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## Radiological Practice and Medical Records in a Large General Hospital in Hiroshima

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広島市内のある総合病院における放射線診療と医学記録

松浦 啓一, 沢田 昭三, Walter J. Russell, 吉永 春馬

(昭和40年4月30日受付)

広島市のある総合病院における放射線科の活動  
状況を知るために、過去15年間のX線検査回数、  
使用フィルム枚数、放射線治療回数などについて  
調べた。同時にこの病院の入院、外来患者数の変  
動についても調査した。その結果、第二次世界大  
戦終結以来、本病院の放射線科活動は漸次増加

し、その増加は主として直接撮影、透視および間  
接撮影にみられたが、治療回数は減少の傾向を示  
していた。調査結果の分析によつて、診療記録と  
放射線照射録が特別な有用性をもつことがわかつ  
た。また、正確に保管してある記録の利点につい  
てもあわせて検討した。

### Introduction

It is generally considered very important to estimate the contribution of medical X-ray to the cumulative radiation dose of the populations of Hiroshima and Nagasaki. A number of surveys and studies are being conducted by the Department of Radiology and Statistics of the Atomic Bomb Casualty Commission

(ABCC) in cooperation with the Research Institute for Nuclear Medicine and Biology of Hiroshima University to elucidate this problem<sup>1-8</sup>.

In order to estimate the total medical X-ray exposure dose received by the citizens of both cities, it was necessary to ascertain the activity of community radiologic practice since the end of World War II. For this purpose, a random survey of small hospitals and clinics, and a survey of all large hospitals were conducted. However, since the period covered by the survey was long and records of radiologic practice were not well kept, much difficulty was encountered in those studies.

Hiroshima Red Cross Hospital was one institution where accurate data had been maintained throughout most of its operations, probably because the hospital withstood the atomic bomb better than other institutions in Hiroshima and because of the efforts made to preserve their records for indefinite periods. Being a large general hospital with long continued operation since 1939, it not only might show characteristics of radiologic practice in a large community hospital, but also reflect, with some limitations, the trend of radiologic practice in Hiroshima City. The study of data of Hiroshima Red Cross Hospital is therefore being reported separately from those of other hospitals and clinics. This study also demonstrated the usefulness of well-kept medical records and X-ray film data.

### History

#### Hiroshima Red Cross Hospital

Hiroshima Red Cross Hospital was established in 1939 to serve the community of Hiroshima City and Hiroshima Prefecture. At that time, the hospital provided examination and treatment facilities in the fields of internal medicine, surgery, obstetrics and gynecology, pediatrics, otorhinolaryngology, dermatology, radiology and dentistry, with a professional and technical staff of 54 persons and a capacity of 229 beds. The hospital became busily engaged with care of military personnel from the Sino-Japanese Incident, and during World War II. From its establishment until the termination of the war, only military patients were hospitalized, but the outpatient clinic was always available to civilians.

Of 45 hospitals and clinics in Hiroshima, Red Cross Hospital was one of three still standing after the A-bomb according to the report of the Joint Commission<sup>4</sup>. It was located 1,570 meters from the hypocenter<sup>5</sup>. Although most of the Red Cross Hospital buildings were of reinforced concrete, they were severely damaged. Many partitions and windows were gone and much of the sterilizing, distilling, and other equipment was rendered useless. Of the staff casualties, 90% were due to flying debris, particularly glass. Of all available medical supplies of Hiroshima, 85% were in outlying towns and villages<sup>4</sup>. In a survey soon after the A-bomb, it was found that Red Cross Hospital ceased to function as a hospital for several weeks but managed to act as an aid station soon afterwards<sup>5</sup>. Some 1,000 patients were cared for and 600 of these died, but no autopsies could be performed and no records could be kept of the token treatment given<sup>4</sup>.

Since the end of the war, Red Cross Hospital has been operated in the spirit in which it was founded, for inpatient and outpatient care for the general public. Repair of the hospital was hindered by shortages of funds and building materials; for two full years the hospital continued to provide medical care in damaged buildings with only a 152 bed capacity. In 1947, the early stages of reconstruction work were completed, and subsequent construction was carried on intermittently, so that the hospital had a capacity of 348 beds in 1953. With gradual measures for more complete examination and treatment and the addition of

Table 1. Department Heads and Periods of Appointment; Radiology Department, Red Cross Hospital

Dr. Iwao Kuramoto	1939
Dr. Sadahira Uehara	October 1943— March 1948
Dr. Kido Hayashi	May 1948— April 1949
Dr. Tsuneo Sugi	April 1949— September 1956
Dr. Tetsuro Watanuki (Part time)	September 1956— January 1957
Dr. Hiroshi Kadota	January 1957— April 1961
Dr. Keiichi Matsuura	April 1961—

the Orthopedics Department in 1960, the bed capacity increased to the present total of 424.

#### Radiology Department, Red Cross Hospital

Since the hospital was established, a number of radiologists have headed the department for varying periods, as shown in Table 1. In 1939–57, one radiologist assisted the department head; since 1957, the department head has had two assistant radiologists. The equipment in the Radiology Department has allowed capabilities of fluoroscopy and radiography and deep X-ray therapy since commencement of practice in 1939. It has been renewed and increased periodically, photofluorographic apparatus having been added in 1945, a tomography unit in 1955, as well as other machines with more specialized capabilities. Six diagnostic units and three deep therapy units are now in use. A new image intensifier apparatus will soon be installed in the diagnostic section.

#### Hiroshima A-bomb Hospital

A-bomb Hospital was built adjacent to and in conjunction with Red Cross Hospital, and began operation in September 1956, to provide examination and treatment facilities to exposed survivors and patients with illnesses attributable to such exposure. Priority is given A-bomb survivors, and treatment is administered in accordance with the program of the National Government<sup>6</sup>. The hospital has 120 beds and consists of the Departments of Internal Medicine, Surgery, Orthopedics and Radiology. The radiologists of Red Cross Hospital concurrently serve the A-bomb Hospital.

Diagnostic studies of the gastrointestinal tract form a large portion of the radiological work performed by the radiologists of Red Cross Hospital for A-bomb Hospital. One diagnostic X-ray unit is in use at the A-bomb Hospital, mainly for chest and orthopedic examinations. Other examinations and radiotherapy for its patients are performed in the Radiology Department of the Red Cross Hospital. However, the Radiology Department of A-bomb Hospital has recently been expanded. A new rotation tele-cobalt 60 unit with 2,000 curie source and a radioisotope laboratory for diagnosis and therapy have been installed in the therapy section.

#### Method of Survey

Records of inpatient and outpatient care for the entire periods of operation of Red Cross and A-bomb Hospitals were reviewed. Ledgers recording daily examinations by type and radiation treatments in the Radiology Departments of Red Cross and A-bomb Hospitals were reviewed. Numbers of examinations performed, films used, and radiation treatments were recorded. Individual technique cards for radiologic examinations for the years 1939–48 of Red Cross Hospital were also reviewed, but this did not provide more useful data. Numbers of examinations and films used in the Dental Department of Red Cross Hospital were also recorded.

### Results of Survey

#### X-ray Examinations and Treatments; Red Cross Hospital

Total examinations by year in medical and dental radiography, fluoroscopy and photofluorography are shown in Table 2 and Figure 1. The number of medical radiographic examinations steadily increased from 1949 to 1963. Twenty-two thousand examinations were performed in 1963—nearly double the total for 1949. There is no particular explanation for the small peak about 1951 (Figure 1). The number of fluoroscopic examinations performed in 1963 was five times that of 1949. A small peak occurred in 1954 because chest fluoroscopy was then employed as a screening examination. It has not been so used since that time. Photofluorography was inaugurated later than radiography and fluoroscopy, but increased more sharply and steadily from 1954 to 1963 (Figure 1).

Table 2. Total Examinations, Films and Treatments Per Year, Hiroshima Red Cross Hospital

Year	Examinations				Films		Treatments
	Radiography		Fluoros- copy	Photofluor- ography	Medical	Dental	
	Medical	Dental					
1949	12384	—	864	—	12856	—	—
1950	13091	—	1299	—	13794	—	—
1951	13971	490	2604	—	15883	527	9138
1952	12455	453	2886	—	14419	490	7998
1953	11898	521	3606	—	14636	576	8194
1954	11423	531	3895	6794	15501	572	9167
1955	11849	548	3117	10075	15450	581	8212
1956	11868	511	3247	11419	16479	565	8394
1957	12663	617	3242	10540	17952	687	10603
1958	13048	617	3232	12114	21322	731	9315
1959	15013	752	3891	13380	22759	936	7358
1960	16775	685	3902	14036	24357	863	7030
1961	17082	711	3770	13842	29058	814	6618
1962	20698	749	4056	17171	38462	982	5665
1963	22225	805	4379	18118	43154	878	5154
Total	216443	7990	47990	127489	316082	9202	102846

—Not available

The number of examinations by type, film consumption, and radiation treatments by month are shown in Table 3. These are averages for each month over the years from 1949, the first year for which complete records were available, through 1963. For all forms of medical X-ray examinations and treatments, relatively few were performed during November, December, January and February. For medical radiography and fluoroscopy, the reduction was nearly 25% of the averages for the remaining months of the year (Figure 2). This probably reflects postponement of medical attention for less serious diseases during the year-end period and New Year festivities, and other difficulties such as transportation of patients residing in outlying areas during adverse weather conditions.

Two abrupt increases in activity for photofluorography occurred in April and September, each followed by a sharp decline (Figure 2). These peaks might have been associated with examinations of school children, the beginning of new fiscal years, and examination periods for employees<sup>7</sup>.

The increase in use of medical X-ray film was not great during 1949—55, but an abrupt rise in film

Figure 1. Yearly Totals Radiology Department, Hiroshima Red Cross Hospital

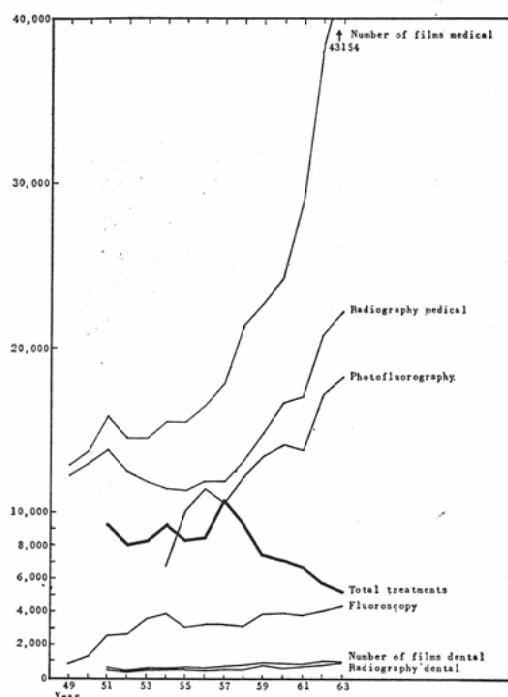
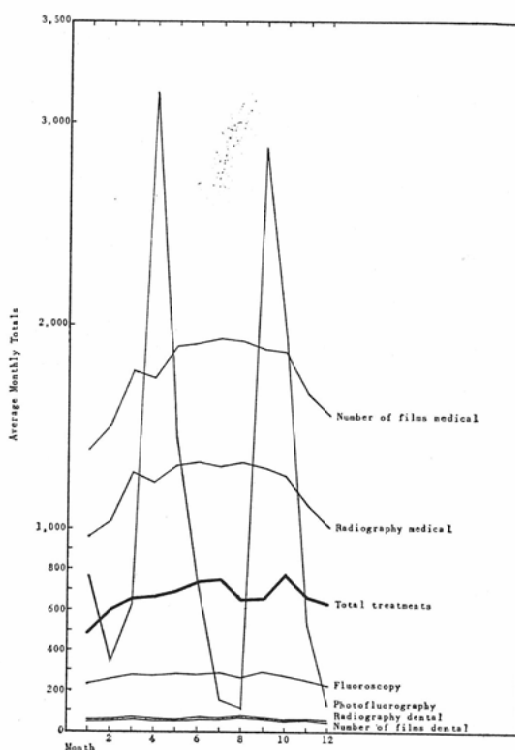


Figure 2. Average Monthly Totals Radiology Department, Hiroshima Red Cross Hospital



consumption did occur from 1956 to 1963. This is probably continuing, considering recent trends. Using 1949, 1956 and 1963 to illustrate, the number of X-ray films consumed per medical radiographic examination was as follows:

Year	Films Per Medical X-ray Examination	
	Red Cross Hospital	A-bomb Hospital
1949	1.03	—
1956	1.39	1.06
1963	1.90	2.14

The number of X-ray films used per examination nearly doubled from 1949 to 1963. The number of examinations also increased. These two factors are responsible for the marked increase in film consumption over the years (Figure 1). Film consumption for medical X-ray roughly paralleled the examinations throughout the year, though it was less during January and February.

The increase in the amount of dental X-ray film used per year followed rather closely the number of dental examinations though the years, on the average one film per dental examination (Figure 1). Dental radiography and its film consumption roughly paralleled each other by months throughout the year. Minimal decreases in numbers of examinations and films used are noted during November, December, January and February, though this reduction is far less than for medical examinations and medical film consumption (Figure 2).

A total of 9,000 X-ray treatments were administered in 1951. The number remained between 8,000

Table 3. Average Number of Examinations, Films and Treatments Per Month, Hiroshima Red Cross Hospital

Month	Examinations				Films		Treatments
	Radiography		Fluoros- copy	Photofluo- rography	Medical	Dental	
	Medical	Dental					
1	966	46	232	763	1386	53	491
2	1041	47	262	347	1510	56	595
3	1278	56	278	621	1780	65	640
4	1222	50	274	3153	1739	58	650
5	1305	49	281	1437	1897	56	691
6	1320	57	278	718	1908	66	734
7	1303	55	286	152	1937	61	745
8	1318	63	264	105	1920	73	653
9	1298	55	291	2868	1887	64	658
10	1257	47	275	1953	1877	54	772
11	1110	49	253	520	1665	55	652
12	1011	40	225	111	1567	46	629

Table 4. Total Examinations and Films Used by Year; Hiroshima A-Bomb Hospital

Year	Examinations		Films
	Radiography	Fluoroscopy	
1956*	181	5	192
1957	1817	322	2167
1958	2750	536	3722
1959	2655	487	3752
1960	3686	640	5266
1961	3514	674	5361
1962	3814	781	6413
1963	3880	897	8289
Total	22297	4342	35162

\* September-December

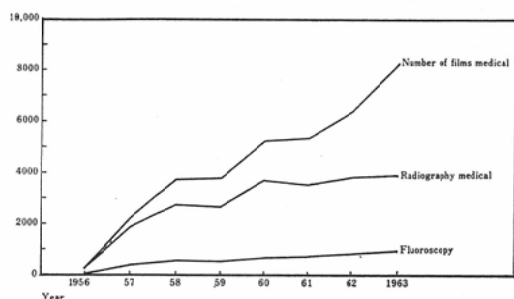
and 9,000 per year until 1957, when a rise to 10,600 occurred. Then there was a gradual decline in radiation treatment numbers to about 5,000 treatments per year in 1963 (Figure 1). This decline is attributed to increasing capabilities of other community hospitals to perform radiation therapy. It cannot be attributed to any change in the treatment program of the Red Cross Hospital.

A rather marked reduction in radiation treatments occurred in January, though the reduction for February, November and December was not as great as that of radiography and fluoroscopy (Figure 2). Such a slight reduction can be anticipated, but greater reductions due to postponement of therapy over extended periods are not to be expected for patients with malignant diseases.

#### X-ray Examinations; A-bomb Hospital

Table 4 and Figure 3 show the number of radiographic and fluoroscopic examinations and films consumed, by year from 1956 to 1963 for Hiroshima A-bomb Hospital. A sharp increase in number of radiographic examinations occurred during the first two or three years after opening of the hospital. This

Figure 3. Yearly Total Examinations, Radiology Department Hiroshima A-Bomb Hospital



initial rise was followed by a period during which number of examinations per year has remained quite constant at about 3,800. Fluoroscopy has maintained a steady increase in rate over the years to nearly 900 cases per year in 1963.

In spite of the moderate increase in number of radiographic and fluoroscopic examinations per year from 1961 to 1963, film consumption has continued to increase markedly. Whereas the ratio was 1:1 in 1956, an average of more than two films were used per examination in 1963.

The average numbers of examinations performed and films consumed per month are shown in Table 5 and Figure 4. Number of fluoroscopic examinations per month have remained rather constant through-

Figure 4. Average Monthly Total Examinations, Radiology Department Hiroshima A-Bomb Hospital

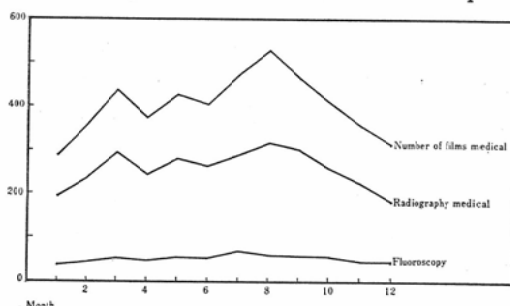


Table 5. Average Number of Examinations and Medical Films Per Month; Hiroshima A-Bomb Hospital

Month	Examinations		Films
	Radiography	Fluoroscopy	
1	192	35	286
2	234	43	357
3	292	51	436
4	241	44	371
5	278	52	423
6	260	51	402
7	285	66	468
8	314	57	524
9	297	55	464
10	256	56	408
11	222	42	355
12	180	42	312

out the year, perhaps because the number of fluoroscopic examinations performed per day was limited. The number of radiographic examinations per month was less during December and January, presumably for the same reasons as with Red Cross Hospital. The increased number of examinations and amount of film used in August coincided with the greater number of inpatients and outpatients for that month at A-bomb Hospital. This increase in number of examinations in August may be greatly influenced by psychological factors, and the patient's desires for detailed examinations in August, associating with the month of the A-bomb. This trend was not evident at Red Cross Hospital. The number of films used



paralleled the number of radiographic examinations performed, throughout the year.

#### Hospital Admissions and Outpatient Visits; Red Cross Hospital and A-bomb Hospital

The total patients hospitalized yearly at Red Cross Hospital since 1949 are shown in Figure 5. A sharp increase in number was seen from 1949 to 1953, with a more gradual increase thereafter. The inpatient census in Red Cross Hospital was relatively constant throughout each year, according to monthly totals of patients hospitalized from 1949 to 1963 (Figure 6). This was a reflection of the fact that the hospital beds are always used to full capacity.

The number of patients seen in the outpatient clinics of Red Cross Hospital are shown by year in Figure 5. After an initial rise to approximately 380,000 from 1949 to 1952, there was a sharp decline in 1953, and an additional decline in 1956. One of the reasons for the sharp decline of 1953 was possibly the opening of Citizens Hospital, whose new patients may have been formerly treated at Red Cross Hospital. A further gradual increase occurred from 180,000 in 1957 to approximately 285,000 in 1963. The number of outpatients at Red Cross Hospital fluctuated little throughout the year (Figure 6). Despite the abrupt decline in number of outpatients at Red Cross Hospital from 1953—57, the number of X-ray examinations showed a slight decrease followed by a slight increase. This cannot be readily explained.

Figure 5. Yearly Total Patients, Hiroshima Red Cross Hospital

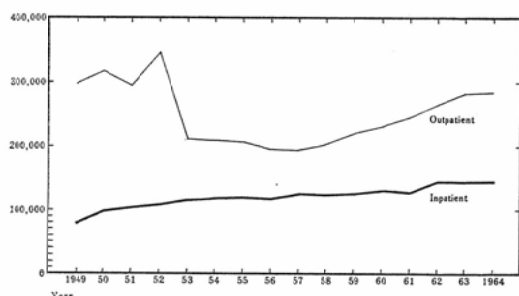


Figure 6. Average Monthly Total Patients, Hiroshima Red Cross Hospital

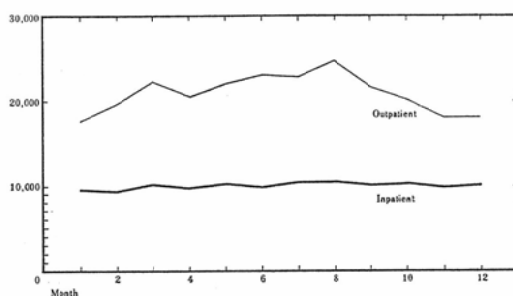


Figure 7. Yearly Total Patients, Hiroshima A-Bomb Hospital

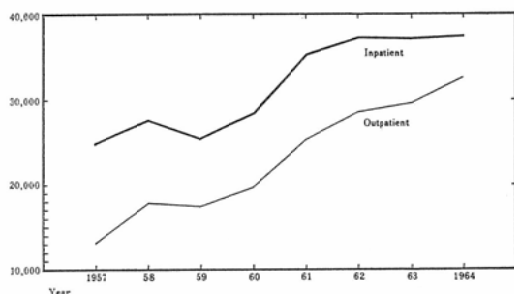
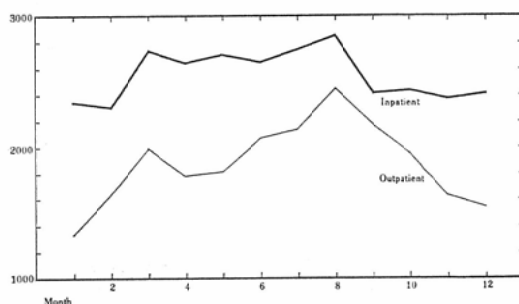


Figure 8. Average Monthly Total Patients, Hiroshima A-Bomb Hospital



The yearly number of inpatients has risen sharply since the foundation of the A-bomb Hospital, continuing to 1964 (Figure 7). The inpatient census was relatively low from September to February, when there was a 20–25% reduction from the usual census during the remainder of the year (Figure 8).

The number of outpatients at A-bomb Hospital have steadily increased since 1957 (Figure 7). Outpatient visits fluctuated considerably throughout the year, with a low in November, December and January,

and a high in August and September (Figure 3). A-bomb Hospital therefore had more fluctuation in number of inpatients and outpatients than Red Cross Hospital, but in both hospitals outpatient visits fluctuated more than inpatient census. These seasonal fluctuations may reflect postponement of care of less serious illnesses.

In summary, comparison of figures of Red Cross Hospital and A-bomb Hospital showed that, over most of the years of operation of each, changes of the following order have occurred using the initial year as the base:

	Red Cross Hospital	A-Bomb Hospital
	1949—1963	1957—1963
	Factor	Factor
Radiography	↑ 1.8	↑ 2.1
Fluoroscopy	↑ 5.1	↑ 2.8
Film Consumption	↑ 3.5	↑ 3.8
Inpatients	↑ 1.9	↑ 1.5
Outpatients	↓ 0.9	↑ 2.3

### Discussion

The data obtained in this study of records of a large general hospital in Hiroshima indicate a marked increase in the use of diagnostic medical X-ray during the past 15 years. This is supported by the increase in use of radiography and fluoroscopy, and by the marked increase in consumption of medical X-ray films. The sharper rise in number of fluoroscopic examinations initially suggests a possible change in examining methods. This was not the case, however. This change was attributable to increasing capacities in fluoroscopy at this institution. Such trends in the community should be demonstrated better by studies of activities of Radiology Departments of other hospitals and clinics. In previous years, there was some curtailment of reimbursement for examinations and number of films per examination by the Health Insurance Medical Fee Disbursement Fund Office. More recently there is less such restriction, resulting in more frequent examinations and more films used per examination. An increasingly larger number of medical insurance plans has also become available to the population over recent years. No doubt these have influenced techniques or methods used in roentgenological practice. This will be assessed in a study of a number of hospitals and smaller clinics in the community, to be reported.

While the records of this large hospital are not necessarily indicative of activity of radiologic practice in the community as a whole, practice in this institution may have paralleled such activity to some extent. It should be noted that some changes may be peculiar to the institutions themselves; for instance, radiation therapy declined rather markedly at Red Cross Hospital from 1952 to 1963, due to increasing capabilities of other community hospitals in this field. Also, photofluorography increased markedly from 1954 to 1963, and although this can be anticipated in the community as a whole, certain hospitals, health centers and commercial organizations, such as Red Cross Hospital, undertake the majority of this work for other organizations in the community. Dental radiography at Red Cross Hospital, with its gradual increase over the years, probably parallels the situation in the community as a whole.

This study also showed that, while the number of films consumed by an institution over a given period of time may be easily ascertained, the number of examinations performed or persons examined cannot

necessarily be estimated by the number of films consumed. However, such information may serve as an index to the total number of exposures. Currently the number of films used per examination is evidently increasing and such increase is more marked than the increase in the number of radiographic and fluoroscopic examinations. As a reflection of activity of a radiology department, it is desirable to consider not only the number of films consumed but also the number of examinations or other denominators. Film numbers per patient are of value in estimating exposure dose per patient.

### Importance of Medical Records

Detailed analyses of records were possible in this institution because of the manner in which the records were kept. It is pertinent to review briefly some important points in connection with the proper filing of records.

The importance of maintaining adequate files of X-ray films and reports thereof has long been recognized<sup>8,9</sup>. There are several advantages of filing systems permitting ready retrieval of such records. These will be described:

#### 1. Legal Requirements

In many countries, law establishes the minimum period for which records must be retained by the physician or hospital. In Japan, this period is five years<sup>10</sup>. Despite this requirement, some hospitals and clinics retain them much longer, realizing that they may be of much further usefulness.

#### 2. Insurance Claims and Workers Compensation

Well-kept records and X-ray films are at times of great benefit to the individual patient, or his employer, where there is a question of reimbursement or compensation because of accidents or illnesses during employment. Sometimes such records form the basis of judgement as to whether dependent members of a deceased patient's family will be awarded compensation.

#### 3. Value to the Patient

In the individual patient, records demonstrate the course of disease, and are sometimes the only means by which the time of its onset can be established. They can be made available to other physicians and institutions where the patient may receive subsequent diagnostic study or treatment, possibly avoiding unnecessary additional exposure to the patient<sup>11</sup>.

#### 4. Facilitation of Analysis; Teaching

If available for large numbers of cases such records can, by furnishing disease patterns, facilitate statistical analysis in epidemiological studies for disease detection and treatment. They can also assist in establishing the frequency in which certain diseases are associated. In certain continuing programs, such as that of ABCC, the indefinite retention of films and reports is mandatory, particularly in view of the fact that detail cannot always be preserved in smaller reproductions of the originals.

Records are aids in teaching and reproductions of them are invaluable for lectures and meetings.

#### 5. Record of Dose

Many of the reasons for proper filing of data in diagnostic studies also pertain to records concerning radiation therapy. Other more pertinent reasons, however, compel physicians and institutions to maintain proper records concerning radiation therapy. These have long been recognized, and their periodic emphasis is also seen in the literature. Though benign conditions are now less frequently treated with ionizing radiation, neoplasms and severe degenerative changes have resulted in patients so treated many years

ago. Individual patients not infrequently receive large cumulative doses during a number of courses of treatment from different practitioners. Dose data has often not been recorded in detail, and in many cases cumulative doses are really unknown.

#### 6. Evaluation and Reproducibility of Treatment Factors

Of course, the former problem of cumulative dose does not arise in cases of malignant disease where the patient has a relatively short life expectancy, and in which the condition treated implies poor prognosis. However, detailed recording of dose data is of utmost importance in these cases as well, to assure proper treatment and retreatment of a lesion, without excessive breakdown of adjacent normal tissue. Evaluation of therapy and reproduction of factors used are facilitated by proper recording<sup>12</sup>. Charts have been designed to assist the practitioner in recording data properly<sup>13</sup>.

#### 7. Storage Problem and Proposed Solutions

The main problem of prolonged filing of films and reports is storage particularly in the larger Radiology Departments where great numbers of patients are examined. A number of systems have been devised to assist in solving this problem<sup>14,15</sup>.

### Summary

The analysis of the records of the Radiology Department of a large general hospital in Hiroshima is reported. This analysis demonstrated that:

1. Over the years since the end of World War II, the activity of radiologic practice in this hospital has gradually increased. This may apply to the entire community as well.
  2. This increase in activity was due mainly to radiography, fluoroscopy, and photofluorography, and not due to radiation therapy. Activity of radiation therapy in this hospital is not thought to be typical for the community as a whole.
  3. The analysis also demonstrated the usefulness which medical records and X-ray film data can serve—in this study—a supplement to a dosimetry program, by indicating the scale of radiologic practice.
  4. While film consumption is not a direct indicator of number of examinations performed or exposures incurred, it is a useful measure of activity for a Radiology Department when properly qualified.
- A brief review of the usefulness of well-kept records is presented.

### Acknowledgement

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