GONADAL DOSE IN ROENTGEN EXAMINATIONS

A Literature Search

by

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The recent report to the public on the Biological Effects of Atomic Radiation prepared under the sponsorship of the National Academy of Sciences contains certain recommendations which if generally accepted and followed will have a profound effect on the practice of medical and dental radiology. The report was prepared from data compiled by several subcommittees made up of many of the most distinguished scientists in the field of atomic radiation and related radio-biological fields, such as genetics, hematology, pathology, meteorology, oceanography, agriculture, and waste disposal.

Public reaction has already been strongly felt, and it appears that the medical profession will be obliged to consider the exposure of patients to radiation resulting from radiological examinations.

The first recommendation of the NAS report is as follows: "Records should be kept for every individual showing his total accumulated lifetime exposure to radiation." No suggestion is made as to whom this responsibility is to be assigned. The three possibilities are (1) the radiologist or dentist, (2) a central agency to which reports should be sent, or (3) the patient himself. There are serious objections to each. Since any individual may be exposed to radiation by many physicians and dentists over a long period of time during his lifetime, the assembly of all the data when needed would be difficult. In addition, it would subject the professional men involved to the necessity of furnishing a cumulative record of exposures whenever a patient may request it.

The central agency solution would require a very large organization with all the inherent administrative problems that go with such a system. The third alternative appears, at present, to be least objectionable.

When the NAS report was first issued, the professional reaction was mixed. A distinguished spokesman of the dental profession (1) stated that the report "was unfortunate and misleading and had caused needless apprehension in hundreds of dental patients." A spokesman for the New York State

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(1) Dr. Herbert L. Taub, President of the Dental Society of the State of New York, as reported in the New York Times, June 14, 1956.

Radiological Society (2), on the other hand, stated that the Society had "endorsed the findings and the recommendations of the N.A.S." and planned to cooperate.

The present tentative plans* of the New York State Society are to furnish patients with a record card showing the type of X-ray examination and the estimated gonadal dose with spaces for future entries. In order to assist the physician or dentist in filling out the card, a literature search was conducted and an unexpected amount of data, both experimental and estimated, was found. The results of the search are given in the table. An inspection of the table shows certain inconsistencies in the data which indicate the need for further experimental work. The table shows also that the gonadal dose associated with certain examinations, such as the teeth, skull, chest, and extremities, when compared to that in the case of pelvic and abdominal examinations, is relatively insignificant. In fact the small gonadal exposure from the former group could undoubtedly be reduced to practically zero, if warranted, by local shielding.

Also included in the table are some recent data on the dose to the fetus, which is important genetically, but would present a recording problem for an unborn and unidentifiable person. An attempt is being made to arrive at reasonable estimates of the average dose for each common technique in order to furnish radiologists with a more usable table.

It has been proposed that a uniform country-wide policy on the matter be established by a group such as the American College of Radiology. Questions such as to the need for radiologists to keep permanent records of each patient's gonadal exposure should be answered. Although the recommendation mentions life-time exposure and parts of the report relate life span with total body dose, the dose limitations recommended refer only to gonadal dose.

If the recommendations of the National Academy of Sciences are to be implemented, some concerted action by the medical and dental profession is indicated.

* It has recently been decided to test the planned program in a relatively small cohesive community to determine the degree of interest and cooperation from the professions and the public.

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(2) P. A. Robin, M. D., President of the New York State Radiological Society, June 19, 1956.

SUMMARY OF LITERATURE SEARCH

Recent estimates of the mean dose to the gonads from various standard medical roentgenographic procedures are presented below.

Mean Dose to Gonads (mr/examination)

Part Examined	Males	Females	Remarks	Note and Ref.
Skull, sinuses, and mastoid	0.8	0.2		7
Teeth	5	5		2
- whole mouth	4.8	0.8		7
- bite wing	0.34	0.06		7
- others	0.34	0.06		7
Chest (PA)	0	0	small area	1
	1	1	>1 for mass surveys (?)	2
	1	3	photofluorography	1
	0.4	2.4		3
	0.2	1.2		6
	0.36	0.07	straight	7
- MM	0.25	0.15		7
- Tomograph	37.2	5.4		7
Shoulder	0.7	3.4		3
(AP)	0.22	0.03		7
Ribs	0.7	3.8		3
(AP)	0.48	0.16		7
Spines:				
Cervical	1.5	1.2		3
(AP)	0.27	0.06		7
(Lat.)	1.84	0.40		7
Dorsal	17.2	12.4		3
(AP)	8	11		7
(Lat.)	13	2.1		7
Lumbar (AP)	0	225	Low Voltage Technique (LVT)	1
"	0	95	High Voltage Technique (HVT)	1
"	24	227	LVT	7
"	6	40	HVT	7
(Lat. Rt. Side Up)	0	80(left) 480(right)	LVT	1
"	0	10(left) 500(right)	HVT	1
(Lat.)	26.6	86	LVT	7
	7	16	HVT	7
Lumbo-sacral joint	81	1025		3
(AP)	22	220		7
(Lat.)	15	800		7
(Rt. Lat.)	0	600(right) 0(left)	HVT	1
Sacro-iliac area (AP)	50	155	HVT	1
	57	180		7
Stomach (PA oblique)	0	50(right) 0(left)	HVT	1
	470	360		3

Part Examined	Males	Females	Remarks	Note and Ref.
Pelvis	279	690		4
(AP)	550	200	LVT	1
"	350	155	HVT	1
"	1080	400		3
"	1100	210		7
"	-	600		5
(Lat.)	-	2664		3
(Lat. sacrum)	-	2800		5
Hips	880	440		3
(AP)	710	210		7
Abdomen	40	20		4
(AP)	0	155	LVT	1
"	0	75	HVT	1
"	69	200		7
(obst.)	-	260		7
I.V.P., renal	207	600		7
, bladder	279	690		7
Gall bladder area	2.7	70		3
Gall bladder	-	210		3
(PA)	1.8	15.6		7
Kidneys	3.7	60		3
Liver	2.0	20		3
Pelvimetry	-	1280		4
(AP)	-	240		7
"	-	400		5
(Lat.)	-	3500		5
"	-	840		7
(Superior-inferior inlet)	-	400		5
Intravenous Urography	-	200	Fluoroscopy	8
Upper Gastrointestinal Tract	-	200	"	8
Urinary Tract	110	203		3
Barium meal	20	9		7
Barieum enema	130	520		3
	40	20		7
	-	400	Fluoroscopy	8
Excretion Pyelography	590	1360		3
Retrograde "	700	900		3
Fingers, wrist, and elbow	0.26	0.05		7
Knee, tibia, fibia	6	1.1		7
Foot and ankle	1.24	0.024		7
Extremities	2.1	1		3
Cystogram (AP)	1400	1190		5
(Oblique)	1400	1160		5
Cholecystography	13.5	378		3
	69	200		4
Hysterosalpingography	-	27000		6
Salpingography	-	200	LVT	1
	-	1700		4
	-	25000		3
Fluoroscopy	2000	2000	45 r skin dose	2
Pediatrics	-	0.9-16.5 r/min		3

NOTES

(1) Measurements made with Victoreen thimble chambers and Keleket pocket dosimeters - values given in mean dose per exposure - maximum sensitivity chamber used was 0.1r and lowest dose reported 1 mr, indicating values reported as zero as something less than 1 mr.

(2) Estimated dose.

(3) Measurements made with ionization chambers in contact with the male scrotum and on the skin surface directly above the ovaries. Ovary dose estimated from depth-dose data and phantom measurements.

(4) Estimated dose, based on the data of Stamford and Vance (Ref. 7).

(5) Measurements in air made with Victoreen condenser r-meter. Values given are maximum doses.

(6) Measurements made with ionization chambers.

(7) Readings taken from exposed film. Values refer to localized exposure.

(8) Measurements made with ionization chamber in lateral or posterior vaginal fornix.

Billings et al (1) estimate that, on the average, children under 11 years of age receive a higher gonadal dose (mr) per examination than adults as follows:

	Males	Females
Adults	20	230
Children	490	290

Their data for specific examinations are as follows:

	Dose to gonads (mr/examination)					
	0-2 yrs.		2-7 yrs.		7-11 yrs.	
	M	F	M	F	M	F
Skull (basal view)	1	1	0	0	0	0
Chest (AP)	2	0	0	0	0	0
Abdomen (AP-KUB)	150	?	310	130	250	240
Lumbar Spine (AP)	-	-	420	190	-	-
(Lat.)	900	300	1200	500	300	730

Osborn and Smith (4) give data on the dose to the fetus for diagnostic roentgenographic examinations during pregnancy:

Examination	Gonadal Dose to Fetus (mr/examination)
Head	0.2
Teeth	0.8
Shoulder	0.03
Arm, hand	0.05
Rib, sternum	0.16
Chest, large film	0.07
" , m.m.r.	0.15
" , special	5.4
Barium swallow and meal	9
Abdomen	20
Cholecystogram	580
Pyelography	15.6
Bladder	3210
Pelvis	2610
Hip, femur	800
Leg, foot	0.6
Spine, Cervical	0.18
" , Thoracic	15
" , Lumbar	713
Lumbo-sacral joint	1540
Sacro-iliac joint	2700
Salpingogram	0
Pelvimetry	2680

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(4) Osborn, S.B. and Smith, E.E. - "The Genetically Significant Radiation Dose from the Diagnostic Use of X-Rays in England and Wales: A Preliminary Survey" - Lancet 270, i, 949, 1956.

(5) Ritter, V.W., Warren, S.R., and Pendergass, E.P. - "Roentgen Doses During Diagnostic Procedures" - Radiology 59, 238, 1952.

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