Pediatric hospital experience for the diminishing of radiation overexposure

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Background/introduction

The number of medical X-ray imaging procedures is growing exponentially across the globe. Even though the overall benefit from medical X-ray imaging procedures far outweighs any associated risks, it is crucial to take all necessary steps to minimize radiation risks to children without jeopardizing image quality [1]. Pediatric patients have a higher average risk of developing cancer compared with adults receiving the same dose. The longer life expectancy in children allows more time for any harmful effects of radiation to manifest, and developing organs and tissues are more sensitive to the effects of radiation. The importance of rigorous justification of radiological procedures is emphasized for every procedure involving ionizing radiation, and the use of imaging modalities that are non-ionizing should always be considered. [2]. The pediatric interventional radiology community also has worked diligently in recent years through education and the use of technology to incorporate numerous dose-reduction strategies [3]. Multiple computed tomography (CT) examinations may cumulatively involve absorbed doses to organs and tissues that can sometimes approach or exceed the levels known from epidemiological studies to significantly increase the probability of cancer development. Radiation protection strategies include rigorous justification of CT examinations and the use of imaging techniques that are non-ionizing, followed by optimization of radiation dose exposure (according to the 'as low as reasonably achievable' principle). Special consideration should be given to the availability of dose reduction technology when acquiring CT scanners [4]. So, significant changes can be expected in modern pediatric radiology. New imaging techniques are progressively added to basic modalities like X-rays and ultrasound [5].

The main goal was to introduce different approaches in a pediatric hospital for the diminishing children x-ray radiation.
Description of activity and work performed

We implemented the program for the diminishing of radiation: 1\textsuperscript{st} - refuse unnecessary x-ray or CT-scan examinations, 2\textsuperscript{nd} - substitute x-ray and CT-scan by non-radiation methods, 3\textsuperscript{rd} - implement a new generation of x-ray and CT-scan, 4\textsuperscript{th} - Cooperation with international subjects, 5\textsuperscript{th} - Introducing the Euro-Safe guidelines (fig. 1).

1\textsuperscript{st} - refuse unnecessary x-ray or CT-scan examinations.

Psychological aspects. X-ray overexposure can be: a) iatrogenic, b) patient-genic.

a) Iatrogenic x-ray overexposure can be of pathological processes which are very clear using ultrasound or MRI but for the reinsurance the pathology referring the patients to the X-ray, native CT-scan, CT-scan with the contrasts, PET-CT-scan.

b) Patient-genic x-ray overexposure can be very rare due to kid's parent's psychological problems. It can happen if the children or family have insurance coverage for all types of examination; patient's parents impose their opinion to do "modern" types of examinations.

Medical aspects. We refuse x-ray examinations for thymus hyperplasia widely used previously in the pediatry as the standard and limited the number of x-ray or CT-scan follow-up.

2\textsuperscript{nd} - To avoid x-ray exposure we often used ultrasound for an emergency. Ultrasound was used also in the operation room during neurosurgery (Fig.2.) and thorax surgery, as the guide for the precise FNA or core biopsy of the mediastinum (Fig.3.), soft tissues masses or fluid collection for follow up after brain, head and neck, thorax (Fig.4. and Fig.5.) and abdomen surgery. In some cases, (hiatal hernia, polyps), we used endoscopy instead of barium contrast x-ray. MRI was used in some brain and trauma pathology instead of CT scan or for the follow-up.

3\textsuperscript{rd} - In the hospital, we changed conventional x-ray machines to digital x-ray machines and starting to use the last generation of low doses CT-scan for the pediatric practice.

4\textsuperscript{th} - The cooperation with international children, hospitals are the key factor. A good example is the IAEA survey of pediatric computed tomography practice in 40 countries in Asia, Europe, Latin America and Africa: procedures and protocols European Society of Radiology 2012. European Society of Radiology 2012.

5\textsuperscript{th} - Introduction of guidelines of Euro-Safe "Ask Euro-Safe Imaging Tips & Tricks Pediatrics Imaging Working Group"."
**Fig. 1:** The program of diminishing of radiation in pediatric hospital.

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Fig. 2: Navigated ultrasound during neurosurgery revealing brain abscess in the 5 years old boy. There is also well visualized hyperechoic tip of the needle in the brain above the abscess.

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Fig. 3: 7 years old girl. Well visualized mediastinum mass easy underwent FNA and Biopsy by the ultrasound navigation. On the left side of the tumor there is the lung tissue.

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Fig. 4: 3.5 years old boy with destructive pneumonia. Thorax ultrasound revealing multilobulated cyst with inflammation about 10 cm in the diameter. Note: the full image of the mass was possible only with the ultrasound convex probe.

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Fig. 5: The same kids at the end of the treatment has solitary small cyst 9mm in the diameter. Note: the full image of the mass was possible with the linear probe.

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Conclusion and recommendations

Introducing local and international types of programs in the pediatric hospital can substantially decrease children radiation. The implementation of such a program in the pediatric hospital departments allows diminishing the x-ray radiation in the different departments (Fig.6.). It can include multiple aspects of possible x-ray overexposure: psychological aspects a) iatrogenic and b) patient-genic, medical aspects, transferring the radiological methods from ionized to non-ionized, changing the old radiological machines to the modern one, cooperate with other pediatric hospital and use Euro-Safe guidelines.
**Fig. 6:** Decreasing of children radiation in the pediatric hospital different departments (%).

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