Paediatric CT dose optimization in a general hospital

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Background/introduction

According to the publication HHS 24 - Dosimetry in Diagnostic Radiology for Pediatric Patients - dosimetry for pediatric patients undergoing diagnostic radiology procedures requires special consideration in addition to the dosimetry methods used for adult patients. The importance of dosimetry for this group of patients is more delicate than for adults given their: longer life expectancy, greater risk of radiation due to relative radiosensitivity of various body tissues that vary according to sex and age, collection and analysis of data for these patients are complex, fundamentally due to the large and continuous range of patients with distinct sizes present in the pediatric population.

The pediatric patients exams differ from the adults in many ways, including: different technical factors, beam quality and, ideally, different radiological equipment; one should also consider the type of tests performed and the skill set of the personnel needed to perform these procedures successfully.

This work was carried out as part of the International Atomic Energy Agency (IAEA) Coordinated Research Project (CRP E2.40.20), entitled "Evaluation and Optimizations of Paediatric Imaging", which consists of a consortium of 10 countries for the study of dose optimization in diagnostic procedures for pediatrics patients. The Dosimetry and Medical Physics Group (Grupo de Dosimetria e Física Médica) of the Physics Institute (IF/USP), which has been working for more than 10 years in a Quality Assurance Program (QA) at the Institute of Radiology of the Clinical Hospital of the School of Medicine (INRAD/HC/FM/USP), participates in this program in the areas of diagnostic radiology and computed tomography.

In Phase 1 of the project signed between the IF/USP and the HC/FM/USP (CAAE: 55420616.3.0000.0068), a survey was performed with relevant information on diagnostic imaging tests performed in pediatric patients. Phase 2 (CAAE: 71052117.1.3001.0068), the data are being used for proposing optimization protocols aimed at reducing doses in pediatric patients, without significant loss in the image quality.
Description of activity and work performed

This work was focused on protocol optimization Head and Thorax exams, primarily. The first strategy was comparing the configuration of these protocols with the suggested by American Association of Physicist in Medicine (AAPM) in the Alliance for Quality Computed Tomography for routine pediatric Chest CT and Head CT. Initially, one CT equipment (Philips - Brilliance 64) of the facility was prioritized. Figure 1 shows a flow chart relating the steps conducted for the optimization process of paediatric chest and head CT by the Brazilian participant.

Figure 1 - Flow chart relating the steps conducted for the optimization process of paediatric chest and head CT by the Brazilian participant

The responsible radiologist and the radiographer checked the proposal and suggested some changes. The first comment of the radiographers was that protocols were with high dose and they liked to try some lower mAs values then the suggested by AAPM.

The medical physicist and the responsible radiographer have adapted the protocols for some ages for Head CT (0 - 1 year, 1 - 2 years, 2 - 6 years, 6 - 16 years and 16 - 20 years) in axial mode and one protocol for helical mode, when 3D reconstructions were necessary. For Chest CT, was suggested just three divisions (0 - 1 year, 1 - 10 years and 10 - 15 years) all in helical mode. The radiographers were trained in the news protocols which were let together in the same CT console screen with the adult's protocols and started to use them in the exams.

After some weeks, the medical physicist group checked some of the Head and Chest protocols and figure out the radiographers were using the helical 3D routine Head for all the pediatric patients. The Chest protocols were well used, because there weren’t so many options to choose. At this time of the implementation of the new protocols none radiologist asked to change some parameters, complaining about the noise or other loss of image quality.

Another intervention was done, separating the pediatric from adult protocols and the medical physicist has followed some pediatric exams for training the whole team of radiographers, asking for technical question or others suggestions. In order to simplify the choice of the adequate protocols by the radiographers, the monitor screen of the CT equipment console was adapted considering the specificities of the paediatric patients and a color code (Figure 2).

Figure 2 - Adapted screens of the CT equipment considering the specific paediatric protocols
**Fig. 1:** Flow chart relating the steps conducted for the optimization process of paediatric chest and head CT by the Brazilian participant.

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**Fig. 2:** Adapted screens of the CT equipment considering the specific paediatric protocols

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Conclusion and recommendations

The first results have presented the dose reductions without perceptive loss in image quality of these two general exams. Just for Head and Neck exam was observed a degradation in the detail structures by the responsible radiologist. The medical physicist contacted the radiographer to made the necessary changes in this protocol. A preliminary global view of the effects of the optimization process is shown in Figure 3 and 4 for head and thorax CT, respectively, showing the comparative results for CTDI\textsubscript{vol} quantity for each age group. Considering the 3\textsuperscript{rd} quartil as a dose reference level, a reduction of 50\% in the CTDI\textsubscript{vol} was reached for patients of 5 - 16 year and for the youngest group (0 - 5 years) the reduction was 66\% for head exams. For thorax, the most expressive dose saving was for the 1 - 5 years group of 47\%.

Figure 3 - Comparative results of the optimized and non-optimizes CTDI resulting for the studied image groups for Brain CT.

Figure 4 - Comparative results of the optimized and non-optimizes CTDI resulting for the studied image groups for Chest CT.
Fig. 3: Comparative results of the optimized and non-optimizes CTDI resulting for the studied image groups for Brain CT.

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Fig. 4: Comparative results of the optimized and non-optimized CTDI yielding for the studied image groups for Chest CT.

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Personal/organisational information

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