Excessive use of medical X-rays and awareness of radiation protection

Poster No.: C-0279
Congress: ECR 2012
Type: Educational Exhibit
Authors: D. Hadnadjev, S. Stojanovic; Novi Sad/RS
Keywords: Radioprotection / Radiation dose, Radiation physics, CT, Radiation safety, Biological effects
DOI: 10.1594/ecr2012/C-0279

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

To familiarise the radiologist with current excessive use of medical X-rays and its potential cumulative harmful effects on health, as well as to arouse the awareness of the importance of radiation protection of the patients.
Background

The part of radiation due to medical exposure increased dramatically with extensive use of multislice computed tomography (CT). Some medical X-rays involve effective doses of only a few microsieverts, however, organ doses and effective doses can easily rise to 100 mSv or more for extensive fluoroscopic or CT examinations when such examinations are repeated through an episode of disease or trauma [1]. Therefore, it is necessary to determine justification of X-ray exams, and to apply optimisation and limitation of these exams, especially in the field of overuse of CT.
A review of the most recent literature regarding medical X-ray overuse is presented.

Fig.1 shows total population exposure to radiation and the share of medical radiation exposure.

Conservative estimates are that more than 60 million CT examinations are done yearly in the United States, representing an estimated 70% of all medical X-ray exposure. Since the development of the first commercial CT scanners in 1972, CT has become the major source of medical radiation [2,3].

Fig.2 shows the data on the frequency of CT scan worldwide.

Sudden and significant increase in CT dose due to frequent use of CT according to the UNSCEAR 2010 is presented in Fig.3.

The popularity of CT imaging is high for many reasons, ranging from its speed and ease of use, to development of new imaging techniques, and finally to a growing body of evidence showing its images to be reliable for diagnosis, and the practice of defensive medicine, resulting in unnecessary scans to minimize the threat of a lawsuit resulting from a missed diagnosis. CT is increasingly being used among healthy individuals, in whom the risk of potential carcinogenesis from CT could outweigh its diagnostic value [2].

Unofficial data about different diagnostic modalities and their use frequency in Serbia are presented in Fig.4.

Fig.5 shows actual situation in diagnostic radiology in Serbia.

Doctors order more tests and procedures than patients need to protect themselves against malpractice suits [4].

In Serbia, clinicians do not pay much attention to the radiation dose received by the patient during various diagnostic procedures. There are often uncritically indicated control CT examinations, for example to monitor the size of pseudocyst in patients with acute pancreatitis rather than to use ultrasound exam. Numerous multiphase CT examinations are performed often as unnecessary, as well as the radiation dose the patient receives
on that occasion. Even though appendicitis is mainly clinical diagnosis and should be confirmed by ultrasound if needed, some clinicians are still of the opinion that appendicitis is diagnostic indication for CT abdomen exam.

Fig. 6 shows patient dose level in Serbia.

In interventional radiology there is a significant radiation dose when performing interventional procedures, therefore it is necessary to avoid excessive diagnostic procedures. For example, in the interventional radiology unit at the Clinical Center of Vojvodina, in Novi Sad, Serbia, in preparing a patient for endovascular aortic repair procedure (EVAR), sometimes diagnostic digital subtraction angiography (DSA) of aorta and its branching arteries of lower extremities is performed twice. First time in the preparation of EVAR, although the patient has had previously done CT angiography of the same segment, with all labeled parameters that are necessary for the procedure. Second time DSA is performed just before the procedure itself. From dosimetric point of view a question of doubt arises whether the patient should do repeated diagnostic X-ray exam.

On the other hand, chest X-ray in pregnant women according to gynecologists in Serbia is still absolute indication for abortion, although it is a low-dose radiation. According to the data in the literature conceptus doses from diagnostic x-ray studies can rarely exceed 100 mGy. Doses to the unborn child below 100 mGy should not be considered a reason for abortion [5]. Exposure to diagnostic radiography in utero has been associated with increased risk of childhood cancer, particularly leukaemia. Although diagnostic radiography and other radiological imaging procedures to the abdomen and pelvis of pregnant women are uncommon, potential adverse effects of exposure to radiation in early life remain a concern with the growing use of computed tomography scans and other recent types of higher dose imaging procedures. Estimates range was from <0.01 mGy to 89 mGy. The fetal dose from radiography to the abdomen or pelvis was thought to be in the order of 10 mGy in the Oxford survey and has been estimated to be 1.3 mGy to 3.4 mGy in more recent years. Radiation doses received by neonates also vary by age at diagnostic procedure and other parameters, but the entrance surface dose for chest radiography has been estimated to be approximately 0.06 mGy to 0.08 mGy for 0-1 year olds. These doses are less than those thought to occur from computed tomography scans at the same age (2.3 mSv to 11.4 mSv), depending on age and body location [6].

Facts about diagnostic radiology and situation in Serbia are presented in Fig. 7, 8, 9, 10 and 11.

Fig. 12 shows status of practice in diagnostic radiology in five Eastern European country.
In a report published in the *Journal of the American Medical Association* Hausleiter and colleagues commented that among 50 centers performing coronary CT angiography, patient radiation doses varied from 5 mSv to 30 mSv. The authors concluded that "effective strategies to reduce radiation dose are available but some strategies are not frequently used" [7].

With the latest CT technologies, it is possible to manage this balance. In some cases such as chest exams use less than 0.1 mSv, pediatric heart studies with as little as 0.25 mSv, and adult coronary angiograms with no more than 1 mSv [7].

Some dose-cutting solutions are found not on the scanner but on the patient, in the form of shields designed for placement over the areas of the patient especially vulnerable to radiation [7].

Medical physicists have developed an automated patient-specific CT dose-monitoring system that estimates radiation risk based on the age, size, and sex of the patient. The software was introduced at the American Association of Physicists in Medicine and the Canadian Organization of Medical Physicists Joint 2011 Meeting [8].

More than 19,500 CT scans are performed every day in the United States. These expose each patient to the equivalent of 30 to 442 chest radiographs per scan. It is becoming clear that the large doses of radiation from such scans will translate, statistically, into additional cancers [9].

If patient doses are higher than the expected level, but not high enough to produce obvious signs of radiation injury, the problem may go undetected and unreported, putting patients at increased risk for long-term radiation effects. While unnecessary radiation exposure should be avoided, a medically-needed CT scan has benefits that outweigh the radiation risks. Because radiation-related risks may be cumulative over time, this information should become a key element of the patient's medical history. Patients and physicians need to discuss the choice for radiological imaging and the relative risks associated with this choice. This is particularly important for discussions of screening in asymptomatic patients [2].
**Fig. 1:** Total population exposure to radiation and the share of medical radiation exposure. (Courtesy Ms Olivera Ciraj Bjelac, assistant professor of med phys.)

© Ciraj Bjelac O (2010) CT school seminar, Novi Sad, Serbia
Fig. 2: Global CT practice (Courtesy Ms Olivera Ciraj Bjelac, assistant professor of med phys.)

© Ciraj Bjelac O (2010) CT school seminar, Novi Sad, Serbia
Fig. 3: Sudden and significant increase in CT dose due to frequent use of CT (Courtesy Ms Olivera Ciraj Bjelac, assistant professor of med phys.)

© Ciraj Bjelac O (2010) CT school seminar, Novi Sad, Serbia
Fig. 4: Diagnostic modalities and their use frequency in Serbia

© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
Diagnostic radiology in Serbia

Mammography
- Dramatic increase
- Preparation for national wide screening programme

Computed tomography
- Increased use and increased awareness about dose levels, increased number of units

Interventional procedures
- Digital units, increased use, cardiologist...

Radiography and Fluoroscopy
- Direct fluoroscopy systems
- Transition to digital systems (less than 10% digital)

Fig. 5: Actual situation in diagnostic radiology in Serbia
© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
### Patient dose levels in Serbia

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Dose (mSv)</th>
<th>Chest radiography equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest PA</td>
<td>0.05</td>
<td>1</td>
</tr>
<tr>
<td>Pelvis</td>
<td>0.6</td>
<td>12</td>
</tr>
<tr>
<td>Lumbar spine AP</td>
<td>0.8</td>
<td>16</td>
</tr>
<tr>
<td>Lumbar spine LAT</td>
<td>0.3</td>
<td>6</td>
</tr>
<tr>
<td>Urinary tract</td>
<td>0.4</td>
<td>8</td>
</tr>
<tr>
<td>Ba enema</td>
<td>4.8</td>
<td>96</td>
</tr>
<tr>
<td>CT chest</td>
<td>2.1</td>
<td>42</td>
</tr>
<tr>
<td>CT abdomen</td>
<td>8</td>
<td>160</td>
</tr>
<tr>
<td>CT pelvis</td>
<td>7</td>
<td>140</td>
</tr>
<tr>
<td>Coronary angiography</td>
<td>10</td>
<td>200</td>
</tr>
</tbody>
</table>

**Fig. 6:** Patient dose level in Serbia

© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
Facts about diagnostic/paediatric radiology in Serbia

- No medical physicists in diagnostic radiology in Serbian hospitals
- Technical services for annual equipment testing
- Radiation protection do not follow technological progress
- No national-wide:
  - Patient exposure surveys
  - Training scheme
  - Occupational exposure database
  - Registry on radiation sources used in medicine

Fig. 7: Facts about diagnostic radiology in Serbia

© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
Facts about diagnostic radiology in Serbia

- Equipment and tools often do not meet the needs of radiology departments
- Equipment – often unreliable and obsolete (QC)
- Shielding – homemade and auxiliary, but regularly used
- Referring physicians commonly are not aware of radiation risks (pressure on radiologists)
- Many radiologists never attended training in radiation protection or accessed to available internet resources as RPOP, Image Wisely or Image Gently, often reluctant to change their practice

Fig. 8: Facts about diagnostic radiology in Serbia

© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
Radiation protection of patients in Serbia

- Activities in the area of radiation protection of patients started in 2005 (R/F in adults only)
- No systematic approach, based on individual enthusiasm
- Patient dose survey have become more intensive since 2007
- Professional networking an communication with radiologists
- Increased awareness of:
  - importance of radiation protection, especially in children
  - patient dose levels, dose quantities (CT and IR)
  - MSc and PhD thesis in dosimetry and dose management

**Fig. 9:** Facts about diagnostic radiology in Serbia

© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
Patient dose records

- Regulatory requirements since 1998 (Regulation on application of ionizing radiation sources in medicine)
- No evidence of implementation

Fig. 10: Facts about diagnostic radiology in Serbia

© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
At the Clinical Center of Vojvodina, Center for Radiology, a clinical study on radiation safety of patients in standard CT examinations has been conducted. This study will help
- 1. to determine average radiation dose per standard CT examination,
- 2. to try applying different protocols and to make quality assessment obtained by examination,
- 3. making standard protocols for certain types of examinations with the application of the minimum required dose.

Fig. 11: Prospectives

© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
Fig. 12: Status of practice in diagnostic radiology in five Eastern European country
© Stojanovic S, Center for Radiology, Clinical Center of Vojvodina, Novi Sad, Serbia
Conclusion

The reduction of patient dose is highly dependent on radiologists, their staff, and even the anatomic parts of the patients that are examined. To deliver the best care, radiologists must image gently striking a balance between patient risk and diagnostic value. Therefore, risks and benefits of exposure to radiation for medical imaging and other sources must be clearly defined for clinicians and their patients.
Personal Information

D. Hadnadjev, S. Stojanović, Clinical Center of Vojvodina, Center for Radiology, Hajduk Veljkova 1, 21 000 Novi Sad, Serbia.

Mail to: darka@eunet.rs
References


http://bjr.birjournals.org/content/79/940/285.full


