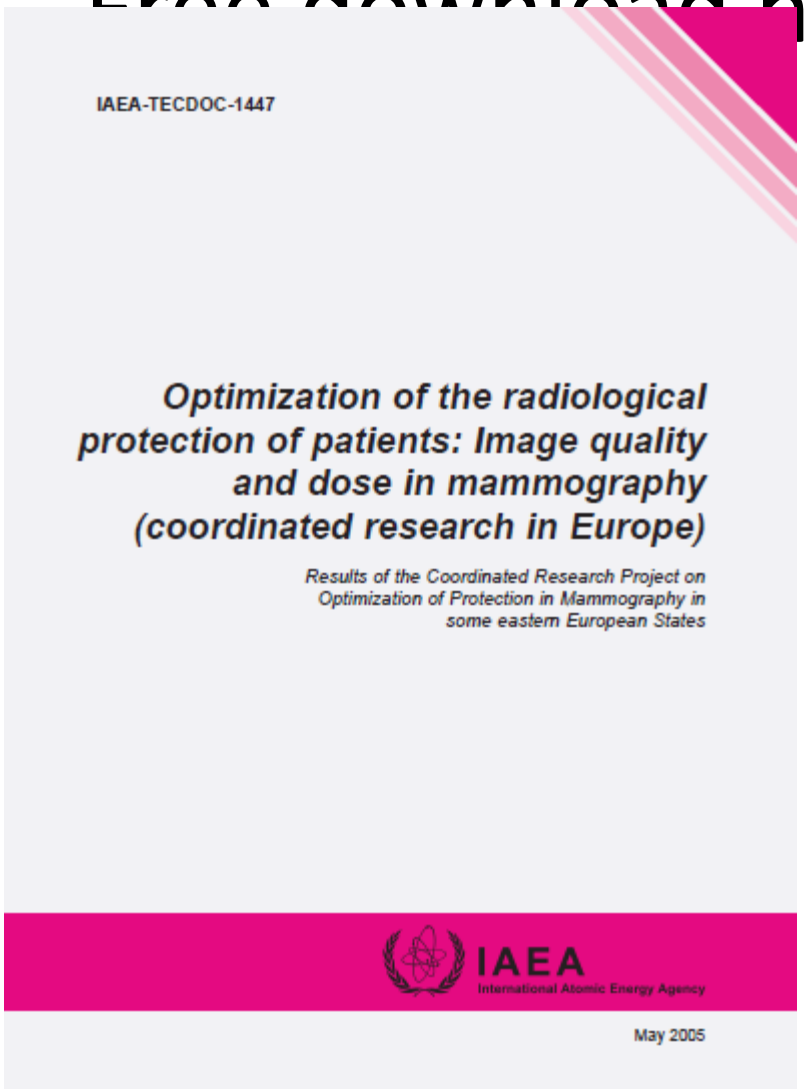

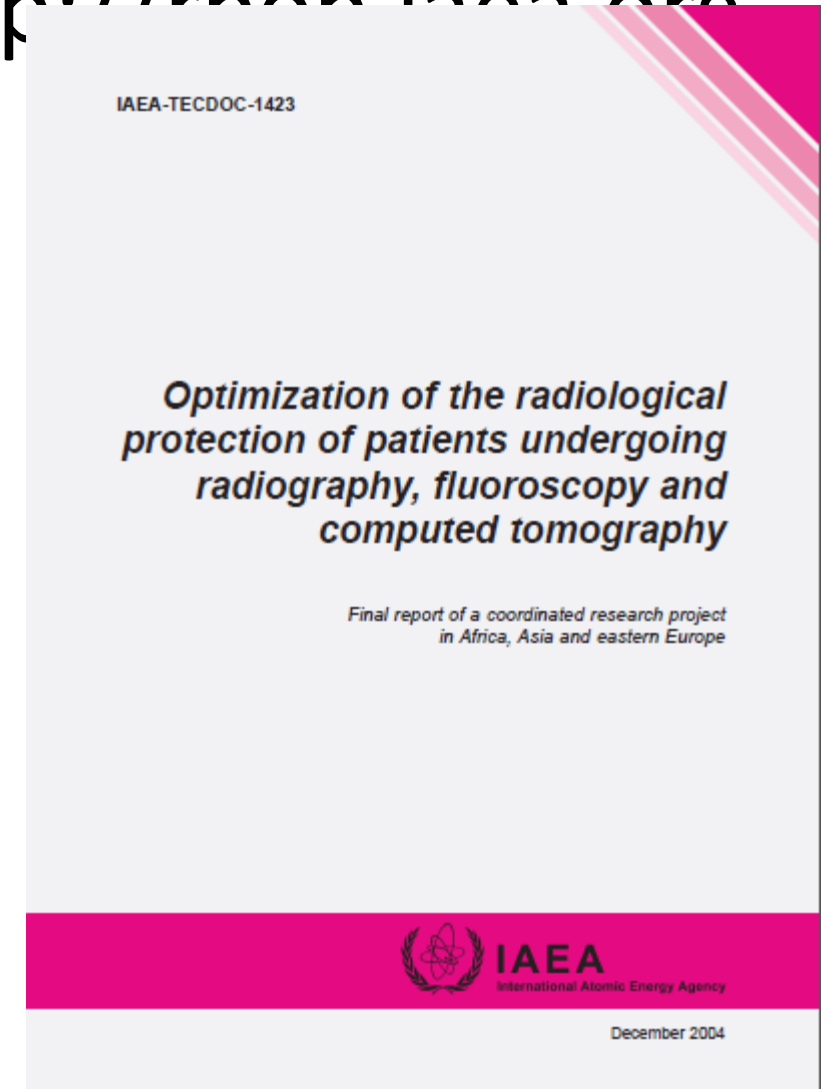

Radiation Protection Dosimetry Advance Access published July 2, 2011

Radiation Protection Dosimetry (2011), pp. 1–4 doi:10.1093/rpd/ncr259

IMPACT OF THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) ACTIONS ON RADIATION PROTECTION OF PATIENTS IN MANY COUNTRIES

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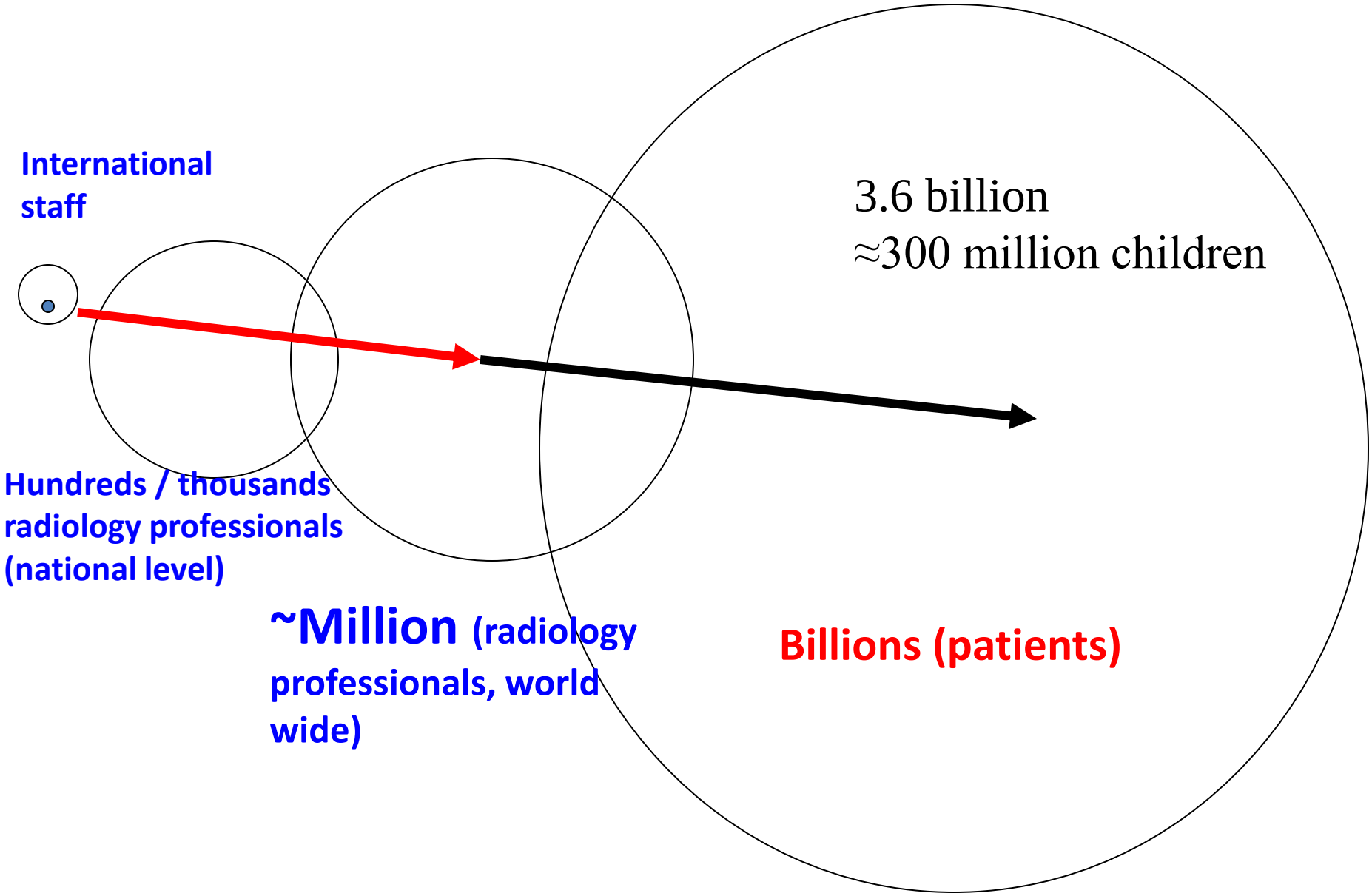
Medical Radiation Protection



Approaches

- **Train people**
- **No idea if it is making a change in situation**

1. **Assessing patient doses and image quality**
2. **Comparing with Standards**
3. **Improving**

Medical Radiation Protection

Networks

Training Courses
≈80 since 2002

Posters

Patient & Staff

Free Material

Smart Card

AJR American Journal of Roentgenology
THE LANCET
Radiation Protection Dosimetry
Radiology

International Action Plan on Radiation Protection of Patients

International Organizations and Professional Bodies

- World Health Organization (WHO)
- Pan American Health Organization (PAHO)
- European Commission
- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
- International Organization for Standardization (ISO)
- International Commission on Radiological Protection (ICRP)
- International Electrotechnical Commission (IEC)

- European Society for Therapeutic Radiology and Oncology (ESTRO)
- International Organization for Medical Physics (IOMP)
- International Radiation Protection Association (IRPA)
- International Society of Radiographers and Radiological Technologists (ISRRT)
- International Society of Radiology (ISR)
- World Federation of Nuclear Medicine and Biology (WFNMB)

Radiation Protection Dosimetry Advance Access published July 7, 2011

Radiation Protection Dosimetry (2011), pp. 1–5 doi:10.1093/rpd/ncr25

INTERNATIONAL ACTION PLAN ON THE RADIATION PROTECTION OF PATIENTS

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Website http://rpop.iaea.org

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Be Informed About the *Safe Use* of Ionizing Radiation in Medicine

Information to help health professionals achieve safer use of radiation in medicine for the benefit of patients

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Health Professionals
Member States
Patients

Additonal Resources
Publications
International Standards
Training

Special Groups
Pregnant Women
Children

Member Area
Member States Area
Drafts Management Area

Actions to Protect Patients In:
- Radiology
- Radiotherapy
- Nuclear Medicine
- Interventional Radiology
- Interventional Cardiology
- Other Specialities & Imaging Modalities

Latest Literature

Ferrandino, M.N., Bagrodia, A., Pierre, S.A., Scales, C.D. Jr., Rampersaud, E., Pearle, M.S., Preminger, G.M.,
Radiation exposure in the acute and short-term management of urolithiasis at 2 academic centers, J. Urol. **181** 2 (Feb. 2009) 668-672.

Keeley, F.X., Jr, Thornton, M.,
Radiation safety: Implications for urologists and patients, J. Urol. **181** 2 (Feb. 2009) 443-444.

Vano, E., Ubeda, C., Leyton, F., Miranda, P., Gonzalez, L.,
Staff Radiation Doses in Interventional Cardiology: Correlation With Patient Exposure, Pediatr. Cardiol. (Jan. 2009)

Did You Know That...

3. It is safe to have an X ray examination of the extremities (feet, legs, hands, arms), provided the examination is clinically justified and radiation protection principles are observed

« Prev Next »

Latest News

New Publications on Newer Imaging Techniques released
Download FREE three new publications on radiation protection in newer imaging techniques (PET/CT, Cardiac CT and CT colonography)

Cardiologists' Newsletter
Next issue of the Newsletter of the Asian Network of Cardiologists in Radiation Protection is now available

All News

Upcoming Events

Meeting planned to prepare contents for patient information part of this website, Vienna, 4-8 May 2009
Meeting to discuss framework for patient information, draw guidelines and prepare contents

Meeting for Smart Card for long term record of patient doses, Vienna, 27-29 April 2009
The first meeting on this project will be held in IAEA Vienna

All Events

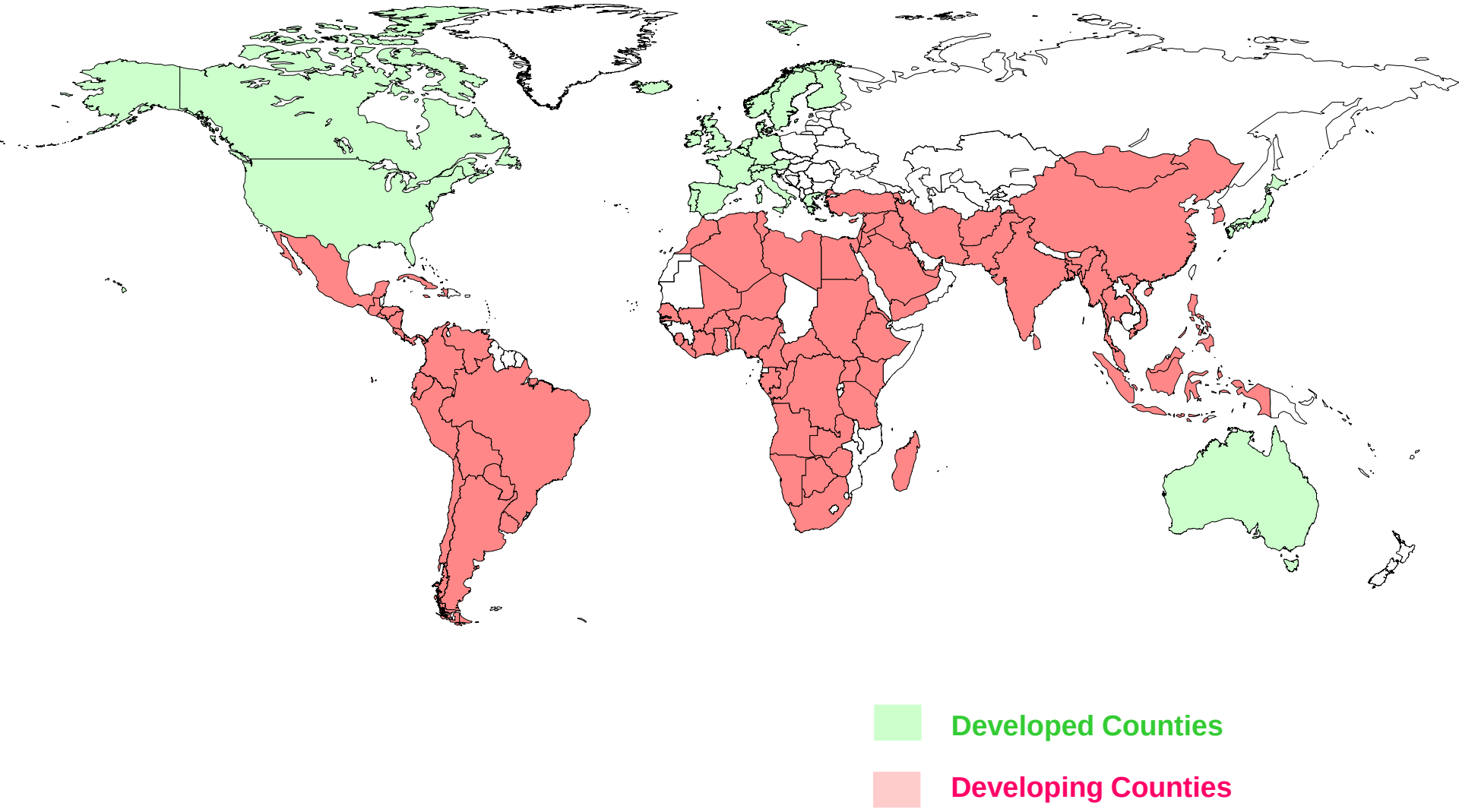
First page of Google search

15 million hits/y

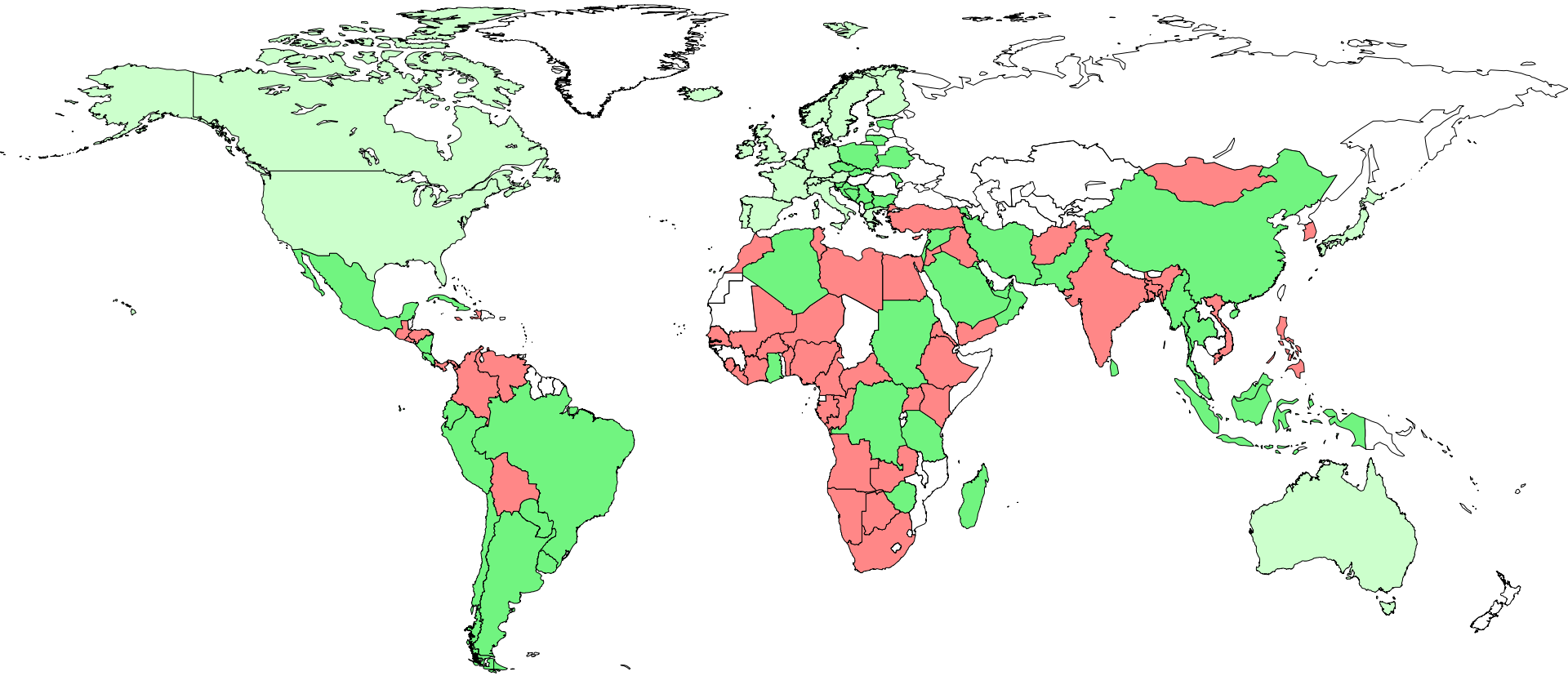
≈0.3 million visits/y, 190 countries

IAEA- Our FIRSTS

- **FIRST to establish a Unit on RPOP**
- **FIRST, International Action Plan on RPOP**
- **FIRST, website on RPOP**
- **FIRST, free training materials for diverse areas**
- **FIRST, Networks of Cardiologists, Gastroenterologists, Children**
- **FIRST, Smart Card project**
- **FIRST, Reporting system (SAFRAD, SAFRON)**


Developed Counties
Developing Counties

Patient Doses in Radiographic Examinations in Asia, Africa, Latin America and Eastern Europe



Algeria	China	FYR Macedonia	Madagascar	Oman	Singapore	United Arab Emirates
Argentina	Costa Rica	Ghana	Malaysia	Pakistan	Slovakia	Uruguay
Armenia	Croatia	Indonesia	Malta	Paraguay	Slovenia	Zimbabwe
Belarus	Cuba	Iran	Mexico	Peru	Sri Lanka	
Bosnia and Herzegovina	Czech Republic	Israel	Moldova	Poland	Sudan	
Brazil	Dem. Rep. of Congo	Kuwait	Montenegro	Qatar	Syria	
Bulgaria	Ecuador	Lebanon	Myanmar	Saudi Arabia	Tanzania	
Chile	Estonia	Lithuania	Nicaragua	Serbia	Thailand	

Analysis

- **Did we spend millions?**
  - **No**
- **Were there diagnostic medical physicists available?**
  - **Hardly any**
- **Did we spend more money in this project than other IAEA projects**
  - **No**

Most participants did not have experience in publishing papers in journals with high IF

Then how?

- **Motivation**
- **Human resource rather than financial resource**
- **Being part of international group**
- **Learning**
- **Exciting**
- **Making a difference in self and in patients**

Becoming a part of this process

- **As expert visiting developing countries for capability building in patient dose assessment and dose management**
- **As trainer in training courses**
- **As expert in meetings**
- **As member of Expert Advisory Panel**
- **Translation of training material**

AAPM Members from USA

For Radiation Protection of Patients

- **Lou Wagner**
- **William Hendee**
- **Steve Balter**
- **Joel Gray**
- **Dr. Perry Sprawls**
- **D. Townsend**
- **Chuck Willis**

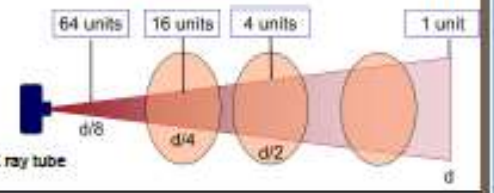
not complete list

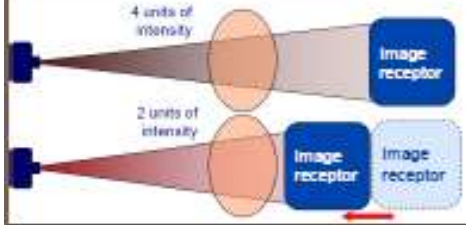
- **Mitch Goodsitt**
- **Bill Davros**
- **Kenneth Nichols**
- **Larry Rothenberg**
- **Suresh Agarwal**
- **Victor Gurvich**
- **William Pavliceck**

NB. Large number through other Sections of IAEA like DMRP…

10 Pearls: Radiation protection of *patients* in fluoroscopy

1. Maximize distance between the X ray tube and the patient to the extent possible

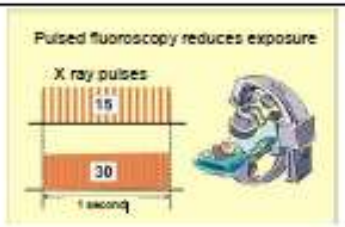




2. Minimize distance between the patient and the image receptor

3. Minimize fluoroscopy time

Keep records of fluoroscopy time for every patient



4. Use pulsed fluoroscopy with the lowest frame rate possible to obtain images of acceptable quality

5. Avoid exposing the same area of the skin in different projections

Vary the beam entrance port by rotating the tube around the patient

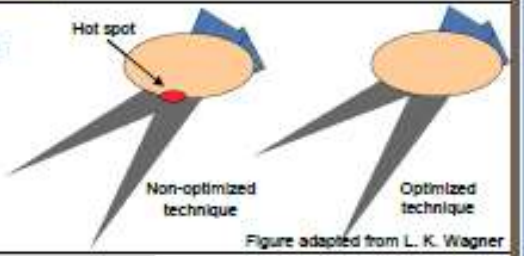


Figure adapted from L. K. Wagner

IAEA RPOP Radiation Protection of Patients

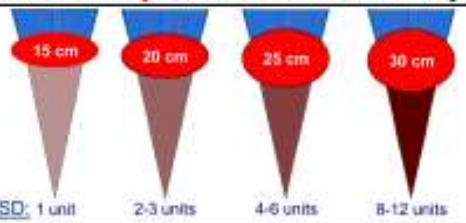
Related Poster!
10 pearls! Radiation protection of staff in fluoroscopy

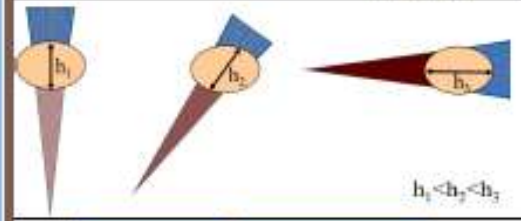
http://rpop.iaea.org

Page 1 of 2
Fluoroscopy
Patient Radiation Protection

10 Pearls: Radiation protection of *patients* in fluoroscopy

6. Larger patients or thicker body parts trigger an increase in entrance surface dose (ESD)





7. Oblique projections also increase ESD

Be aware that increased ESD increases the probability of skin injury

INTENSIFIER Field-of-view (FOV)	RELATIVE PATIENT ENTRANCE DOSE RATE FOR SOME UNITS
12" (32 cm)	100
9" (22 cm)	200
6" (16 cm)	300
4.5" (11 cm)	400

8. Avoid the use of magnification

Decreasing the field of view by a factor of two increases dose rate by a factor of four

9. Minimize number of frames and cine runs to clinically acceptable level

Avoid using the acquisition mode for fluoroscopy

Documentation should be performed with last image hold whenever possible and not with cine images

10. Use collimation

Collimate the X ray beam to the area of interest

IAEA RPOP Radiation Protection of Patients

Related Poster!
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Page 2 of 2
Fluoroscopy
Patient Radiation Protection

Andrei Pugachev
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Russian

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Children

Children have higher radiation sensitivity than adults and have a longer life expectancy. Therefore, imaging techniques that do not use ionizing radiation should always be considered as an alternative. Increasing numbers of radiological examinations are being performed in infants and children. Millions of children undergo high dose procedures such as computed tomography and interventional procedures. A paediatric radiological procedure should be individually planned and projections should be limited to what is absolutely necessary for a diagnosis.

Radiography and fluoroscopy

1. What X ray procedures contribute most to individual patient dose and collective population dose?
2. Are there special technical considerations required to reduce patient exposure and maintain good image quality in paediatric radiography?
3. How does the radiation dose in screen-film combination imaging compare to digital imaging in paediatric radiography?
4. Can low dose fluoroscopic image replace conventional radiographic examinations?
5. What are the typical dose levels in paediatric radiology?
6. What are the most significant things I can do to reduce patient dose during fluoroscopic examinations?
7. Are there situations in which I should consider reducing the number of radiographic projections?
8. How should one deal with possible pregnancy in adolescent patients?

image gently℠

Networks on Radiation Protection of Children

Training material paediatric radiology

Publications

Children Posters

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Use of social media to achieve interaction with the public on medical radiation protection

The IAEA's Division of Public Information organized an interactive session with the public through social media to encourage people to address their medical radiation protection questions to experts. Questions received over a stipulated period of about a week were pooled. Two experts answered selected questions that pertained to medical radiation protection.

According to the IAEA's Division of Public Information, the event "Ask an Expert in Radiation Protection" had unprecedented popularity. 140 people connected to and tweeted this event, commenting or asking questions. The overall discussion was very scientific. The information on radiation protection of patients posted during the event week received an average of 35,000 impressions per post and over 50 likes.

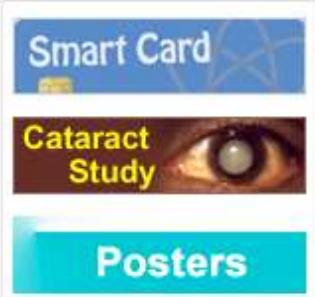
More than 15,000 impressions (number of people who saw these posts) for each video have been observed during the three weeks following the posting of the videos.

The feedback on the videos and the important scientific information contained therein was very positive, congratulatory and appreciative.

Please see links below for answers to questions:

Professor Marilyn Goske, Cincinnati Children Hospital, Cincinnati, USA

Dr Madan M Rehani, Radiation Safety Specialist, International Atomic Energy Agency



Directions

- **QC testing, QA, QM, CQE (1980's, 1990s)**
- **Patient protection (2000's)**
- **Protection outside radiology**
- **Justification in medical imaging**
- **Patient centricity**

Patient Centric

- **DRLs**
- **Risk Estimates**
- **Patient dose: Is it really patient dose**
- **Collective or cumulative dose**

Recap

- **Situation way back in 2001**
- **How we could make a difference in last decade**
- **What approaches we used**
- **Cooperation**
- **Utilization of AAPM colleague**
- **How you can contribute internationally**
- **Future directions**

Thank You

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