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

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

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.

First ever study of this kind

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Findings from these papers

• Dedicated CT protocols in 94%
• Protocols for some age groups not available 50%
• Indication based protocols used in 57%
• $\text{CTDI}_{\text{vol}}$ 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)

<table>
<thead>
<tr>
<th>Scanner number</th>
<th>mode</th>
<th>Tube voltage, kV</th>
<th>Tube current, mA</th>
<th>t rot, s</th>
<th>Pitch value</th>
<th>CTDI$_{vol}$, mGy</th>
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<tr>
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<td>80</td>
<td>129</td>
<td>0.5</td>
<td>1.3</td>
<td>1.89</td>
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<td>120</td>
<td>0.5</td>
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<td>10.21</td>
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<tr>
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<tr>
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<td>80</td>
<td>100-250</td>
<td>0.5</td>
<td>0.96</td>
<td>4.2</td>
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<tr>
<td>29</td>
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<td>100</td>
<td>180</td>
<td>0.4</td>
<td>0.98</td>
<td>3.2</td>
</tr>
<tr>
<td>8</td>
<td>helical</td>
<td>120</td>
<td>80</td>
<td>0.4</td>
<td>1.375</td>
<td>4.5</td>
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<tr>
<td>124</td>
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<td>80</td>
<td>25</td>
<td>0.5</td>
<td>0.9</td>
<td>0.71</td>
</tr>
<tr>
<td>119</td>
<td>helical</td>
<td>120</td>
<td>80</td>
<td>0.6</td>
<td>0.9</td>
<td>10</td>
</tr>
</tbody>
</table>

14.5-fold variation

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Head CT

- CTDI\textsubscript{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\textsubscript{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

Before (Phase I) vs. After (Phase II)

- Head CT Age 1-5 (Czech Rep., 6)
- Head CT Age 5-10 (Serbia, 20)
- Head CT Age 5-10 (Thailand, 131)
- Head CT Age 10-15 (UAE, 29)
- Head CT Age 10-15 (Slovenia, 22)
- Chest CT Age 1-5 (Czech Rep., 22)
- Abd. CT Age 1-5 (Czech Rep., 5)
- Abd. CT Age 1-5 (Slovenia, 22)
How many have experience in documenting impact of optimization with time???
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

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


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14Department of Medical Physics and Radiation Protection, University Hospital Olomouc, I.P. Pavlova 6.
PAEDIATRIC CT EXAMINATIONS IN 19 DEVELOPING COUNTRIES: FREQUENCY AND RADIATION DOSE


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

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
Optimization of the radiological protection of patients: Image quality and dose in mammography (coordinated research in Europe)

Results of the Coordinated Research Project on Optimization of Protection in Mammography in some eastern European States

Optimization of the radiological protection of patients undergoing radiography, fluoroscopy and computed tomography

Final report of a coordinated research project in Africa, Asia and eastern Europe
IMPACT OF THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) ACTIONS ON RADIATION PROTECTION OF PATIENTS IN MANY COUNTRIES

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Medical Radiation Protection

Billions (patients) ~ Million [radiology professionals, worldwide]

3.6 billion ≈ 300 million children

International staff

Hundreds / thousands radiology professionals (national level)

~ Million (radiology professionals, worldwide)

Billions (patients)
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

Patient & Staff

Networks

Training Courses
≈80 since 2002

Posters

Free Material

SAFRAD

Smart Card

Cataract Study

AJR
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)
INTERNATIONAL ACTION PLAN ON THE RADIATION PROTECTION OF PATIENTS

Madan M. Rehani1,*, Ola Holmberg1, Pedro Ortiz López2 and Fred Mettler3
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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

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

Map showing the patient doses in various countries, coded in different colors.
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

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

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
<table>
<thead>
<tr>
<th>Language</th>
<th>Title (Arabic)</th>
<th>Title (Bulgarian)</th>
<th>Title (Croatian)</th>
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<th>Title (Russian)</th>
<th>Title (Spanish)</th>
<th>Title (Swedish)</th>
</tr>
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<tbody>
<tr>
<td>English</td>
<td>10 pearls on radiation protection of patients in fluoroscopy Download PDF</td>
<td>10 pearls on radiation protection of staff in fluoroscopy Download PDF</td>
<td>10 Zlatni Pravila—Zaštita bolesnika od zračenja u dijaskopiji Download PDF</td>
<td>10 Recommandations; Radioprotection des patients on fluoroscopie Télécharger PDF</td>
<td>10 χρυσοί κανόνες: Ακτινοπροστασία ασθενών κατά την ακτίνακοπτήτη Λήψη αρχείου PDF</td>
<td>10 כללי מנהל ל每位 המלון המזיק.pdf</td>
<td>10 개 원칙: 투시검사 시 환자의 방사선 방어 다음료 PDF</td>
<td>10 Златни правила: Защита на пациентите от радиация при флуророскопия Превземете PDF</td>
<td>10 Шинтгэн санамж: Рентген харалтын уед ажилтанд усугул хязагийн хамгаалалт Download PDF</td>
<td>10 Recomendações para a proteção de pacientes em fluoroscopia baixar PDF</td>
<td>10 Способов радиационной защиты пациентов скачать PDF</td>
<td>10 Recomendaciones para la protección de los pacientes en fluoroscopía descargar PDF</td>
<td>10 ράδια: Στρακτώδη για πασίγνωστο personale vid genomlysnings hälma PDF</td>
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</table>
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?
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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