TITLE: STRATEGIES TO IMPLEMENT DOSE REFERENCE LEVEL IN TOMOGRAPHY IN BRAZIL: PRELIMINARY ANALYSIS

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OBJECTIVE: To establish standards for determining local, regional, and national Dose Reference Level in Brazil, according to clinical indication in CT procedures.
JUSTIFICATION: The present work proposes the development of a pilot program to establish standards for data collection required for determination of diagnostic reference level associated to CT clinical indication. This study was implemented in accordance to the statements of the Bonn: Call for Actions for Radiological Protection and aims to improve patient safety regarding exposure to ionizing radiation in Brazil,
METHODS: The methodology is characterized as an observational, cross-sectional, and multicenter study, including 15 hospitals in 8 states in Brazil, from July to September 2021. The data collection was done using specially designed Excel spreadsheets and Google Forms. Demographic and procedure-dependent information were recorded from hospital information systems. Technical and dose related information were collected from DICOM headers. These data from different brands of scanners were validated by local hospital supervisors. Samples of Structured Dose Report were verified.

Reported data included patient´s age, gender, weight, height, CT scan modality, clinical indication, DLP per series, $CTDI_{vol}$, voltage, current, use of TCM, use of iterative reconstruction, pitch, range, contrast administration, calibration phantom type (16/32), slice thickness and Automatic Exposure Control. A total of 10 clinical indications for 5 anatomical areas (head, cervical spine/neck, chest, abdomen-pelvis, chest-abdomen-pelvis) were identified. The descriptive statistical analysis of the demographic and DLP and CTDI-vol data was done using boxplot graphics.

RESULTS: The hospital's minimum and maximum value of median for $CTDI_{vol}$ (in mGy) and DLP (in mGy.cm) for the most frequent clinical indications in the evaluated sample (total of 976 adult patients) were: headache: N=233, $CTDI_{vol}$ (25.83, 59.8), DLP (581.35, 989.45); sinusitis: N=147, $CTDI_{vol}$ (1.4; 19.37), DLP (27; 350.90); and cranial trauma: N=93, $CTDI_{vol}$ (25.83; 52.91), DLP (578.8; 1027). Brazilian National Health Surveillance Agency recommends as a standard patient the weight range of 60 to 75 kg and height range of 160 to 175 cm. However, in the preliminary sample, the patient's demography showed a second prevalent weight range, from 75 to 90 kg and a height range less than 160 cm, especially in women.

CONCLUSION: This project is pioneering the determination of dose level by clinical indication for CT examinations in the country. Data will continue to be collected and further analysis will be carried out.

Keywords: Dose Reference Level, Computed tomography, Clinical indications, patient safety, Radiological Protection

1. BACKGROUND

The relevance of this study is to implement actions in accordance with the statements of the Bonn: Call for Actions for Radiological Protection [1] and it aims to improve patient safety regarding exposure to ionizing radiation in Brazil.

The second action of Bonn for action: “enhance the implementation of the principle of optimization of protection and safety” and “ensure establishment, use of reference levels for radiological procedures” will be our main objectives [1].

The gold of the project will be reinforced patient safety with good medical practice and applying Radiation Protection of Patients (RPOP) [2]. The focus on each patient information and characteristic basically can contribute to reduce ionization radiation exposure.

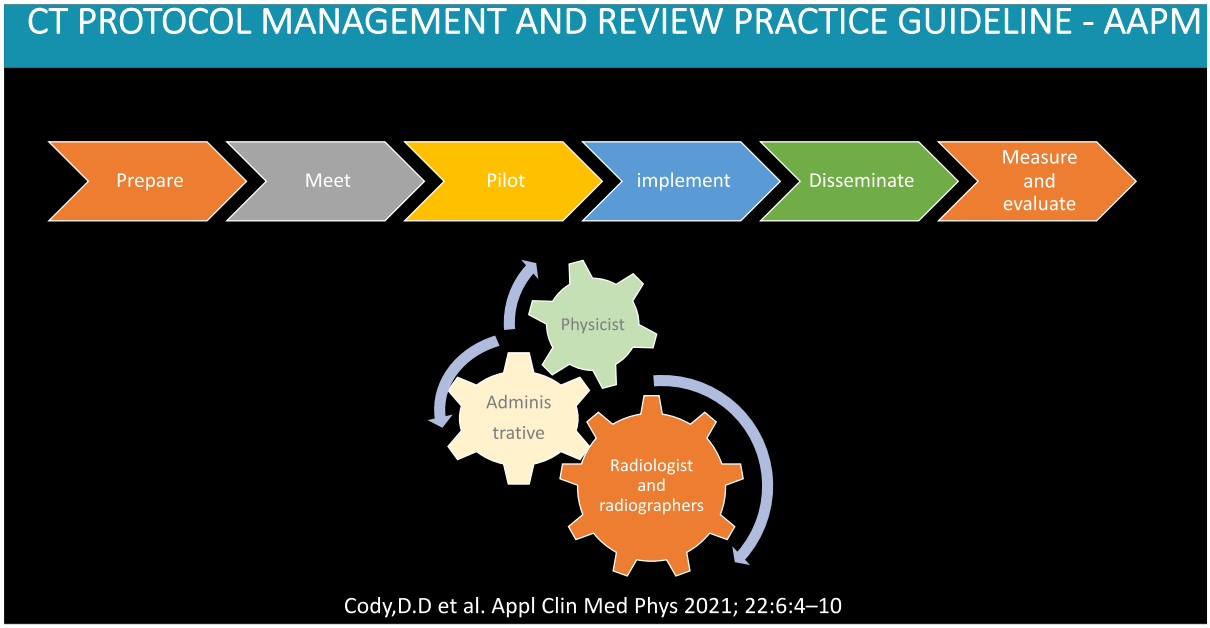
The increase in medical radiological exams has got international attention. The use of medical radiological exams is fundamental for diagnostic accuracy, but it needs to be always justified and optimized [3]. The knowledge about ionizing radiation exams, the benefits and the risks needs to be more clarify to the population and the health professional team.

The importance of the project it is the application of Dose Reference Levels as tool to optimize, decrease outliers in the daily practice of the technologist, apply dose monitoring with the supervision of the radiologist [4] and to follow optimization dose

as low as achievable as possible (ALARA) [5].

CT protocol management and review practice guideline can be used as a guideline to help the multi professional team (administrative, physicist, radiologist, and radiographers) to prepare and build strategies, design, and implement a pilot study in the dose adjust and quality exams evaluation and after that to disseminate to other modalities [6], shown in Figure 01.

Figure 01: Strategies of implementation of the project.



Purpose of this study in progress is the development of a pilot program to establish standards for data collection for the determination of the Diagnostic Reference Levels based on clinical indications in computed tomography based on a Graciano Paulo et al study (2020) [7].

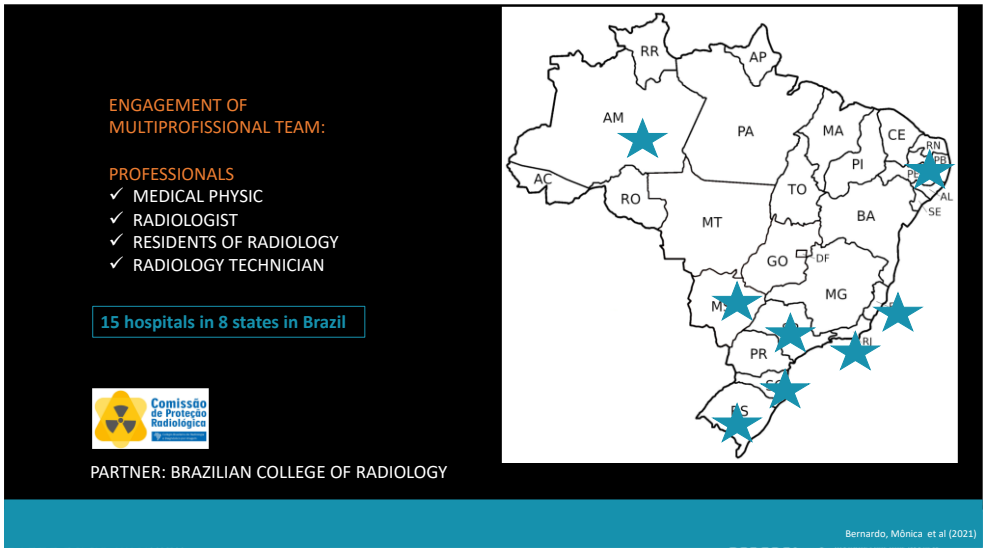
2. METHODS

2.1 DESIGN

The design of the study is an observational, cross-sectional, and multicenter study in Brazil, engaging 15 hospitals (radiology departments) in 8 states in different regions. It has Ethical board approved: CAAE 39736120.3.1001.5373.

Data Collection were done from July to October in 2021 and engaged a multi professional team (N=20) in different states in the country as shown in Figure 02, having the Radiological Protection of the Brazilian College of Radiology as a partner, representing Societies of Medical Physical and Radiologist.

Figure 02: Map shown different places in the country that is applying the project.



2.2 DATA COLLECTION AND ANALYSES

Brazilian National Health Surveillance Agency recommends as an adult standard patient, the individual with the weight range of 60 to 75 kg and height range of 160 to 175 cm for at least 30 patients for each modality and type of exam [7].

The data collection was done using specially designed Excel spreadsheets and Google Forms. These data from different brands of scanners were validated by local hospital supervisors. Samples of Structured Dose Report were verified. Demographic and procedure-dependent information were recorded from hospital information systems. Technical and dose related information were collected from DICOM headers.

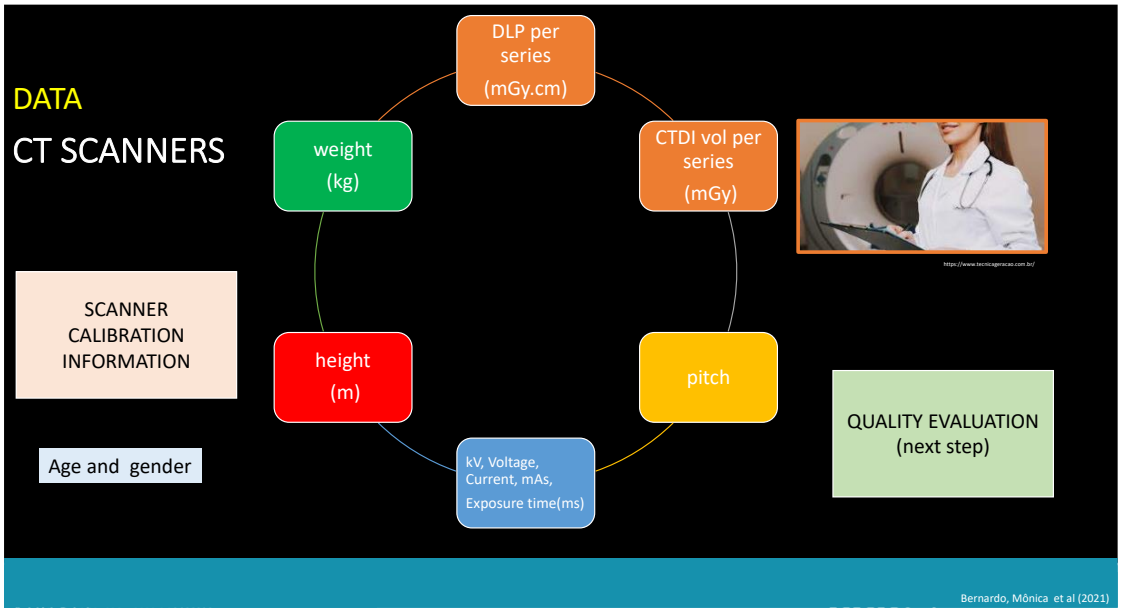
The hospital's minimum and maximum value of median for $CTDI_{vol}$ (in mGy) and DLP (in mGy.cm) for the most frequent clinical indications in the evaluated sample [8]. The descriptive statistical analysis of the demographic and DLP and $CTDI_{vol}$ data was done using boxplot.

As shown in Figure 04, the reported data included:

- patient´s age;
- gender;
- weight;

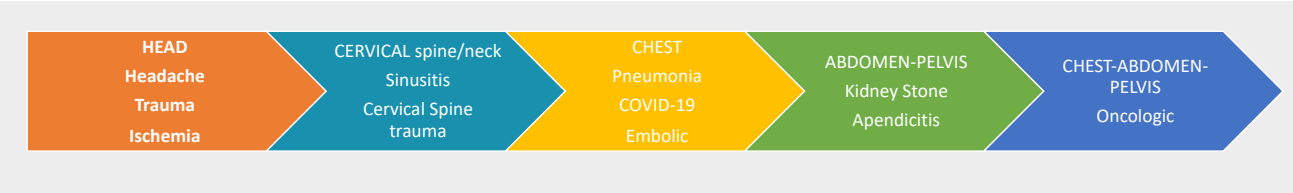
- height;
- CT scan modality;
- clinical indication;
- DLP per series;
- CTDI $_{vol}$;
- voltage;
- current;
- use of TCM;
- use of iterative reconstruction;
- pitch;
- range;
- contrast administration;
- calibration phantom type (16/32) ;
- slice thickness;
- Automatic Exposure Control;
- scanner calibration information;
- quality evaluation will be the next step.

Figure 04: Shows the descriptors and details of the data.



A total of 10 clinical indications for 5 anatomical areas (head, cervical spine/neck, chest, abdomen-pelvis, chest-abdomen-pelvis) are going to be analyzed.

Figure 05: Shows the anatomical and clinical indications defined to the project.



3. RESULTS:

There was the engagement of multi professional team professionals in the project. The study has a local manager supervisor the following professionals:

- medical physicist;
- radiologist;
- residents of radiology;
- radiology technician.

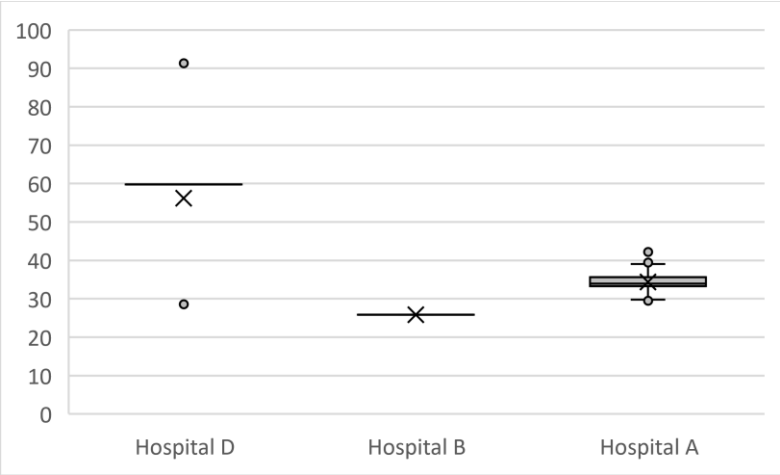
The hospital's minimum and maximum value of median for $CTDI_{vol}$ (in mGy) and DLP (in mGy.cm) for the most frequent clinical indications in the evaluated sample (total of 976 adult patients) were:

- headache: N=233, $CTDI_{vol}$ (25.83, 59.8), DLP (581.35, 989.45);
- sinusitis: N=147, $CTDI_{vol}$ (1.4; 19.37), DLP (27; 350.90); and
- cranial trauma: N=93, $CTDI_{vol}$ (25.83; 52.91), DLP (578.8; 1027).

Brazilian National Health Surveillance Agency recommends as a standard patient the weight range of 60 to 75 kg and height range of 160 to 175 cm. However, in the preliminary sample, the patient's demography showed a second prevalent weight range, from 75 to 90 kg and a height range less than 160 cm, especially in women.

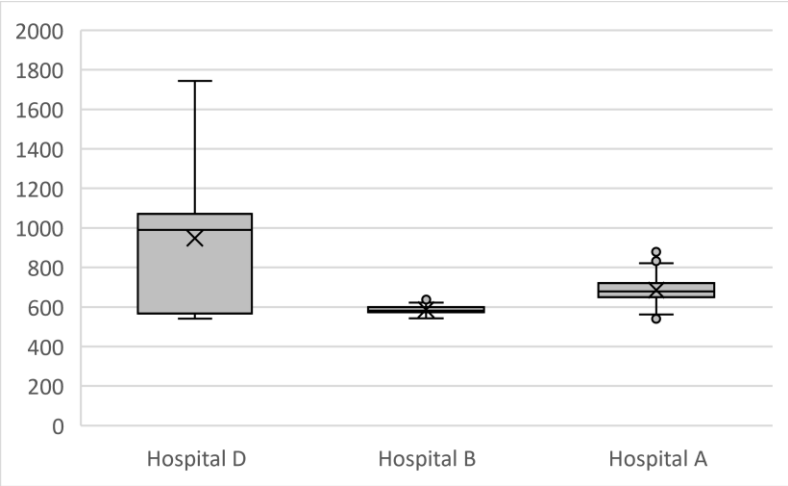
The descriptive statistical analysis of the DLP and $CTDI_{vol}$ data according to each clinical indication was done using boxplot.

Graphic 1 – Boxplot of $CTDI_{vol}$ (mGy) of CT adult for Headache clinical indication



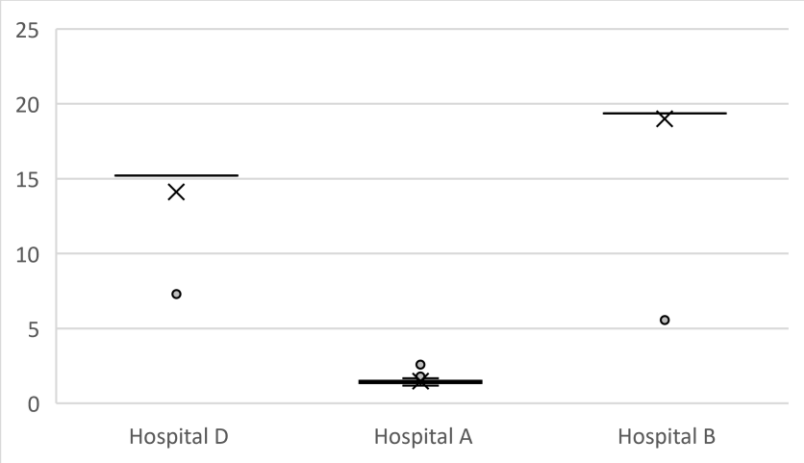
Source: Hospitals' system

Graphic 2 – Boxplot of DLP (mGy.cm) of CT adult for Headache clinical indication



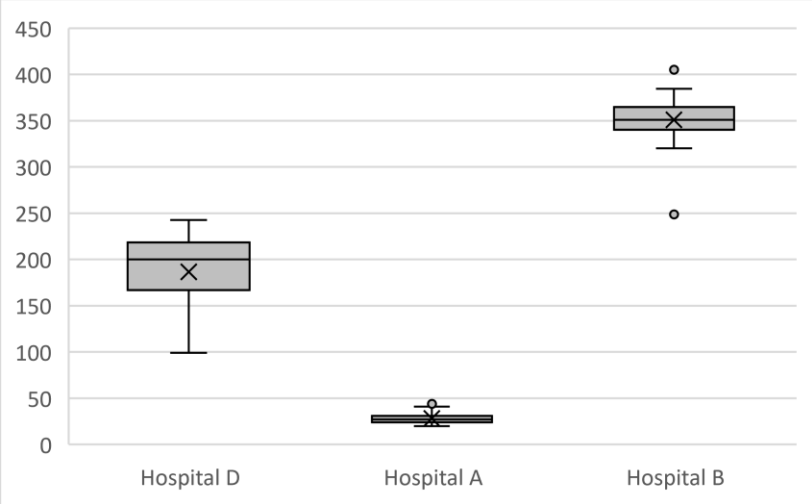
Source: Hospitals' system

Graphic 3 –Boxplot of $CTDI_{vol}$ (mGy) of CT adult for Sinusitis clinical indication



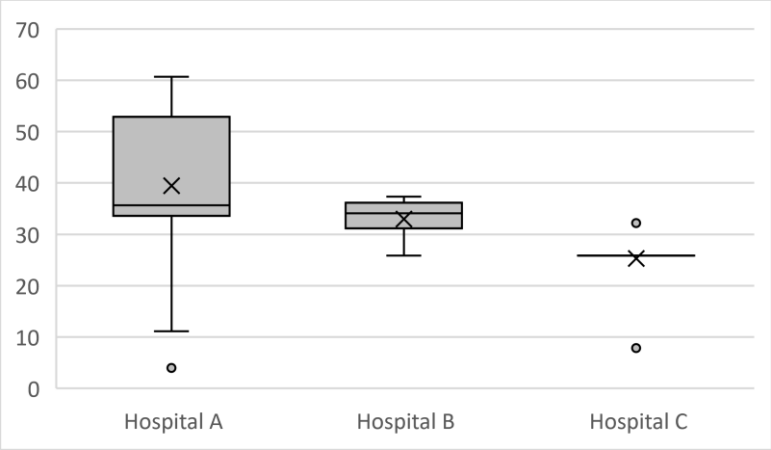
Source: Hospitals' system

Graphic 4 – Boxplot of DLP (mGy.cm) of CT adult for Sinusitis clinical indication



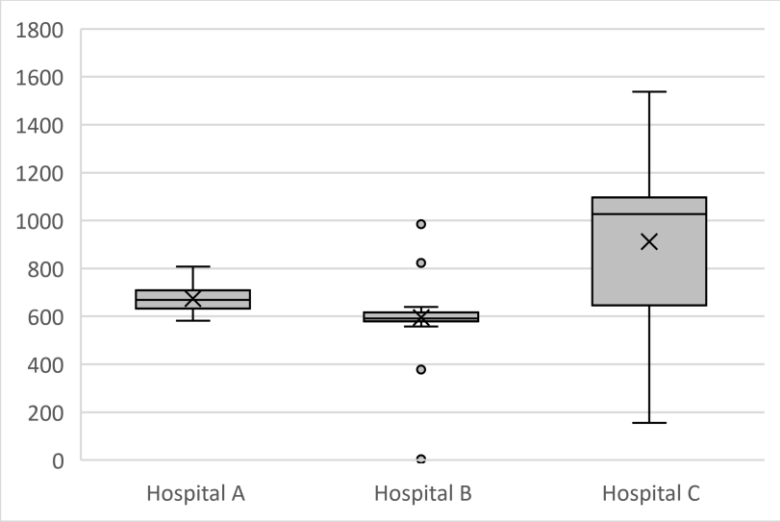
Source: Hospitals' system

Graphic 5 – Boxplot of $CTDI_{vol}$ (mGy) of CT adult for Cranial Trauma clinical indication



Source: Hospitals' system

Graphic 6 – Boxplot of DLP (mGy.cm) of CT adult for Cranial Trauma clinical indication



Source: Hospitals' system

4. DISCUSSION AND CONCLUSION

This project is in progress and is pioneering the determination of local dose value level and dose reference level by clinical indication for CT examinations in the country.

Preliminary results have been done to cranial and paranasal CT clinical indications.

Data will continue to be collected and further analysis will be carried out including paediatric CT exams.

5. LIMITATIONS

The study has one to five representatives local of each State in Brazil. It needs more data to represent a continental country.

6. CHALLENGES

A challenge like the task force for standardization (international lexicon) of protocols related to clinical indications is being observed.

Some other challenges were observed including:

- Awareness of radiation dose in medicine;
- Lack of interaction in Radiological Protection;
- Heterogeneity of protocols and equipment;
- Disparity in access to technologies and resources;
- Reinforce strengthen the justification of exams;
- Reinforce strengthen interprofessional dialogue;
- Reinforce patient safety and quality image evaluation;
- Application of accreditation programs.

7. FUTURE

Other modalities and clinical indications will be studied in this multicentric study.

Communication of benefits and risks need to be reinforced to the population, requester, and radiology staff [9].

Further recommendations for CT optimization dose need be applied engaging a multi professional action.

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