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Clinical Indication Based Diagnostic Reference Levels (DRLci) for Contrast Radiography Examinations: A Guide for Radiation Safety culture and good clinical practice

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ABSTRACT

Clinical Indication specific DRLs is pivotal in optimization of medical procedures and it serves as a guide to Radiology practitioners in achieving the international recommendations and current trends by International Commission on Radiological Protection (ICRP). The study was carried out to establish DRLci for contrast radiography examinations in two teaching hospitals in North Eastern Nigeria. A Prospective cross - sectional study was conducted in two major University Teaching Hospitals. Three hundred and Sixty (360) patients participated in the study. Doses were recorded using thermo-luminescent dosimeter (TLD) chips and dose area product (DAP) meter. Student T-test was used to determine the relationship between the mean entrance skin doses (ESD) obtained in the two centers while Pearson's correlation was used to determine the relationship between the dose and anthropo-technical parameters. Statistical significance was set at $p < 0.05$. Findings showed that the clinical DRLs for this study were 6.68 mGy and 10.66 mGy.cm^2 (IVU), 2.31 mGy and 3.67 mGy.cm^2 (HSG), 2.66 mGy and 8.98 mGy.cm^2 (barium meal), 12.78 mGy and 20.64 mGy.cm^2 (barium enema), 2.73 mGy and 6.56 mGy.cm^2 (barium swallow), and 2.05 mGy and 7.77 mGy.cm^2 Retrograte Urethrography (RUG), respectively. The Entrance Skin Dose (ESD) and Dose Area Product (DAP) showed statistically significant relationship with technical parameters ($p <0.05$) for barium enema. The remaining studies showed no statistical significance ($p > 0.05$). Clinical DRLs in this work recorded lower values. However, regular dose optimization technique and etiquettes are required to ensure good practice.

Key words: *Barium Meal, Barium Enema, Barium Swallow, Hysterosalpingography (HSG), Intravenous Urography (IVU)*

1. INTRODUCTION

Diagnostic reference levels (DRLs) are intended to improve patient protection by allowing comparison of current practice, comparison of similar examinations for similar purposes and should be based around clinical indications, rather than broad categories of examinations [1]. In practice, DRLs are a percentile point (75th) of the observed distribution of $CTDI_{vol}$ or DLP to patients. Hence DRLs provides awareness of radiation protection at local levels, and the identification of abnormally high doses [2]. Most of the existing DRLs have been established based on anatomical locations. However, some limitations of this approach were pointed out for CT as, for the same anatomical location, one could have several clinical indications with consequently different protocols corresponding to different radiation exposure levels [2].

The clinical approach to DRLs was mentioned some years ago by the International Commission on Radiological Protection (ICRP), but most of the European National Competent Authorities (NCAs) still consider DRLs for anatomical location and not specifically for clinical indications. However, some countries have recently established DRLs based on clinical indications (DRL_{ci}) but for adults and many others are planning to do so in the near future [3]. There is no published work on DRLci for contrast radiographic studies from literature search.

Despite the clear need and recommendations for clinical DRLs, only few countries have set such DRLs [4]. Hence, establishing clinical DRLs with a comparison to international values can facilitate dose audit and improve patient radiation protection. It was against this backdrop that this study aimed to determine the DRLci for contrast studies**.**

2. METHODOLOGY

The study was a Prospective cross - sectional study was conducted in two major University Teaching Hospitals. Three hundred and Sixty (360) patients participated in the study. Study was categorized based on clinical indication for each contrast examination depending on the indication. Ethical clearance and patient consent were given befor embarking on the study.Doses were recorded using thermo-luminescent dosimeter (TLD) chips and dose area product (DAP) meter. Student T-test was used to determine the relationship between the mean entrance skin doses (ESD) obtained in the two centers while Pearson's correlation was used to determine the relationship between the dose and anthropo-technical parameters

3. RESULTS

3.1 Table 1 Relationship between doses received by patients during contrast radiographic examination and technical parameters

Examination	Technical Parameters	ESD Vs Technical Parameters		DAP Vs Technical Parameters	
		R-value	p-value		
IVU	FSD	0.534	0.002	0.077	0.686
	kVp	-0.317	0.088	-0.209	0.268
	mAs	-0.067	0.726	-0.469**	0.009
HSG	FSD	0.171	0.367	-0.096	0.613
	kVp	0.250	0.183	-0.071	0.708
	mAs	0.012	0.949	-0.132	0.488
RUG	FSD	-0.235	0.211	0.671	0.000
	kVp	-0.153	0.420	0.485	0.007
	mAs	0.213	0.259	-0.010	0.956
BA ENEMA	FSD	0.386	0.035	0.390*	0.033
	kVp	-0.086	0.650	-0.199	0.292
	mAs	-0.013	0.944	0.230	0.222
BA SWALLOW	FSD	0.174	0.357	-0.137	0.470
	kVp	0.448	0.013	-0.110	0.562
	mAs	0.678	0.000	-0.056	0.769
BA MEAL	FSD	0.139	0.465	0.185	0.327
	kVp	-0.532	0.002	-0.162	0.393
	mAs	-0.437	0.016	-0.246	0.191

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significantat the 0.05 level (2-tailed).

Key-IVU- Intravenous urography, HSG- Hysterosalpingography, RUG- Retrograteurethrography, ESD- Entrance skin dose, DAP-Dose area product, kVp- kilo volt peak, mAs- milli ampere seconds, FSD- Focus to skin distance, BA- Barium.

3.2 Table 2 Comparison of patient's mean radiation dose and technical parameters for contrast radiographic examination for hospital A and Hospital B

Examination	Parameters	Mean±Std (Hospital A)	Mean±Std (Hospital B)	P-value	T-value
IVU	KVp	78.50±9.16	81.50±10.00	0.06	0.383
	mAs	32.00±10.00	49.23±10.00	0.07	2.110
	ESD	3.17±1.02	6.61±2.00	0.15	2.654
	DAP	9.25±0.00	10.26±2.00	0.25	0.875
HSG	KVp	66.90±5.00	76.63±4.00	0.06	2.632
	mAs	25.67±10.00	40.80±10.00	0.07	1.853
	ESD	1.41±0.91	2.30±0.88	0.09	1.207
	DAP	2.97±0.00	3.44±0.40	0.11	2.035
RUG	KVp	74.67±3.00	79.33±10.00	0.08	0.773
	mAs	34.83±10.00	39.60±10.00	0.06	0.584
	ESD	1.18±1.00	1.82±0.80	0.06	0.866
	DAP	5.91±0.00	7.14±1.00	0.06	2.130
Barium enema	KVp	78.50±10.00	86.00±2.00	0.07	1.274
	mAs	32.00±10.00	29.67±10.00	0.06	0.285
	ESD	10.63±4.00	2.62±0.00*	0.02	3.374
	DAP	16.26±0.00	7.90±1.00*	0.03	14.480
Barium swallow	KVp	65.67±10.00	80.00±3.50	0.25	2.343
	mAs	24.17±4.00	50.00±5.00*	0.04	6.987
	ESD	1.62±1.00	2.62±1.00	0.75	1.225
	DAP	7.62±1.00	6.24±1.00	0.25	2.390
Bariummeal	KVp	66.97±6.00	86.00±2.50*	0.03	5.071
	mAs	24.42±10.00	29.67±10.00	0.06	0.643
	ESD	0.34±0.20	0.55±0.20	0.08	1.286
	DAP	7.33±0.00	7.90±1.00	0.06	0.987

Key:**. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed).

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kVp- kilo volt peak, mAs- milli ampere seconds.

3.3 Table 3 Comparison of DRLs for contrast radiographic examination in this work with European Commission, United Kingdom and Australian radiation protection and nuclear safety agency DRLs.

Examination	ARPANSA DRL		EC, DRL		UK, DRL		DRL This work	
	mGy	DAP	mGy	DAP	mGy	DAP	mGy	DAP
IVU	----	16	---	14	10	14	6.68	10.66
HSG	----	4	---	2	24		2.31	3.67
Barium meal	----	13	---	12	5.0	12	2.66	8.98
Barium enema	----	31	---	23	15	21	12.78	20.64
Ba swallow	----	11	---	3.4	4	7.5	2.73	6.56
RUG	----	13	---	7	15	7	2.05	7.77

Fluoroscopy time is between 2 - 15 seconds with mean time of 8.12±1.03 minutes

Key- DAP - dose area product in mGy.cm2. EC- European commission, UK- United Kingdom, ARPANSA-Australian radiation protection and nuclear safety agency.

4 RESULTS

The DRL for Australian radiation protection and nuclear safety agency (ARPANSA) were 16mGy.cm^2, 4 mGy.cm^2, 13 mGy.cm^2, 31 mGy.cm^2,11mGy.cm^2 and 13 mGy.cm^2 for IVU, HSG, barium meal, barium enema and barium swallow and RUG respectively. From the table, European commission (EC) DRL are 14 mGy.cm^2,2 mGy.cm^2,12 mGy.cm^2,23 mGy.cm^2,3.4 mGy.cm^2 and 7 mGy.cm^2 for IVU, HSG, barium

meal, barium enema and barium swallow and RUG respectively. United kingdom DRL are presented as follows 10,2,5,15,4 and 15mGy and 14,4,12,21,7.5 and 7 in mGy.cm^2 for IVU, HSG, barium meal, barium enema and barium swallow and RUG . DRL for this study are 6.68 mGy ,10.66 mGy.cm^2 for IVU, 2.31mGy,3.6723 mGy.cm^2 for HSG, 2.66mGy,8.98 mGy.cm^2 for barium meal, 12.78mGy,20.64 mGy.cm^2 for barium enema,2.73 mGy and 6.56 mGy.cm^2 for barium swallow and 2.05mGy, 7.77 mGy.cm^2 for RUG respectively. DRLs for IVU , HSG Barium meal and Barium enema in this work recorded lower values when compared with that of European ,UK and ARPANSA respectively.

Statistical significance was set at $p < 0.05$. Findings showed that the clinical DRLs for this study were 6.68 mGy and 10.66 mGy.cm^2 (IVU), 2.31 mGy and 3.67 mGy.cm^2 (HSG), 2.66 mGy and 8.98 mGy.cm^2 (barium meal), 12.78 mGy and 20.64 mGy.cm^2 (barium enema), 2.73 mGy and 6.56 mGy.cm^2 (barium swallow), and 2.05 mGy and 7.77 mGy.cm^2 Retrograte Urethrography (RUG), respectively. The Entrance Skin Dose (ESD) and Dose Area Product (DAP) showed statistically significant relationship with technical parameters ($p <0.05$) for barium enema. The remaining studies showed no statistical significance ($p > 0.05$).

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5 CONCLUSION

DRLs for IVU , HSG Barium meal and Barium enema in this work recorded lower values when compared with that of European ,UK and ARPANSA respectively. However, regular dose optimization technique and etiquettes are required to ensure good practice.

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