

Development of the Diagnostic Reference Level (DRL) for Plain Radiographic Exams: Results of the Nation-Wide Survey in South Korea

Young Hoon Cho, MD; Kyung-Hyun Do, MD; Hong Eo, MD; Kwang Pyo Kim, MD

Asan Medical Center, University of Ulsan College of Medicine



BACK GROUND

- Overall amount of **ionizing radiation exposures** due to medical imaging procedures have markedly increased → heightened needs for **dose reduction** and **close radiation surveillance**
- **Diagnostic reference levels (DRL)**
 - First introduced by the International Commission on Radiological Protection (ICRP) in 1990 → clarified further in 1998
 - Utilized as the '**optimized radiation dose**' for commonly performed medical imaging procedures
 - Should not be considered as a 'regulatory limit', but rather as a '**benchmark**' for radiation protection
 - Typically set at the 75th percentile of the dose distribution from a survey conducted across a broad user base

PURPOSE

- Perform nation-wide survey in South Korea regarding the radiation exposure associated with plain radiographs for various parts of the body
- Assess the accumulated data, especially in comparison with previous reports, to establish recommendation DRLs of each radiographic exam for adults and children (previous DRL guideline given at 2007 - 2013)
- Inform and educate the results from this study to the doctors (especially radiologists) and radiology technicians

METHODS

- Total of **103 hospitals** in various regions within South Korea with installed x-ray examination **machines (total number, 115)** were chosen for thorough survey and testing from February 2017 to November 2017

	Digital Radiography	Computed Radiography	Total
Tertiary referral centers	25	1	26
General hospitals	55	3	58
Private clinics	16	15	31
Total	96	19	115

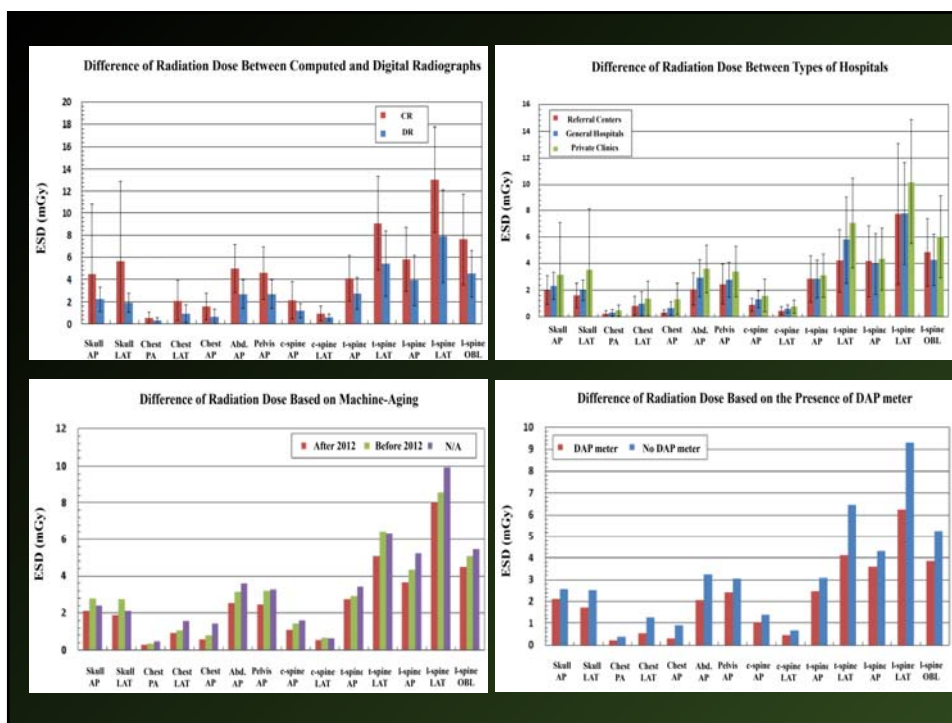
- Radiation exposure was measured as **entrance surface dose (ESD, mGy)** with dedicated phantoms design to represent adults, 10-yr old children, and 5-yr old children
- DRL was established as the **upper quartile (75th percentile)** value of the average ESD for each exam (glass dosimeter & Unfors survey meter)

Entrance Skin Dose (mGy) of Examined Plain Radiographs

	Exam	Projection	25 percentile	Average	Median	75 percentile
5-year old	Skull	AP	0.55	0.99	0.73	1.02
		Lat	0.47	0.86	0.62	0.92
		PA	0.05	0.13	0.09	0.17
	Chest	Lat	0.09	0.26	0.2	0.33
		AP	0.12	0.31	0.21	0.35
	Abdomen	AP	0.26	0.68	0.49	0.8
Pelvis	AP	0.35	0.73	0.6	0.88	
10-year old	Skull	AP	0.73	1.26	0.97	1.38
		Lat	0.63	1.14	0.88	1.2
		PA	0.08	0.18	0.12	0.24
	Chest	Lat	0.13	0.4	0.25	0.5
		AP	0.15	0.42	0.25	0.47
	Abdomen	AP	0.36	1.06	0.8	1.38
Pelvis	AP	0.64	1.19	0.96	1.43	
Adult	Skull	AP	1.47	2.45	1.96	2.85
		Lat	1.3	2.3	1.87	2.48
		PA	0.13	0.33	0.25	0.4
	Chest	Lat	0.48	1.06	0.75	1.26
		AP	0.26	0.75	0.48	0.9
	Abdomen	AP	1.85	2.91	2.61	3.64
		AP	1.86	2.87	2.45	3.59
	C-spine	AP	0.75	1.31	1.06	1.65
		Lat	0.37	0.61	0.54	0.74
	T-spine	AP	1.88	2.91	2.61	3.64
		Lat	3.57	5.81	5.59	7.29
	L-spine	AP	2.63	4.12	3.74	4.89
		Lat	5.29	8.44	7.55	10.55
		Obl	3.02	4.85	4.33	6.09

Comparison of DRLs with Previous Domestic and International Reports

ESD (mGy)	DRL	Korea 2011	England 2010	Europe (low group)	Europe (high group)
Skull (AP)	2.85	2.65	1.80	2.88	5.00
Skull (LAT)	2.48	2.97	Belgium, Bulgaria, Switzerland, Finland, England, Denmark		Czechoslovakia, Spain, France, Croatia, Italy, Lithuania, Moldova, Romania, Slovakia
Chest (PA)	0.40	0.66	0.54	0.79	
Chest (LAT)	1.26	2.8			
Chest (AP)	0.90	1.63	0.20	-	-
Abdomen (AP)	3.64	3.75	4.40	5.17	8.83
Pelvis (AP)	3.59	3.68	3.90	4.38	9.33
C-spine (AP)	1.65	1.86	-	-	-
C-spine (LAT)	0.74	1.03	-	-	-
T-spine (AP)	3.64	3.79	3.30	3.50	6.50
T-spine (LAT)	7.29	8.15	7.20	10.0	16.2
L-spine (AP)	4.89	4.08	5.7	6.8	10.0
L-spine (LAT)	10.55	10.53	10	13.4	28.3
L-spine (OBL)	6.09	6.35	-	-	-



CONCLUSION 1/2

- Thorough nation-wide survey program, **exam-specific DRLs** for plain radiographs were established for both adults and children
 - DRL established for the **first time for children** in Korea
 - 2017 DRL were generally **lower than 2011 DRL**, with the exception of Skull AP and L-spine AP exams
- 2017 Korea DRL was generally **similar or higher level DRL** than **England 2010** and **similar to low-DRL group in Europe**
 - Especially, consistently **higher level of radiation in chest exams** were noted
 - Definite room for future improvements

CONCLUSION 2/2

- Radiation dose was **higher** in *DR* machines, *smaller* medical centers, *aged*-machines, and machines *without DAP meters*
 - Many of the doctors and technicians who participated in this survey had **inadequate knowledge regarding DRL**
 - Majority of tested X-ray machines **did not have DAP meters** or documented/archived radiation dose per exam
- **Need for thorough personnel educations, mechanical & technological maintenance, and both voluntary & institutional means for dose surveillance/reduction**