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Dose optimization in pediatric studies: Why this is important and can benefit every nuclear medicine department

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Ionizing radiation dose optimization aims at insuring that the patient dose is suitable for the medical purpose and that unnecessary radiation is avoided. This principle of dose optimization is a general radiation protection principle applied in nuclear medicine and radiology required by law in many countries (*1*). It is generally combined with the principle of level-2 "justification", which ensures that the procedure is clinically indicated and traceable to national or international practice guidelines. Of course, exceptions are always possible when taking into account the singularities of a specific patient such as metallic implant or impaired renal function impeding the realization of an MRI and justifying the use of ionizing radiation in a young patient (level-3 justification). It is sensible to avoid unnecessary exposure to ionizing radiation in children as they are more radiosensitive and have a longer life expectancy than adults.

Two international guidelines exist for recommendation of activities to inject in children: the North American Consensus Guidelines and the European association of Nuclear Medicine (EANM) pediatric dosage card. Following obvious differences between these two guidelines evidenced by a comparison study (*2*), a new version of the pediatric dosage card was issued to reduce these differences. Since then, the EANM pediatric dosage card has been once more updated to its most current version (05.07.2016), available at https://www.eanm.org/publications/dosage-card/ as online calculator or smartphone application (PedDose App). As nuclear medicine instrumentation improves, e.g. with the introduction of the PET SiPM detectors, further modifications are expected.

In the study by G. L. Poli *et al* published along with this editorial (*3*), the authors have undertaken an International Atomic Energy Agency (IAEA) coordinated research project on the evaluation and optimization of pediatric imaging in response to existing divergences among the optimal activity to use for specific pediatric scintigraphic examinations. They present their results for the procedure with the highest impact in terms of dose optimization, which was ^{99m}Tc-DMSA imaging. They used a standard 5-step optimization method (*3*). Instead of a circle representation used in their article, we prefer to think of a staircase representation with quality improvement after each cycle completion (Fig. 1). It is worth mentioning that the methodology used for optimization was very different for each of the two participating centers. In the first center (Site 1: Department of Nuclear Medicine, DIC, CENTIS, Havana, Cuba), the usual static acquisition was replaced by a dynamic one, allowing to simulate a statistical lower count image. The results were that administered activities could be lowered between 30-38% across different age categories as compared to the baseline situation. In the second center (Site 2: Medscan Nuclear Medicine and PET/CT Center, Concepcion, Chile), a phantom approach led to using longer acquisition times than usual for the center allowing reductions of 50-70% from the baseline situation without image quality loss. Consequently, Poli *et al* concluded that using their 5-step approach, centers could significantly decrease radiation dose between 30% and 70% without compromising image quality.

Instead of applying blindly guidelines that may not take into account the centers' specificities (nuclear medicine instrumentation, gamma-camera, collimators, etc.), the proposed approach can certainly help determine what reduction is acceptable for each center without altering image quality to a point the local physician would not feel comfortable with. For instance, radiation dose reduction might be achieved by longer acquisition times, which can be problematic with younger children more prone to patient motion, unless alternative strategies are used (contention, sedation or anesthesia, depending on the examination).

This approach of initiating a project of comparing a center's administered activities in children — even if pediatric nuclear medicine is not performed frequently — is a worthwhile project and an initial step towards continuous improvement. As stressed in the study of Poli *et al* (*3*), this optimization process needs to be performed by a multidisciplinary working group with the nuclear medicine physician bearing the responsibility for evaluating image quality and assessment of adequate administered activity. When such an optimization project is completed, it might be worth embarking on the next one, be it with the same radiopharmaceutical after another observation period or with a different one according to the frequencies of studies performed by the clinics. This was also the aim of the two initiatives optimizing radiation dose in nuclear medicine and radiology called "*Image Gently*" in children and "*Image Wisely*" in adults.

Moreover, the proposed process for radiation dose optimization does not apply only to children and can virtually benefit to any nuclear medicine department or practice. The proposed methodology of continuous quality improvement complies with the fundamental process of quality management in nuclear medicine (QUANUM). The IAEA QUANUM has introduced such a comprehensive audit program, freely available for self-administration by any nuclear medicine department, as the basis for developing quality insurance aimed to deliver a safe service to the patient and staff, improving weaknesses and reinforcing strengths of nuclear medicine (*4*). Such audits can also be performed by external auditors and possibly declared mandatory by law in a specific country. The so-called "clinical audits" have been introduced as a tool to improve health protection against ionizing radiation by the European Community Council Directive 97/43/EURATOM (*1*). Accordingly, EURATOM member states are asked to implement national procedures as a tool to improve the quality of patient care and outcome. Procedures should be formally reviewed and compared to defined standards and subsequent practice changes based on the results of this review should be implemented.

Actually, the accreditation of nuclear medicine departments exists since year 2000 across Europe and aims to deliver the highest possible level of quality in the field of nuclear medicine (*5*). This is done under the umbrella of the Union of European Medical Specialist (UEMS) and the European Board of Nuclear Medicine (EBNM) in close collaboration with the EANM (http://uems.eanm.org/). By comparing "*what is done*" with "*what should be done*", it helps to compare our local clinical practice against national and international standards to ensure a correct day-to-day consistent and safe practice of nuclear medicine. This includes continuous improvement of radiation dose to patients, their families and the nuclear medicine staff. Clinical audits and accreditation bring multiple further benefits such as improving quality given the available resources, reducing service's expenses, wastages, and duplications not imagined before, while revealing incorrect practices and avoiding accidents or near-misses (*5*). When a center is accredited as a UEMS/EBNM nuclear medicine department and is also a training center, there is the possibility to further become accredited as a UEMS/EBNM nuclear medicine training center when adopting the unified training requirement syllabus. This also ensures that high standards are also maintained in nuclear medicine education.

To conclude, a simple optimization project as the one presented by Poli *et al* can identify suboptimal nuclear medicine diagnostic procedures and bring immediate significant reduction in radiation dose without loss in image quality using an easily applicable methodology. This has key implications for patient care and even greater implications for nuclear medicine by starting the virtuous cycle of continuous quality improvement that can lead to further changes in practice. This is what is required in a rapidly changing field like nuclear medicine to deliver the highest quality patient care.

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Figure

Figure 1. Optimization methodology leading to improvement in quality after each completed 5-step cycle. This is in line with the well-known “PDAC” (Plan-Do-Check-Act) approach of continuous quality improvement.