Patient Radiation Doses from Radiographic Examinations in Korea

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Background

❖ **Radiation Exposure from Medical Imaging:**
Medical imaging results in radiation exposure and thus potentially negative health effects such as cancer.

❖ **Rapid Increase of Medical Exposure:**
According to a recent NCRP report, increasing use of medical radiation contributed to half of total to exposure to the US population.

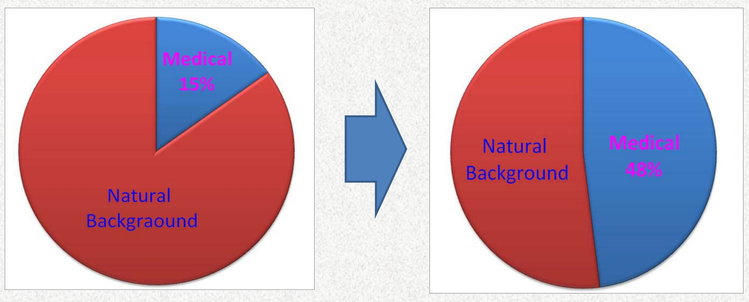


Figure 1. Percent contribution to effective dose per individual in the US population (Source: NCRP report 160)

❖ **Justification and Optimization of Medical Exposure:** By adjusting technical parameters of x-ray machine, radiation dose to patients can be minimized without detriment to the clinical purpose.

❖ **DRL (Diagnostic Reference Level):**
There are significant variations in national practice with medical imaging and radiation dose. → DRL to indicate whether patient exposure is unusually high. → DRL can effectively minimize radiation exposure to patients.

Objectives

❖ **To measure radiation doses to patients from radiographic examinations**

❖ **To collect information associated with patient dose**

Materials and Methods

❖ **Number of Hospitals:** 320 Hospitals in 3 Provinces

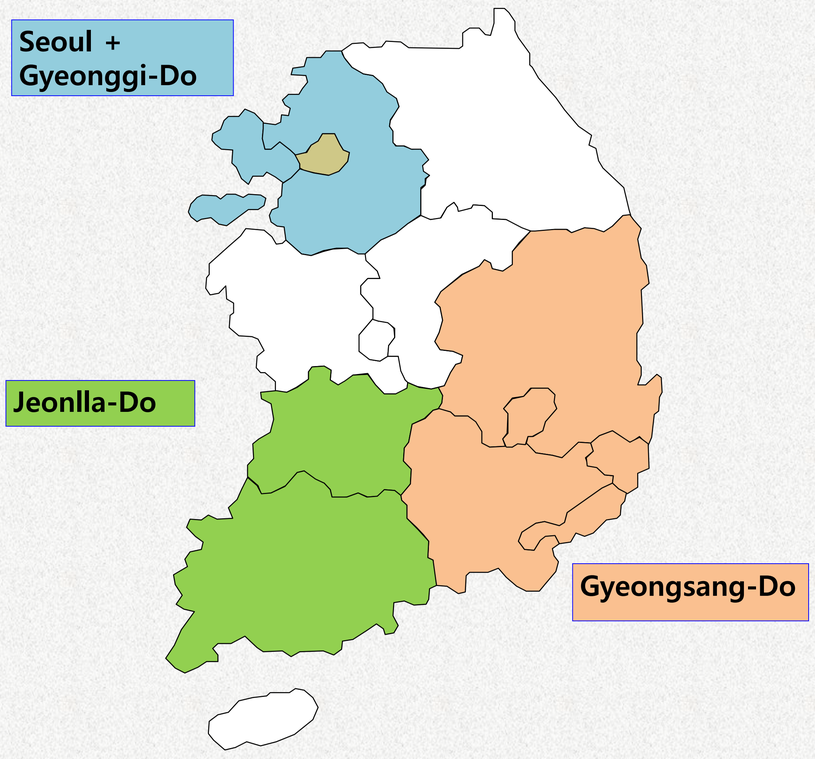


Figure 2. Survey areas

❖ **Examination Types**

Conventional Radiography	
(1) Skull AP	(12) L-spine AP
(2) Skull LAT	(13) L-spine LAT
(3) Chest PA	(14) L-spine OB
(4) Chest AP	(15) Clavicles AP
(5) Chest LAT	(16) Shoulder AP
(6) Abdomen AP	(17) Humerus AP
(7) Pelvis AP	(18) Elbow AP
(8) C-spine AP	(19) Wrist AP
(9) C-spine LAT	(20) Hip AP
(10) T-spine AP	(21) Knee AP
(11) T-spine LAT	(22) Ankle AP

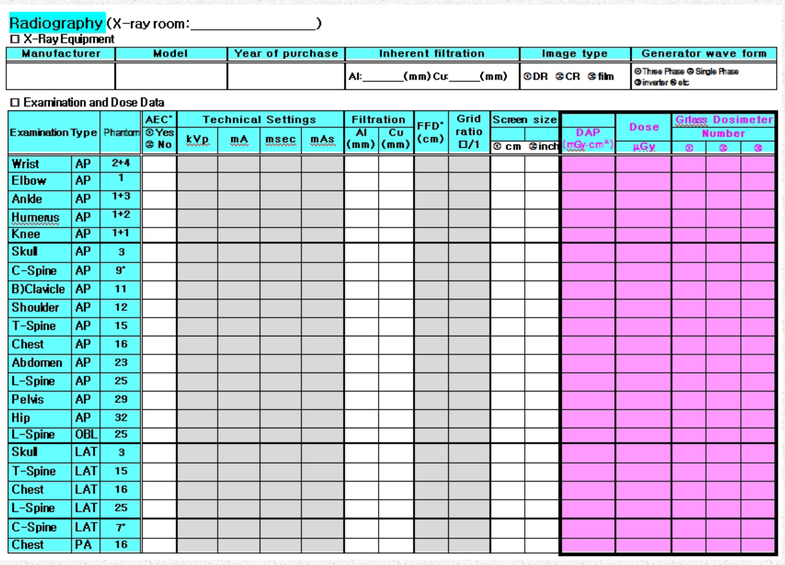
❖ **Dose Measurements**

- Rando and PMMA phantoms were exposed under typical x-ray technical settings (e.g., kVp, mAs, etc.).
- Entrance surface dose (ESD) was measured using glass dosimeters placed on the phantom.

Figure 3. Radiation dose measurements

❖ **Collection of Information Associated with Patient Dose**

- Checklist was developed to collect the information.
- Information on x-ray equipments, operation settings, dose reduction techniques.



Radiography (X-ray room:_____)
☐ X-Ray Equipment

Manufacturer	Model	Year of purchase	Inherent filtration	Image type	Generator wave form
			Al:_____(mm) Cu:_____(mm)	⊙DR ⊙CR ⊙film	⊙Three Phase ⊙Single Phase ⊙inverter ⊙etc

☐ Examination and Dose Data

Examination Type		Phantom	AEC* ⊙Yes ⊙No	Technical Settings kVp	mA	msec	mAs	Filtration Al (mm)	Cu (mm)	FFD* (cm)	Grid ratio ☐/1	Screen size ⊙cm ⊙inch	DAP mGy·cm²*	Dose μGy	Glass Dosimeter Number ①	②	③
Wrist	AP	2+4															
Elbow	AP	1															
Ankle	AP	1+3															
Humerus	AP	1+2															
Knee	AP	1+1															
Skull	AP	3															
C-Spine	AP	9*															
B)Clavicle	AP	11															
Shoulder	AP	12															
T-Spine	AP	15															
Chest	AP	16															
Abdomen	AP	23															
L-Spine	AP	25															
Pelvis	AP	29															
Hip	AP	32															
L-Spine	OBL	25															
Skull	LAT	3															
T-Spine	LAT	15															
Chest	LAT	16															
L-Spine	LAT	25															
C-Spine	LAT	7*															
Chest	PA	16															

Figure 4. Checklist to dose survey

Results and Discussion

❖ **Information associated with patient dose**

- **Tube Voltage**
  - Relatively less variation among hospitals
  - Mean kVp: 51 (Wrist) – 100 (Chest PA) kVp, Mostly 80 kVp

- **Current-time product**
  - Wide variation among hospitals for the same type of examination.
  - Mean mAs: 5.7 (Wrist) – 51 (L-spine LAT) mAs

Table 1. Technical settings and radiation doses from radiographic examinations

Examination Type	Voltage (kVp)	Current·time (mAs)	ESD (mGy
Skull (AP)	74 (±6)	23 (±10)	2.3 (0.2-8.6)
Skull (LAT)	74 (±7)	23 (±13)	2.5 (0.1-11)
Chest (PA)	100 (±19)	10 (±9)	0.5 (0.1-2.6)
Chest (AP)	86 (±17)	10 (±8)	1.4 (0.1-6.2)
Chest (LAT)	97 (±18)	25 (±21)	2.6 (0.1-23)
Abdomen(AP)	77 (±7)	28 (±15)	3.1 (0.3-14)
Pelvis (AP)	76 (±7)	28 (±13)	3.1 (0.3-10)
T-Spine (AP)	76 (±7)	29 (±16)	3.2 (0.3-12)
T-Spine (LAT)	83 (±11)	41 (±23)	6.8 (0.3-34)
L-Spine (AP)	79 (±7)	32 (±16)	3.8 (0.3-18)
L-Spine (LAT)	86 (±8)	51 (±31)	8.8 (0.1-50)
L-Spine (OBL)	83 (±8)	51 (±20)	5.2 (0.1-24)

❖ **Mean radiation dose varied with exam types**

- ESD : 0.2 (Wrist AP) ~ 8.8 (L-spine LAT) mGy
- High dose group : L-spine, T-spine
- Median dose group : pelvis, abdomen, hip, skull, cervical spine, clavicle, shoulder, and chest
- Low dose group: extremity

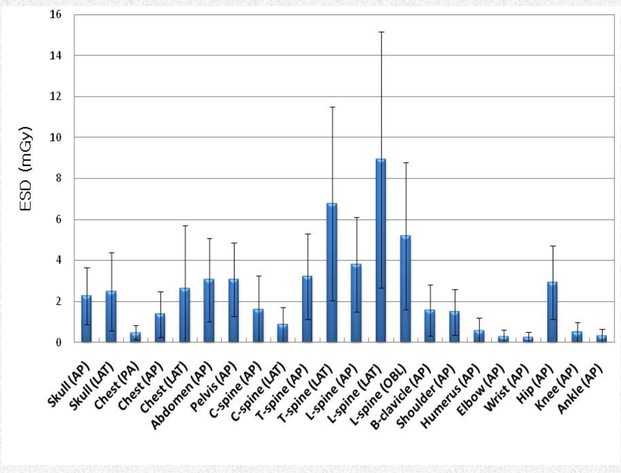


Figure 5. Entrance surface dose

Summary

❖ **A nationwide investigation of patient exposure from radiography was performed in Korea.**

❖ **Exposure condition and radiation dose varied with hospital.**

❖ **It can be precluded that level of radiation safety of medical imaging in Korea is not different from that in the developed countries based on the collected database.**

❖ **Development of DRL based on the survey data is necessary to reduce patient exposure.**

❖ **The developed DRLs will effectively contribute to minimize radiation exposure to patients without detriment to the clinical purpose.**

Acknowledgement: This research was supported by a grant (11172KFDA524) from Korea Food & Drug Administration in 2011