ESTABLISHMENT OF TYPICAL DOSE VALUE FOR PAEDIATRIC CT BRAIN AND DOSE REFERENCE VALUE FOR CT THORAX AT THE DEPARTMENT OF RADIOLOGY, HOSPITAL SULTAN ABDUL AZIZ SHAH, UNIVERSITI PUTRA MALAYSIA.

Nor Mazleen Mokhtar [1], Nooramaliza Mohd Noor [2], Adiela Saiful Fazad [3], Faizal Mohamed [4]

[1] Department of Applied Physics, Faculty of Science and Technology, Universiti Kebangsaan Malaysia: Bangi, Selangor, Malaysia, 43600; mazleenmokhtar@gmail.com
[2] Medical Physics Laboratory, Department of Radiology, Faculty of Medicine and Health Sciences, 43400 Serdang, Selangor, Malaysia; noramaliza@upm.edu.my
[3] Medical Physics Unit, Hospital Sultan Abdul Aziz Shah, Universiti Putra Malaysia: 43400 Serdang, Selangor, Malaysia; adiela@upm.edu.my
[4] Department of Applied Physics, Faculty of Science and Technology, Universiti Kebangsaan Malaysia: Bangi, Selangor, Malaysia, 43600; faizalm@ukm.edu.my

EXTENDED ABSTRACT

CT scan or computed tomography is one of the medical procedures which uses diagnostic imaging technology that belongs in the nuclear medicine category. Typical dose is a dose value that can be decided from the parameter value of Computed Tomography (CT) imaging data of paediatric patients using standard metric that is taken into account which are Volume-Weighted Computed Tomography Dose Index ($CTDI_{VOL}$) and Dose Length Product (DLP). This research is carried out in order to make sure that paediatric patients are exposed to optimum radiation dose and are not excessive in any way during a CT imaging examination. According to research (Shao et al. 2020), the results show a high probability that those who have received CT scans, women are at higher risk for thyroid cancer and leukemia to be compared with men. As for this study, Children are more exposed to ionizing radiation than adults (Gricienė et al. 2021). At the same time, making sure that patient's safety is prioritized, and the quality of diagnostic image is acceptable, according to the standard. Dose and image quality are two main hints in mirroring the reference point which helps radiology staff to find and optimize CT techniques (Muhammad et al. 2020). This research is carried out in Hospital Sultan Abdul Aziz Shah (HSAAS) and using retrospective research method where the paediatrics patient's data from the year 2022 to 2024 is used to determine the typical dose and facility Diagnostic Reference Level (DRL) value for HSAAS. DoseWatch software which records all patients' data that are related is accessed and the needed standard metric value is obtained. Once the data is calculated and analyzed, the typical dose value and facility DRL value is obtained by determining the value for 25th, 50th (median), and 75th percentile. The facility DRL value is compared to other facility DRL value in Malaysia.

The obtained brain protocol typical dose value for $CTDI_{VOL}$ is 28.26 mGy for the age group of 1- to 5-year-old, 30.72 mGy for 6- to 10-year-old, and 32.92 mGy for 11 to 15 year old and as for DLP, the value is 528.57 mGy.cm for the age group of 1 to 5 year old, 607.25 mGy.cm for 6 to 10 year old and 629.17 mGy.cm for 11 to 15 year old. As for thorax protocol, the reference dose value obtained for $CTDI_{VOL}$ and DLP is 6.34 mGy and 36 mGy.cm, respectively. Comparative study is also carried out in this study on the DRL value from several countries which act as the first step in optimization of protection and can indicate whether an investigation of local practice should be performed, according to ICRP-135. There is a significant difference in DRL values for $CTDI_{VOL}$ and DLP of each country. According to Table 1, when compared according to the age group of the pediatric patients. A comparison of the $CTDI_{VOL}$ value for the age group of 6 to 10 years for Japan recorded the highest value compared to other countries which is 67.7 mGy. China has gradually increased. These values are not determined as the dose limit but more to a guideline for the healthcare officers to ensure that patients are $CTDI_{VOL}$ values for each age group while France and Switzerland have approximately the same $CTDI_{VOL}$ values for each age group. These values are not determined as the dose limit but more to a guideline for the healthcare officers to ensure the patients are receiving optimized radiation dose and especially for paediatric patients as they are more radiosensitive due to the tissues and cells in their body and the cumulative radiation dose that is too high due to CT scan and other factors might lead to the risk of existing of cancer cells.

The obtained value for 25th, 50th (median), and 75th percentile for both $CTDI_{VOL}$ and DLP shows that the facility has set CT protocol according to patient age and size. The Size-Specific Dose Estimate (SSDE) method used at this facility is used to adjust $CTDI_{VOL}$ based on phantoms according to patient size to provide a more appropriate dose estimate for the patient. Generally, factors that affect the value of typical dose and DRL are patients age and weight and efficiency of the operator of the CT machine (Zurihanaz et al. 2023). The difference in values for each percentile increases and this indicates that pediatric patients are exposed to the appropriate amount of radiation according to their age group to avoid unnecessary exposure and potential harm to pediatric patients who are more radiosensitive than adult patients. Through the determination of typical dose values at HSAAS and the comparison of DRL value determination studies for $CTDI_{VOL}$ and DLP in terms of facilities and nationally from UMMC and several different countries that have been selected, which are Japan, Morocco, China, United Kingdom, France, and Switzerland included in this study, it can be concluded that the establishment and determination of DRL values for pediatric brain CT scans is very important because it is a useful guideline or tool to avoid excessive radiation exposure to pediatric patients during CT scans. This is because pediatric patients are more radiosensitive than adult patients and excessive radiation is likely to harm pediatric patients in the long term. However, it should be emphasized that the highest priority for any diagnostic imaging examination is to achieve image quality that is adequate for clinical purposes. Image quality must be assessed as part of the DRL process, and methods to achieve optimization should be implemented. In addition, healthcare providers performing ionizing radiation medical imaging should also receive guidance and education on the concept and appropriate use of DRL.

ACKNOWLEDGMENTS

The authors thank the Ethical Board of Universiti Putra Malaysia for granting ethical clearance to conduct this research (REFERENCE NUMBER: JKEUPM-2024-75). The authors acknowledged the staff of Medical Physics Department of Hospital Sultan Abdul Aziz Shah for providing guidance and access to patients' data.

REFERENCES

[1] Zurihanaz, A.A., Noor, N.M., 2023. Establishment of Typical Dose Value for Interventional Radiology Examination in Radiology Department, Hospital Pengajar UPM. Asian Journal Of Medical Technology, 3(1), 37-46.
[2] Muhammad, N. A., Abdul Karim, M. K., Abu Hassan, H., Ahmad Kamarudin, M., Ding Wong, J. H. & Ng, K. H. 2020. Diagnostic Reference Level of Radiation Dose and Image Quality among Paediatric Ct Examinations in a Tertiary Hospital in Malaysia. Diagnostics (Basel) 10(8):
[3] Shao, Y. H., Tsai, K., Kim, S., Wu, Y. J. & Demissie, K. 2020. Exposure to Tomographic Scans and Cancer Risks. JNCI Cancer Spectr 4(1): pkz072.
[4] Gricienė, B. & Šiukšterytė, M. 2021. Local Diagnostic Reference Levels for Paediatric Head Ct Procedures. Acta medica Lituanica 28(2): 253.