The Abdus Salam International Centre for Theoretical Physics

Joint ICTP-IAEA Training Course on Quality Assurance, Quality Control and Optimization of Equipment and Procedures Used in Fluoroscopically-Guided Interventional Radiology | (SMR 3884)

09 Oct 2023 - 13 Oct 2023
ICTP, Trieste, Italy

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T01

Quality Assurance Control, Quality Control in the Radiology department: the Medical Physicist perspective in Ghana

The World Health Organization (WHO) defines a quality assurance (QA) programme in diagnostic radiology as an organized effort by the staff operating a facility to ensure that the diagnostic images produced are of sufficiently high quality so that they consistently provide adequate diagnostic information at the lowest possible cost and with the least possible exposure of the patient to radiation. Quality assurance actions include both quality control (QC) techniques and quality administration procedures. QC is normally part of the QA programme and quality control techniques are those techniques used in the monitoring (or testing) and maintenance of the technical elements or components of an X-ray system.

In Ghana, the diagnostic medical equipment used are; Plain and Dental radiography, Mammography, Fluoroscopy, Computed Tomography, Magnetic Resonance Imaging and Ultrasound. The medical physicist plays a number of essential roles in the radiology department.

Medical Physics practice in Ghana was fully recognized by the health professions regulatory bodies Act 2013 (Act 857). Medical Physics was fully incorporated into the health structure of Ghana in 2019 and from 2020 to date, there is a formalized recruitment of certified Medical Physicists at the various radiology and radiotherapy departments in the country.

With significant contributions in clinical service, education, and research, Medical Physics continues to grow in importance both as a profession and as science, driven by the technological developments of societies in general and medicine in particular.

T02

Establishing Local Diagnostic Reference Levels for Image-Guided Interventional Procedures: A Study at Sultan Qaboos Comprehensive Cancer Care and Research Centre

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Introduction:

Fluoroscopy in medical applications can lead to high radiation doses for patients and operators. Local Diagnostic Reference Levels (DRLs) have been implemented in interventional radiology to minimize radiation exposure while optimizing imaging quality and patient safety.

Purpose:

This study aimed to establish DRLs for Image-Guided Interventional Procedures (IGIPs) at Sultan Qaboos Comprehensive Cancer Care and Research Centre (SQCCCRC). The objective was to enhance radiological practice by setting specific benchmarks for radiation doses, optimizing patient safety, imaging quality, and therapeutic outcomes.

Methods:

The study focused on various IGIPs, collecting data such as dose area product (DAP), air kerma at the reference point (AK_{Ref}), fluoroscopy time (FT), frames, kilovoltage (kV), and milliampere-seconds (mAs). The data pertained to adult patients weighing 60kg to 80kg. DRLs were set as the 3rd quartile of DAP values and fluoroscopy time.

Results:

Determined DRLs for DAP and fluoroscopy time in the studied procedures were as follows: Catheter Insertion: DAP: 0.73 Gy∗cm², FT: 0.52 min, Stent Insertion: DAP: 63.73 Gy∗cm², FT: 12.42 min, Nephrostomy: DAP: 2.21 Gy∗cm², FT: 1.6 min, Embolization: DAP: 136.28 Gy∗cm², FT: 23.65 min, Chemoembolization: DAP: 155.35 Gy∗cm², FT: 22.51 min, Cholangiogram: DAP: 4.31 Gy∗cm², FT: 2.62 min, and Biliary Drainage: DAP: 10.09 Gy∗cm², FT: 9.31 min.

Conclusion:

The established DRLs align with international studies, ensuring radiation doses in IGIPs at SQCCCRC are within acceptable limits and global best practices. The study contributes to radiation safety knowledge, providing guidance for healthcare professionals and patient safety.

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T03

Preliminary diagnostic reference level of radiation dose in coronary angiography and intervention in Senegal

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Hôpital Aristide LeDantec (HALD)

ABSTRACT: The number of coronary angiography procedures performed in Senegal has widely increased as angiography is a powerful tool for the evaluation of the coronary arteries. This study attempts to create a LDRL for optimizing radiation dose in coronary angiography.

OBJECTIF: The purpose of this study is to establish Local Diagnostic Reference Levels (LDRLs) at the University Hospital of Aristide LeDantec for angiography examinations and to compare these values with the international Diagnostic Reference Levels (DRLs) to benchmark the local practice.

MATERIALS/METHODS: This was a cross-sectional survey carried out in HALD between January 2021 and December 2021. Two hundred fifty examinations performed on adult patients were collected from request forms and angiography machine consoles. Data was segregated into one hundred fifty diagnostic Coronary Angiography (CA) and one hundred Percutaneous Transluminal Coronary Angioplasty (PTCA). The parameters collected include Fluoroscopy Time (FT), Skin Surface Entry Dose (SSED), and dose surface product (DSP).

RESULTS: For CA group, the mean SSED, DSP and FT were respectively 700mGy, 4770 cGy.cm^2 and 3,43 min. The 3rd quartile was calculated as 7150 cGy.cm^2. In the PTCA group, the mean SSED, DSP and FT were respectively 1675 mGy, 8850 cGy.cm^2 and 9,17 min. The 3rd quartile was calculated as 11660 cGy.cm^2.

CONCLUSION: This study established reference radiation dose level for interventional and diagnostic coronary procedures in Senegal. These results can be used for future studies in other institutions in the country and to compare with other countries.

Keywords: Diagnostic Reference Level, Coronary intervention, Optimization

T04

A Comparative Study of C-Arm Spine Imaging: Fluoroscopy Mode vs. Radiography Mode

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Abstract

A comparative study was conducted to evaluate the efficacy of C-arm spine imaging in fluoroscopy mode versus radiography mode. The purpose of this study was to determine which modality provided the most accurate and reliable results for spinal imaging. Results revealed that while both modes were effective, there was a statistically significant difference between the two with regards to image quality and accuracy. This research has important implications for medical professionals who rely on spinal imaging for diagnosis and treatment planning, as well as for patients who require such imaging procedures. Overall, further research is needed to fully understand the benefits and limitations of these different modes of C-arm spine studies in order to optimize patient care outcomes.

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T05

Establishing a diagnostic reference level of radiation dose in coronary angiography and intervention : A prospective Evaluation

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Introduction .

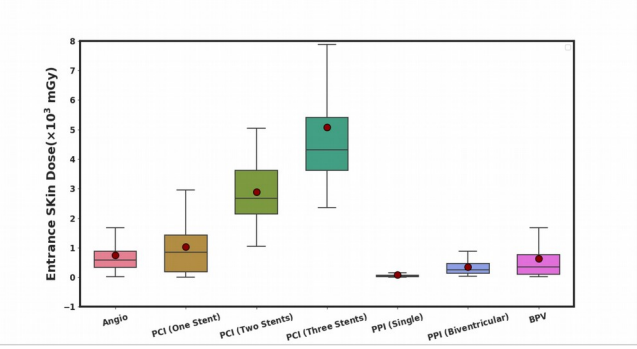
Invasive coronary Angiography (CAG) leads to significant radiation Exposure to the patients. Guidelines suggested that a local land mark or Diagnostic Reference level (DRL) for these procedures will be established for every region and country. This study attempted to create a DRLs for Uganda Heart Institute, acting as an interm DRL for the institution.

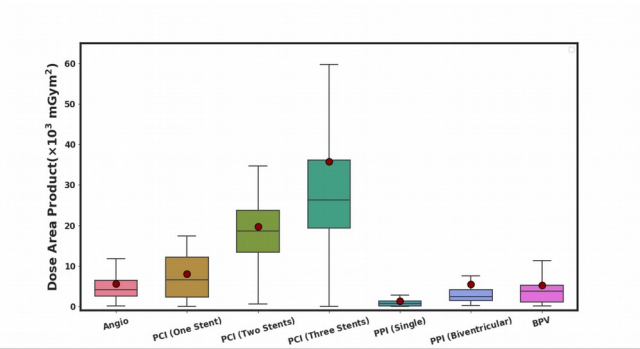
Methods

Radiation exposures data for all coronary procedures done at Uganda Heart Institution between June 2019 – June 2020 were collected .
Data was segregated into diagnostic coronary Angiography (CAG) and single vessel percutaneous intervention (PCI) and double vessel percutaneous intervention(PCI) . The parameters collected include dose surface product (Pka), skin surface entry dose (Kar) and fluoroscopy time (FT).
The 75 th percentile of the Pka was used to define the DRL.

Results

159 patients included in the CAG group in which median KAR was 599mGy .
Median Pka was 3995µGysqm and medium FT was 4 min.
The DRL for coronary angiography was calculated as 5975.4 µGysqm. 149 patients were in PCI group , the median KAR was 2304mGy.
Median Pka was 14035.5 µGysqm, the median FT was 14 min.
The DRL for single vessel coronary intervention was 12818.8 µGysqm The DRL for double vessel coronary intervention was 1632.6 µGysqm





Conclusion

This study established a bench mark for a radiation dose for diagnostic coronary angiography and single vessel coronary intervention at Uganda Heart Institution. It establishesd an interim DRL that will be used for future studies in other institutions in the region and country and to compare with other countries.

T06

Skin Dose Mapping using TLD-100H during Interventional Radiology

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Skin injuries can result from high radiation doses. Patients may experience radiation-induced skin damage due to the use of inappropriate equipment or, even worse, subpar operating procedures during certain surgeries [1]. To assess the risk for body sections receiving the maximum dosage during a procedure, skin dose mapping is performed using thermoluminescence dosimeters, specifically TLD-100H and the Hope Atom (Female) phantom. TLD-100H was chosen for its 30 times greater sensitivity than TLD-100, which allows it to measure low doses. Out of a total of 83 annealed TLD chips, five were designated as controls, while the remaining 78 were packaged into 26 sets, each consisting of three chips, and sealed, ready for irradiation using the abdomen (AP) angiography protocol without contrast. These 26 sets of TLD chips were then placed onto the phantom slabs at intervals of 5 cm. Analysis of the TLD chips revealed that the maximum recorded skin dose was 1.95 ± 0.203 mGy at Slab 31 during pelvis posteroanterior irradiation.

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T07

The Study of Local Diagnostic Reference Levels at Unit of Vascular and Intervention Radiology, King Chulalongkorn Memorial Hospital

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Interventional Radiology (IR) procedures are minimally invasive surgery using angiographic equipment which the patients and staffs may receive high radiation dose. The objective of this study is to establish the local DRLs distribution of patient radiation dose and related parameters in interventional radiology procedures in standard-sized of Thai patients.

The patient data of neuro-intervention and body intervention were reviewed and collected between January 2019 and June 2020. The result show that the median KAP value and 75th percentile (DRLs) of Cerebral angiogram were 49 and 61 Gy.cm^2, Embolization of intracranial aneurysm were 121 and 144 Gy.cm^2 , Embolization of brain AVM were 157 and 244 Gy.cm^2 , CT-guided TACE were 287 and 459 Gy.cm^2 , CBCT-guided TACE were 238 and 397 Gy.cm^2 , PICC line were 0.7 and 1 Gy.cm^2 , PERM cath were 1 and 4 Gy.cm^2, PCD were 2 and 4 Gy.cm^2 , PTBD cath were 6 and 14 Gy.cm^2 , Peripheral angiogram were 4 and 18 Gy.cm^2 , Peripheral angioplasty were 7 and 16 Gy.cm^2 , CBCT-guided Biopsy were 12 and 17 Gy.cm^2 ,respectively.

As the patient radiation doses in the therapeutic procedure are always higher than the diagnostic procedures, the DRLs of interventional radiology procedures should be optimized and reviewed DRLs annually. The exposure techniques to decrease the risk of patient radiation dose and reducing scatter radiation to all staffs should be reviewed. The Local DRLs of interventional radiology procedures is established in 2020 while Thailand DRLs is established in 2021. The Local DRLs report is useful in providing a guidance on National DRLs database.

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T08

Dose Audit and Determination of Typical Values in Coronary Angiography (CAG) Procedures

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Coronary angiography (CAG) and percutaneous coronary intervention (PCI) procedures effective used to treatment heart disease surgery through the radial and femoral arteries [1]. Interventional radiology (IR) procedures can increase the accumulation radiation dose received[2]. International Commission on Radiological Protection (ICRP) recommends diagnostic reference levels (DRL) as a tool to optimize radiation dose patient and image quality[3]. Dose audit on CAG with 22 patients in the Catheterization Laboratory (Cath Lab) MRCCC Siloam Hospitals Semanggi obtained the typical values cumulative Kinetic Energy Released per Unit Mass (KERMA) of 373.91 mGy and cumulative Dose Area Product (DAP) of 40.87 Gy.cm^2. Typical values is "the median value of the distribution dosimetric quantity for a clinical imaging procedure" and compared to the national diagnostic reference levels are 75% percentile of the distribution national data for use as a dose audit evaluation. If the typical values is below the national diagnostic reference levels, it must maintain and ensure that the image has diagnostic quality and if the typical values is above the level national diagnostic reference levels it is necessary to investigate the causes and optimize by optimization scenario. Nuclear Energy Regulatory Agency of the Republic of Indonesia (BAPETEN) has determined that the DRL for the CAG procedure for cumulative KERMA is 330 mGy and DAP is 24 Gy.cm^2. From the results dose audit of typical values comparison dose with at the national diagnostic reference levels, optimization necessary as an implementation of the principle of radiation protection and aims to improve the radiation safety of staff and patients.

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T09

Dose and Image Quality Optimization for Computed Radiography (CR): A Phantom Study

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ABSTRACT

Purpose: Knowing the complexity of the optimization process in fluoroscopy, we have proposed a method adapted to the Moroccan context.

Material and methods: we have proposed a simple and effective method for optimizing interventional radiology practices, using available equipment and involving a multidisciplinary team (including surgeons, radiologists, medical physicists, technicians and biomedical staff).
The PURE.18 phantom from PureimagingTM is used to evaluate the image quality and dosimetry measurements were obtained using a solid-state detector and a multisensor (Radcal AGMS-DM+) for the acquisition parameters used during the three radiographic procedures.

Results: the results obtained conclude that interventional practices can be improved by involving the whole team and using quality control methods based on the harmonized quality control program drawn up by the IAEA and dedicated to African countries.

Conclusion: The use of a phantom and radiation detector is now a scientific approach to optimize radiation dose and image quality by selecting image parameters that give an acceptable image with the lowest possible radiation dose.

K E Y W O R D S: *Interventional Radiology Radiation Dosimetry; Image quality; Optimization.*

T10

Advice on Radioprotection to the Public Hospital

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Medical exposures are the largest artificial source of ionizing radiation, with interventional radiology being a practice that generates high doses of radiation in both patients and workers. Originally exclusive to radiologists, the practice has recently incorporated other specialists such as cardiologists, traumatologists, vascular surgeons, and urologists. However, this, combined with a lack of knowledge in radiation protection, has resulted in excessive doses for both patients and workers, including documented cases of severe skin lesions. The Laboratory of Dosimetry and Radiological Protection (LaDoPro) at the Facultad de Ciencias Exactas, Universidad Nacional de La Plata, provides radioprotection advice to both public and private hospitals. This work describes the tasks carried out in a public hospital to ensure equipment operation, facility shielding, and work protocol optimization for the safety of both occupationally exposed personnel and patients.