〔第3回放射線技術シンポジウム，特別講演〕

RADIATION DAMAGE AND MEDICAL RADIATION EXPOSURE

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Summary

Our assessments of medical X-ray dose and of radiologic practice in Hiroshima and Nagasaki revealed numerous deficiencies in radiologic procedures which, if eradicated, would greatly reduce doses to patients and their examiners. The urgent reasons for improving these areas are stressed, for example, by results of recent laboratory investigations and by the late effects resulting from exposure to the ionizing radiation of the atomic bombs. Some of these studies indicate that radiation effects can be anticipated from much lower doses than was previously thought. Guidelines and cautionary measures by which doses to patients and their examiners can be effectively reduced are cited.

放射線障害と医療用放射線被曝

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広島，長崎における放射線検査の状況および医療用X線による被曝線量の測定によって，X線検査の手技に不適当な点が数多くあることが示された。これらの点を改善することによって，患者および検者の被曝線量を著しく減少せられる。被曝線量の軽減が急を要する理由として，最近の放射線影響に関する実験的研究および原爆放射線による後障害を例にあげることができる。これらの研究のうち，幾つかの報告では，これまでに考えられていたより，低い線量で放射線障害が発生する恐れがあることが示されている。患者および検者の線量を効果的に減少させるための手引き，および注意事項を述べる。

Early in their use, doses from X-ray examinations were given little attention except in special cases, as with physicians who were heavily exposed during their examinations of patients. During the 1930's the possibility of genetic damage from relatively small doses of X-ray was recognized.

The advents of the atomic bombs and nuclear reactors increased concern for population exposure. After the end of World War II, skin and gonad doses from diagnostic procedures were investigated. In the late 1950's attention was focused on dose to the bone marrow because of its possible contribution to the development of leukemia.

The development of leukemia in irradiated ankylosing spondylitis patients;¹⁾ thyroid neoplasms after thymus gland irradiation;²⁾ breast cancer following many chest fluoroscopies;³⁾ and the late effects of the Hiroshima and Nagasaki atomic bombs were among the events causing increasing concern for human exposure to ionizing radiation.

During the Atomic Bomb Casualty Commission's (ABCC) investigations of late A-bomb radiation effects, it was clear that other sources of ionizing radiation might be acting as contaminants. Medical X-ray is the most important source of such exposure. Some diagnostic and most therapeutic X-ray exposures result in high doses to patients. It is also possible that, after experiencing the A-bomb, some individuals might receive more medical X-ray examinations than other members of the Hiroshima and Nagasaki populations.

Adult Health Study

With the beginning of the ABCC-JNIH (Japanese National Institute of Health) Adult Health Study (AHS)⁴⁾ in 1957, a fixed sample of the Hiroshima and Nagasaki populations originally consisting of 20,000 members were examined every two years. This sample (Table 1) consists of exposed subjects in three groups based on their distances from the hypocenters and any symptoms or signs, such as epilation, which they reported. The nonexposed are in group 4.

Table 1. ABCC-JNIH Adult Health Study Sample

Comparison Groups	HIROSHIMA	NAGASAKI
1 0-1999 m with Symptoms*	3428	1565
2 0-1999 m—No Symptoms*	3427	1560
3 NAGASAKI—3000-3999 m HIROSHIMA—3000-3499 m	3431	1559
4 10,000+m or Not-in-City	3433	1559
Total	13719	6243

* Acute Radiation Symptoms as Reported by A-Bomb Survivors.

TECHNIQUE CARD												
Name						M.F.No.						
Address						X-ray No.						
Referred by Dr.												
Address						Age			Sex			
Examinations												
Date	No. Exp.	Examiner	M.A.	Sec.	Fluor. Min.	Views	K.V.	Thickness Part (cm)	FTB (in)	Dose Skin Gonad.		

Fig. 1.

During the early years of these follow-up investigations, some procedures used in Hiroshima and Nagasaki radiologic practice resulted in relatively high doses to some patients. For example, there were frequent fluoroscopy because film was scarce, low peak kilovoltage, and less added filtration, all of which incurred relatively high doses. Radiation therapy for benign disease was another dose contributor in these continuing programs. It was therefore important to study in detail the individual exposures of AHS subjects both at ABCC and in other hospitals, and to estimate the degree of exposure of the general populations of Hiroshima and Nagasaki.

In the Department of Radiology of ABCC, now the Radiation Effects Research Foundation (RERF), technical factors of radiological ex-

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posure—including body site, projection, kVp, mA and time—are routinely recorded on technique cards (Fig. 1) during each examination of all AHS subjects, and later transcribed to calculate their individual dose records or profiles.

Study of the X-ray exposure of AHS subjects in other hospitals and clinics has included first, their routine interview in our Department of Radiology for time and location of diagnostic and treatment procedures they receive between their regular examinations. In the second step, hospitals where they were exposed have been periodically surveyed to confirm these exposures and learn the technical factors used during them. The third step was dosimetry.

Dosimetry

The diagnostic procedures used at those hospitals were reproduced at ABCC with the same technical factors and with phantom human material. Hospital units were surveyed for radiation output and quality to correct for any differences between them and our experimental X-ray apparatus.

For radiation therapy, the apparatus of the hospitals which performed the treatments were studied for output and quality. Air doses, skin doses or tissue doses were accordingly estimated using hospital records.⁵⁾

We used a phantom human the average size of an adult Japanese, made of Mix-D, containing a complete human skeleton, and beeswax-impregnated cellulose for lung tissue. A drawer system accommodated Memorial ionization chambers, at the skull vertex; at C-4, T-6, T-12, L-5 vertebrae; in the body of the sternum; in the lateral portions of both 6th ribs; in both iliac crests; in the trachanteric regions of both femurs; in the pubic symphysis; at the female gonads; and at one position for the male gonads. Two Mix-D inserts; one, plain; the other, containing a simulated stomach and duodenum, were inserted for monitoring radiographic and fluoroscopic procedures, respectively (Fig. 2).

To define the quantity of irradiated active bone marrow according to beam margins and various projections and depths, the distribution of active marrow was calculated according to a three-dimensional lattice consisting of 5 cm cubes, an example of which is shown. The active marrow values of Ellis were applied to this lattice. The resulting data were used to calculate bone marrow integral dose from X-ray procedures.⁶⁾

Fig. 2.

Radiography

First, a comparison of a few results of our surveys of 1963⁷⁾ and 1965⁸⁾ will be made. In both years, a wider distribution of body sites was encountered in Hiroshima, partially due to a greater number of subjects (Fig. 3). Chest radiography and upper gastrointestinal series predominated in both cities, both in 1963 and 1965, and detailed analyses of exposure factors were made for these examinations. In Hiroshima, generally higher kVp and low mAs were used in hospitals than in clinics. In 1965 higher kVp was used for chest radiography than in 1963, especially in Nagasaki.

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Fig. 3. Number of Examination by Body Site, Sex and City, 1965

(): Institutions & exposures by multiple collimator

Fig. 4. Cone type, field size (1/2) and gonad position in PA chest examinations by sex, city and institution, 1963

Clinics in both cities used longer exposure times than hospitals, but higher mAs was being employed in 1963 than in 1965, especially in Nagasaki hospitals. Round cones were most popular (Fig. 4), and multiple plane collimators were more frequent in hospitals than clinics in 1963. By 1965 only five round cones and no square or rectangular ones were encountered. More multiple plane collimators were in use by that time.

Age and sex distributions for chest radiography were essentially the same in both studies. The 48–59 kVp range predominated in 1963; 60–79 kVp, in 1965. In 1963 and in 1965 the testes were infrequently exposed by the direct beam, but the ovaries were frequently directly exposed (Fig. 4).

Assuming 0.5 mmAl equivalent inherent filtration in 1963, as many as 122 units appeared not to have been complying with the legal requirement of 2.0 mm effective filtration. Even in 1968, three of these apparatus had no filters at all (Table 2).

In 1965, Nagasaki hospitals had improved slightly in respect to Japanese legal requirements for added filtration. To mini-

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Table 2. Added Filtration in Diagnostic X-Ray Apparatus for Routine Chest Examinations by City, 1963

Added Filtration	HIROSHIMA			NAGASAKI		
	Hospitals	Clinics	Others	Hospitals	Clinics	Others
None	1	2	0	0	0	0
0.5 mmAL	14	48	1	6	15	0
1.0 mmAL	6	17	2	2	1	0
1.5 mmAL	4	1	0	1	0	1
2.0 mmAL	1	1	0	2	0	1
2.5 mmAL	0	0	0	1	0	0
3.0 mmAL	1	0	0	0	0	0
0.2 mmAL+0.1 mmCu	1	0	0	0	0	0
1.0 mmAL+0.1 mmCu	1	0	0	0	0	0
1.0 mmAL+0.2 mmCu	1	0	0	0	0	0
0.5 mmAL+0.3 mmCu	0	0	0	1	0	0
Total Apparatus	30	69	3	13	16	2

mize gonadal dose, the anode is preferably caudad, but only half the tubes were so arranged, and a considerable number were horizontal.⁹⁾

Fluoroscopy

Upper gastrointestinal series exposure factors used in 1965 were analyzed in detail (**Table 3**). There was a nearly equal distribution of this type of examination by age. kVp used in hospitals was higher than that in clinics for both fluoroscopy and spot filming. For spot filming, lower mAs was used in hospitals than in clinics. For fluoroscopy, 3 mA was most frequent in both cities; 4.0 mA was used in some Hiroshima institutions.

Few facilities kept good records of their fluoroscopy times. Five and 10 minute fluoroscopy times were most frequent, especially in Hiroshima clinics (**Table 4**). Though most Hiroshima

Table 3. Fluoroscopy Time-per Examination by Body Site HIROSHIMA Plus NAGASAKI Upper Gastrointestinal Series Examination Excluded, 1965

Time	Chest		Barium enema		GI+BE		GI+Small bowel+BE		GI+Small bowel		Gallbladder		GI+GB		Angiocardiography	
	Inst.	Exam.	Inst.	Exam.	Inst.	Exam.	Inst.	Exam.	Inst.	Exam.	Inst.	Exam.	Inst.	Exam.	Inst.	Exam.
30 min									1	1						
20															1	1
15					1	2			1	1						
10.0-11.9					1	1			2	3			1	1		
8.0-9.9			1	1												
6.0-7.9									1	1			1	1		
4.0-5.9			3	3			1	1	1	1			1	1		
2.0-3.9	4	6	1	1	2	3			4	4	3	3	1	1		
1.0-1.9	3	4									2	6				
1.0	3	6									4	5				

Table 4. Upper GI Series Doses

	Bone Marrow (g-rad)	Gonadal Male	Female (mrad)	Surface (mrad)
Image Fluoroscopy	7.21/min	0.348/min	12.8/min	328/min
Spot	1.35	0.07	2.68	101
AP	17.7	11.6 (6.59)	51.1	159
PA	39.0	7.54	33.1	265
RAO* 45°	46.5	3.20	29.6	400
RAO* 60°	34.7	3.65	24.7	413

* RAO: Right Anterior Oblique.

hospitals used 5 minutes or less for an upper gastrointestinal series, a few reported times of 20 or 30 minutes. Fluoroscopy times were shorter for hospitals than clinics in Hiroshima, but the reverse was true in Nagasaki. Spot radiography occurred approximately five times per examination in both cities. Doses from fluoroscopy procedures were also assessed by a film-jacket method.^{10),11)}

Photofluorography

Survey of institutions for technical factors in photofluorography in 1965 was based on an earlier study in which 674 of 5,293 Hiroshima and 96 of 2,221 Nagasaki subjects reported photofluorography exposure.¹²⁾ Only 88 of the Hiroshima subjects could identify the institutions responsible, because the majority of Hiroshima examinations was performed by mobile units. The institutions responsible for the examinations were traced through schools, employers, and health centers. Seventy-eight per cent of Hiroshima and 74% of Nagasaki examinations reported were confirmed.

Seventy-five to 85 kVp was most frequently used in both cities, whereas 60 kVp had been most frequent for chest radiography in an earlier survey. Square cones predominated and the gonads were not in the direct X-ray beam except in the case of one Hiroshima unit with a round cone.

ABCC Radiography and Fluoroscopy

Because of wide variations in exposure parameters, the dose data of other institutions' radiology departments could not be applied to our own examinations. Therefore, using our technical factors, all of the exposures in all of our radiographic and fluoroscopic examinations were reproduced using a phantom human¹³⁾—the techniques being similar to those which were used for other hospitals and clinics. Bone marrow integral, gonadal and surface doses were obtained for all examinations received by each AHS subject in the Department of Radiology of ABCC.

Each subject's doses were cumulated and routinely updated with every reexamination. The average cumulated doses of AHS subjects from these exposures are shown in **Table 5**. These data are useful for comparison with subjects' doses received in Hiroshima and Nagasaki hospitals and clinics

Table 5. Exposure of AHS Subjects Inside ABCC, 1973

	Average Cumulated Doses
Bone Marrow Integral	330 g-rad
Gonadal, Male	140 mrad
Female	540 mrad
Surface	6300 mrad

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Medical Exposure in Hiroshima and Nagasaki

The average doses per examination, by type, for Hiroshima and Nagasaki are shown in **Table 6**. However, the medical X-ray doses of each AHS subject are even more useful when they are compared with doses they received from the A-bombs.

Trends in radiologic practice in Hiroshima and Nagasaki were determined by extensive surveys of all large hospitals and a 40% random sample of small hospitals and clinics in the cities (**Fig. 5**). Three such surveys have been performed respectively covering the periods from 1945 to 1963;¹⁴ from 1964 to 1970;¹⁵ and since 1971,¹⁶ the latter currently in progress. Results of these surveys indicated an abrupt increase in use of all types of medical X-ray to 1950, followed by a steady increase since that time. Dose from dental radiography has been studied.¹⁷ Deficiencies in meeting safety requirements were found.¹⁸ Use of dental X-ray has increased abruptly since 1960, and these increases are continuing.¹⁹

Using dose data, yearly trends in medical radiography, and census data, dose per capita from diagnostic X-ray examinations was calculated. In **Table 7**, the cumulative bone marrow integral dose per capita is shown for two periods for each city. This shows the dose from medical X-ray is continuing to increase—especially in recent years. In the last seven years, the dose was about two times that of the preceding 17 years.

It is interesting to compare the cumulated bone marrow integral doses per capita with the

Table 6. Average Doses per Examination in HIROSHIMA and NAGASAKI

Examination	Bone Marrow Integral (g-rad)	Gonadal (mrad)		Surface (rad)
		Male	Female	
Radiography	23	4.8	30	0.8
Fluoroscopy	370	40.0	700	16.0
Photofluorography	41	0.3	2	0.6

Fig. 5.

Table 7. Cumulative Bone Marrow Integral Dose per Capita from Diagnostic Radiology, HIROSHIMA and NAGASAKI

HIROSHIMA	1946-1963	1270 (g-rad)
	1946-1970	2300
NAGASAKI	1946-1963	450
	1946-1970	1000

T65 doses²⁰⁾ by distances from the hypocenters of the Hiroshima and Nagasaki A-bombs. An active bone marrow weight of approximately 1,000 g was assumed.⁶⁾ In 1963, the cumulated dose to the active bone marrow from medical X-ray exposure approximated doses from the A-bombs at distances of 3,200 m in Nagasaki and 2,200 m in Hiroshima. In 1970 these distances were 2,800 m and 2,000 m, respectively, indicating

the steadily increasing contribution of medical X-ray exposure.

The numbers of fluoroscopy examinations reported by AHS subjects during their visits to the ABCC Department of Radiology were also cumulated and coded. These reported exposures, because of their great numbers, cannot be routinely investigated at the responsible hospitals and clinics. However, they can be investigated for subjects who contract diseases attributable to ionizing radiation exposure, providing the pertinent hospital records are still available.

Medical vs A-Bomb Doses

Table 8 is an illustration of dose comparisons using selected AHS cancer subjects. To clarify the extent to which medical X-ray exposure—especially radiation therapy and fluoroscopy—may be causing neoplasms, we are reviewing all AHS cases of cancer of the lung, breast, thyroid, stomach,

Table 8. Comparison of A-Bomb, ABCC Examination, and Therapy Doses and Reported Fluoroscopy, Selected Cases

Cancer	A-Bomb rad	ABCC Skin rad	Radiation Therapy R	Fluoroscopy Exminations Reported
A-Bomb Dose>ABCC Dose				
1 Lung	340	0.8	4140	1
2 Breast	Unknown	1	4000	>30
3 Breast	364	3	13800	1
4 Breast	588	1	10800	3
5 Thyroid	153	0.4	6500	2
A-Bomb Dose=ABCC Dose				
6 Breast Lung	31	18	16600	1 1 (1)
7 Breast		0.3	12920	
8 Gastric	36	20		
9 Gastric	64	66		
A-Bomb Dose<ABCC Dose				
10 Lung	2	21	3850	8 20
11 Gastric		10	4000	
12 Gastric		22	2379	
13 Gastric	7	115		
14 Gastric		8		

() = Confirmed

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parotid tumors and leukemia, from all available sources, including tumor registries, death certificates and leukemia investigations. Each subject has been assigned a T65 A-bomb dose,²⁰⁾ a cumulated dose from his ABCC and RERF X-ray examinations, the number of fluoroscopies he reported, and the dose from any radiation therapy he received. Note the upper, middle and lower groups in respect to ABCC's X-ray doses, less than, equal to, and greater, than A-bomb doses. These dose data now permit study of all major sources of ionizing radiation in the evaluation of subjects who develop cancer or other abnormalities attributable to A-bomb exposure.

We are also evaluating various fluoroscopy and radiography examinations as hazards in the development of various cancers and leukemia. The variety of cumulating medical X-ray doses and comparing them with those from the A-bombs can be questioned. A-bomb exposure involved a single, relatively large dose from high energy gamma rays and neutrons, with presumably little recuperability of tissue. By contrast, medical X-ray exposure involves numerous repeated small doses from relatively low energy X- and gamma rays, with relatively great recuperability of tissue. For these, no conversion factors exist, but we must attempt such comparisons.

By continuing to determine the frequency of exposure of A-bomb survivors to diagnostic and therapeutic X-ray at RERF and in other institutions, and doses therefrom, and by studying trends in radiologic practice, these ongoing investigations are assisting in avoiding erroneously attributing abnormalities to A-bomb exposure.

Radiation Effects

It is clear from these studies of our practices, that all of us must be more cautious in order to minimize exposure of our patients and ourselves. There is very much room for improvement. Some recent reports in the scientific literature—about doses from diagnostic X-ray exposure—are shocking.

From animal experiments, relatively low doses reportedly can cause leukemia. Leukemia reportedly can be induced in mice by as low as 25 rad. And 25 is within the diagnostic region of exposure.

We must assume leukemia and benign and malignant neoplasms as producible at relatively low levels of dose—within the diagnostic range of exposure.

At ABCC and RERF late radiation effects are studied because there was no such A-bomb experience before and because the late effects were not known. Methods include comparison studies of exposed and nonexposed people—by physicians in several medical specialties—and analysis of data by statistical methods. Study of the exposed was for somatic effects; study of children of the exposed was for genetic effects. Since the resulting diseases and abnormalities are like those spontaneously occurring in a population, a radiation effect is indicated by the increased numbers of patients with those diseases and abnormalities.

Late effects of the ionizing radiation of the A-bombs (**Table 9**) have included: a 1.5 times increase in leukemia;²¹⁾ a 9 times increase in thyroid cancer;²²⁾ a 1.5 times increase in lung cancer;²³⁾ a 3.5 times increase in breast cancer;²⁴⁾ lens opacities;²⁵⁾ altered stature in those exposed in childhood;²⁶⁾ small head size²⁷⁾ and mental retardation among in utero exposed; somatic chromosome abnormalities,²⁸⁾ and a suggestive increase in salivary gland tumors²⁹⁾ and stomach cancer.³⁰⁾ The small head size occurred at 20 rad to the mother. The increase in leukemia occurred in those who were exposed to as low as 20 rad.

Radiologists have been studied for any effects of their radiation exposure, including cancer,

Table 9. A-Bomb Late Radiation Effects

	rad	Increased Rate Factor
Definite		
Leukemia	>20	1.5
Cancer—Thyroid	>100	Female 6-9 Male 2-3
—Lung	>200	1.5
—Breast, Female	>200	3.5
Lens Opacities	>200	
Retarded Growth and Development		
Adolescents		
in Utero	>20	
Small Head, Body		
Mental Retardation		
Chromosome Abnormalities	>200	
Suggestive		
Cancer—Salivary Gland		
—Stomach		

Table 10. Exposure of Radiologists

Time	Effect	Investigator
Before 1921	↑ Cancer	Brown—Doll
After 1920	no ↑ Cancer	Brown—Doll
1938—42	↑ Leukemia	Dublin
1935—54	↑ Leukemia	Seltser—Sartwell
1945—58	no ↑ Leukemia	Seltser—Sartwell
1945	↓ Life Span	Warren
1935—45	↓ Life Span	Seltser—Sartwell
1945	no ↓ Life Span	Brown—Doll

That fluoroscopy actually caused breast cancer is shocking. The studies of MacMahon³⁹⁾ further increase our concern. He found that radiography of the abdomen and pelvis during pregnancy resulted in increased cancer deaths among the children of those mothers.

Precautions

At times, all of us are to some extent lax in use of precautions in our practices. When we carefully consider this, and our knowledge of doses from the various types of radiologic examinations all of us perform, and when we consider the known effects of radiation—even at low dose levels—we must stop and reevaluate our daily work. What more can we do to effectively minimize doses?

In 1956 the U.S. National Academy of Sciences recommended that the average person's exposure should be no more than 10 rad during his 30 or so reproductive years.⁴⁰⁾ The Academy assumed that: (1) mutations are generally harmful; (2) any dose to reproductive cells can result

leukemia and decreased life span (**Table 10**).^{31)~35)} It is noteworthy that, with the passage of time—as more precautions were taken against unnecessary exposure—the rates of these diseases decreased. However, more recent observations indicate that there was accelerated aging among radiologists³⁶⁾ and that immunologic changes induced by radiation may have been responsible for an excess lymphoma mortality among U.S. radiologists who entered the specialty between 1930–39 and 1940–49.³⁷⁾

Partial body exposure is of interest, such as radiation treatments of the head for tinea capitis³⁸⁾ and of the spine and pelvis for ankylosing spondylitis¹—both of which have resulted in excesses of leukemia. Treatment of the thymus gland has resulted in thyroid cancer.²⁾ Of special interest were Mackenzie's observations that multiple chest fluoroscopies in females resulted in breast cancer.³⁾ In one case, the cumulative exposure to the breast from fluoroscopy was suspected to have been at least 4,000 roentgens.

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in mutation; (3) the number of mutations is proportional to the dose; (4) a low dose can be validly estimated by linear extrapolation from a high dose and (5) effects are independent of dose rates and dose fractionation.

What is a necessary examination? An examination must be clinically indicated by a physician's careful history and thorough physical examination and/or by positive laboratory findings. When are screening type examinations justified? There is justification, for example, for chest surveys in smokers over 45 years of age,⁴¹⁾ and in mass gastric surveys in Japan. But the answer is "no" to mass gastric surveys in the U.S.,⁴²⁾ and "no" to chest and abdomen⁴³⁾ surveys among unselected subjects, anywhere. And despite possibly strong pressure to the contrary, examinations should never be done only for medicolegal reasons.

Whenever an examination is scheduled—but not indicated—it should be cancelled.⁴⁴⁾ Unnecessary pelvimetry is a good example. There should be a minimum number of exposures per examination and no overexposures. As fast films and fast screens as possible should be used—without sacrificing detail. Examinations whose films have been interpreted by the radiologist, but lost, should not be repeated merely to complete the patient's film file. To avoid unnecessary exposures, films should be freely borrowed and lent among radiologists and their staffs. In Japan, law⁴⁵⁾ prescribes that films should be kept five years before disposal. Thereafter, to preserve these films and records, should the patient be custodian of this films?⁴⁶⁾ Perhaps we should consider doing this.

Conclusions

There is no correlation between less than 20 rad dose data and any somatic or genetic effects. Therefore, we must linearly extrapolate from the high dose region to the low dose region. We must realize that there is a very real risk from diagnostic X-ray exposure—to the patient and to the examiners and to the offspring of both. We must avoid unnecessary exposure, abide by NCRP and ICRP recommendations, and assure that any necessarily incurred doses are at the lowest possible levels.

Some statements made by Margulis in 1972, and which appeared in the American Journal of Roentgenology⁴⁶⁾ are included here because his report is a good guide. It was translated into Japanese in the Rinsho Hoshasen.⁴⁷⁾ I urge you to read his report and other pertinent articles on this subject in the literature. We have a great responsibility to our patients, the population, the future generations and to ourselves, to see that medical radiation exposure is held to the minimum. We can do this only by conscientiously checking the condition of our equipment; by periodic monitoring; and by using proper techniques during clinically indicated radiological examinations. In our work—no matter where we are—each of us must ask himself: What are my responsibilities? Why am I here?

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