ISSN: 2582-7162

Original Article

Diagnostic Reference Levels for Radiological Procedures: Institutional Evaluation and Comparison

Ramesh Chand Sharma[1], Mukesh Jain[2], Mary Joan[3], Arun Chougule[4], Rajesh Kumar Jangir[5]

[1,2,]SMS Medical College and Hospitals Jaipur, India
[3]Christian Medical College and Hospital, Ludhiana, India
[4]Swasthya Kalyan Group, Jaipur, India
[5]Department of Radio-Diagnosis, Mahatma Gandhi Medical College, Jaipur

Corresponding Author:
Mukesh Jain, SMS Medical College and Hospitals Jaipur, India

E-mail:
mukeshpatni05@gmail.com

How to cite this article: Sharma RC, Jain M, Joan M, Chougule A, Jangir RK. Diagnostic Reference Levels for Radiological Procedures: Institutional Evaluation and Comparison. GFNPSS-IJMR 2024; 5:5: 2600-2603

Submitted: 22-April-2024: **Accepted:** 29-May-2024: **Published:** 03-June -2024

Abstract

Introduction: DRLs or Dose Reference Levels can be defined for various Radiographic procedures and for various dosimetric parameters as per the available of various literatures.

Materials & Methods: To find the DRLs we need to find the entrance surface dose (ESD) during various radiological procedures. For finding this we can measure it by using Optically Stimulated Dosimeters (OSLD) or may be by other instruments like Dose Area Product (DAP), Thermoluminesence Dosimeters (TLD) etc. This will help to optimize the radiation protection and safety standards of the radiological procedures carried out at the institute and compared it with the available international data or can also be compare with the practice for various institutes of a city or a region.

Results: The entrance surface dose for various radiographic imaging procedures were carried out on 15 X-ray generating equipment at S.M.S. Hospital Jaipur and on 6 X-ray generating equipment at Mahatma Gandhi Hospital Jaipur. A total of 2670 adult patient examinations were evaluated with a minimum of 50 examinations of each part. Most of the machines at both the centers were as per the norms of AERB. After calculation of ESD at both the institutes the 75th percentile or 3ed quartile value of the distribution of patient ESD doses obtained for various Radiological examinations is tabulated and are compared with the data obtained a5t both the hospitals and also compared with the international reference guideline and other national DRLs. The radiation given to patients during various radiological examinations and for various examination views is expected to decrease as emphasis is placed on optimization of procedure and as equipment improves. The radiation dose to patients should be brought down as low as reasonably achievable (ALARA) as no dose is safe.

Conclusions: As optimization occurs and practice improves, an institutional reference dose levels are necessary for updating dose received by patients at the center and can also be compared with other institutes so that we canperiodically updating our practices.

Keywords: Entrance surface dose; optically stimulated luminescent dosimeter; Thermoluminesence Dosimetry; dose area product; dose reference levels; 3ed quartile

https://doi.org/10.46376/ijmr/05.05.2024:2600-2603

Introduction:

Now a day's Radiological imaging is an indispensable element of modern medicine. No clinician or a surgeon starts his treatment until and unless he does not have radiological procedures for the patient. No doubt the various radiological procedures helped doctors to analyze the correct treatment line for the patient but we should be aware that these procedures provide ionizing radiation doses to patients which are found to be dangerous as these radiations are found to be cause cancer as well as large number of other harmful effects on the patients. The diagnostic reference levels (DRLs) are one of the main operational tools for optimization of patient protection in radiological imaging. The DRLs are used to identify imaging procedures, which cause radiation doses to patients and should therefore be reviewed with respect to their optimization and corrective action applied where needed. For a radiographer optimization and justification will lead to good work practice and it also helps to obtain good quality radiographs. Very less work have been done in India regarding the DRL values while most of the European Countries and most of the developed countries of the globe have their own national DRL values. For our country India which is very big in size as well as variation in condition, quality and age of equipment, technique and size of patient, we need to have various regional DRL's for radiological procedures. The radiation doses received by patients of different age groups including pediatric and of all genders who underwent diagnostic radiological procedures were measured and evaluated. The radiation protection survey and quality assurance of x – ray installations in the institute was carried out prior to the study.

Diagnostic reference levels (DRLs) have been recommended by the International Commission on Radiological Protection and various other international organizations as an advisory measure to improve optimization of patient protection, by identifying high patient dose levels which might not be justified on the basis of image quality requirements. DRLs should be set for common examinations using easily measurable dose quantities. National DRLs are usually set by a collaboration of authorities and professional societies, typically using a percentile point (most commonly 75% or the 3rd quartile) of the observed distribution of patient doses in the country. ICRP has also stated (ICRP 2001) that DRLs specific to clinical indications (clinical protocols) are desirable. Consequently, in several groups of examinations, mainly of the adult population, DRLs have become a valuable tool in the optimization of the procedures.

Lot of work have been done in various countries of the world for collection of DRL values for various Radiological Examinations and there are many papers were published based on data collected from individual regions or countries for establishment of national DRLs and some proposing national DRLs for specific radiological procedures. There are many attempts to establish local or regional DRLs for various radiological procedures from different parts of India.

Although DRLs may be defined for each radiographic procedure for multiple dosimetric parameters, in the present study we evaluated the entrance surface dose measured using Optically Stimulated Dosimeters (OSLD) to set the reference level for our institute and Mahatma Gandhi institute and compared it with the available international data.

Materials & Methods:

The entrance surface dose for various radiographic imaging procedures were carried out on 15 X-ray generating equipment at the S.M.S. Medical College and 6 at Mahatma Gandhi Medical College. A total of 2670 patient examinations were evaluated in the present study. The 3rd quartile (the 75th percentile) value of the distribution of patient doses obtained for various sites of examination is tabulated and compared with the international reference guideline and other national DRLs.

Results

Despite the recommendations and the clear need for DRLs for radiological examinations, only very few DRL data are available and they are only set in a particular radiological examination or in a small region of the county. The reasons for this are many-fold: patient dose levels vary considerably as a function of age, size or weight of the patients and therefore, DRLs for several age, size or weight groups need to be defined; due to the lack of standardization of these groups, the comparison of DRLs or patient dose data with other countries is not straightforward; due to the general paucity of patient dose data for radiologic examinations, it is often difficult to collect sufficient data to establish DRLs, or to compare local values with established DRLs, for

https://doi.org/10.46376/ijmr/05.05.2024:2600-2603

each age or weight sub-group. Patient dose surveys are needed to establish DRLs, and there is little guidance on the statistical requirements for such surveys and on how to derive the DRL values. Special challenges may be introduced by different institutions, e.g. the procedures in a specialty cancer center might require different DRLs compared to those in a more general institution. Further, the rapidly evolving technology may complicate the establishment of DRLs. The calculation of ESD at the both the institutes were done on the same type of Radiological procedures

Radiographic examinations

The dose reference levels observed for radiographic procedures are comparable with the guidance levels but on a higher side. As could be inferred from the literature review, DRL values are not static. The radiation administered to patients for radiological examinations is expected to decrease as emphasis is placed on optimization of protection and as equipment improves. This has been demonstrated in U.K. surveys of radiography and fluoroscopy [23]. We should aim to bring down the radiation dose to patients as low as reasonably achievable (ALARA) as no dose is safe. As optimization occurs and practice improves, DRL values require periodic updating.

COMPARISON OF ESD FOR VARIOUS RADIOLOGICAL EXAMINATIONS

Entrance Surface Dose (ESD) per radiograph (mGy)				
Examination Part	**UK 2014**	**Japan 2015**	**S.M.S.Hospital, Jaipur**	**Mahatma Gandhi Hospital, Jaipur**
Chest PA	**0.15**	**0.3**	**1.46**	**1.52**
Skull AP/PA	**1.8**	**3**	**4.26**	**4.12**
Skull LAT	**1.1**	**2**	**2.62**	**2.46**
Abdomen AP	**4.4**	**3**	**1.83**	**1.78**
C Spine	**-**	**0.9**	**1.02**	**1.13**
T Spine AP	**3.5**	**3**	**6.26**	**5.46**
T Spine LAT	**7**	**6**	**8.3**	**7.75**
L Spine AP	**5.7**	**4**	**10.15**	**9.75**
L Spine LAT	**10**	**11**	**12.64**	**11.96**
Femur	**-**	**2**	**2.82**	**2.24**
Ankle	**-**	**0.2**	**1.61**	**1.54**
Forearm	**-**	**0.2**	**0.99**	**1.06**

In more advanced setting of DRLs other questions arise such as how to deal with different equipment generations and technologies and the different levels of implementation of automatic dose saving systems. This is especially significant in our country's scenario.

An easy and effective follow-up of patient doses and their comparison with DRLs still suffers from non-existence of patient dose data management systems in India. The availability of more compatible systems regardless of the type of x-ray equipment and the development of institutions' overall data management systems in the future could provide valuable support for the implementation of DRLs, not only for occasional comparisons but for continuous patient dose monitoring and comparisons, with appropriate practices to alert staff on any unusually high or low dose levels.

Conclusions

OSLD is used to calculate the organ site dose. The method used in this study can provide important information of patient absorbed dose and enhance the radiation protection of patient in radiological procedures. This will also help to reduce the redundancy of patient imaging by making standard imaging protocols.

In order to establish the regional/local dose reference levels, patient radiation dose data set needs to be created for different radiological examinations after optimizing the protocols followed for various procedures. Optimizing the practices based on the short comings inferred from the initial observations and dose measurements helped to bring down the patient doses. Regular update of knowledge and training enabled the radiation professionals to perform the radiological examinations with lower radiation dose to the patients as well as to themselves.

As inferred from this study, we may further reduce the radiation doses to patients as well as professionals by optimizing the practices, improving the radiation safety and protection awareness and hence the confidence in practice and adopting advanced technology. The quality assurance and quality control of all radiation equipment needs to be regularly verified and strictly adhered. As observed from the literature review, regular follow up helps in significantly reducing the set DRLs. A large scale multi-centric study in the region is highly recommended so that the cumulative population radiation dose may be reduced.

https://doi.org/10.46376/ijmr/05.05.2024:2600-2603

Financial support and sponsorship: No

Conflict of Interest: There are no conflicts of interest

References:

1. International Commission on Radiological Protection (ICRP) (1991). 1990 Recommendations of International Commission on Radiological Protection. ICRP Publication 60. Ann. ICRP 21 (1-3).
2. International Commission on Radiological Protection (ICRP) (1996). Radiological protection in medicine. ICRP Publication 73. Ann. ICRP 26 (2).
3. International Commission on Radiological Protection (ICRP) (2001). Radiation and your patient: A guide for medical practitioners. ICRP Supporting Guidance 2. Ann. ICRP 31 (4).
4. International Commission on Radiological Protection (ICRP) (2007a). The 2007 Recommendations of International Commission on Radiological Protection. Ann. ICRP 37 (2-4).
5. International Commission on Radiological Protection (ICRP) (2007b). Radiological protection in medicine. ICRP Publication 105. Ann. ICRP 37 (5).
6. International Commission on Radiological Protection (ICRP) (2013). Radiological Protection in paediatric diagnostic and interventional radiology, ICRP-121.
7. European Commission (EC), 2014. Dose Datamed 2 (DDM2) Project Report Part 2: Diagnostic Reference Levels (DRLs) in Europe.
8. R. Ruiz-Cruces,"Estimación de las dosis poblaciones en España (DOPOES project)". Memorandum of specific agreement between Spanish Nuclear Safety Council and the University of Malaga), 2015
9. K. Schneider, M. M. Kohn, and G. Ernst,"The derivation of reference dose values to chest X-rays in paediatric radiography", Radiation Protection Dosimetry, 1998, 80: 199-202.
10. A. Chougule, "Reference dose levels in Radiological Imaging– Indian Scenario", Polish J.Med.Phys.Eng., 2005, 11(2), 115-126.
11. A. Chougule, "Quality Assurance Survey of X – Ray Machines and Patient doses during Various Radiological Procedures", Hungarian Medical Physics Journal, 2007, 28-31.
12. A. Chougule,R. K. Gupta,and G. R. Agarwal,"Evaluation of radiation doses to patient's organ during radiography of the abdomen", Ind. J. Radiol. Imag., 1992, 2:139-142.
13. A. Chougule,R. K. Gupta, and G. R. Agarwal, "Measurement of patient skin exposure by thermo luminescence dosimetry during some radiological examinations", Ind. J. Radiol. Imag, 1992, 2: 193-195.
14. S. J. Supe, P. S. Iyer, J. B. Sasane, S. G. Sawant, and V. K. Shirva,"Examination and significance of patient doses from diagnostic X – rays in India", Rad. Prot. Dosim., 1992, 43: 209-211
15. European Commission (EC), 1999. Guidance on Diagnostic Reference Levels (DRLs) for medical exposures, Radiation Protection 109
16. T. Kiljunen, H. Järvinen, and S. Savolainen,"Diagnostic reference levels for thorax X-ray examinations of paediatric patients", Br J Radiol. 2007, 80 (954): 452-9. doi:10.1259/bjr/60918774.

https://doi.org/10.46376/ijmr/05.05.2024:2600-2603