MEDICAL RADIATION PROTECTION IN THE EASTERN MEDITERRANEAN REGION

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Abstract

Six hundred and fifty diagnostic X-ray installations, representing over 50 percent of the existing ones, were surveyed in sixteen countries of the Middle East in 1969/70. A number of technical and human deficiencies were observed. Sixty-five percent of the X-ray units surveyed lacked one or more of the following radiological safety features: Adequate filtration; beam no larger than needed to cover the X-ray film; adequate operators' protection; and adequate protection of neighbours and all other personnel. The measures taken to tackle these problems will be described.

Introduction

The Eastern Mediterranean Regional Office of WHO undertook early in 1969 to assist the X-ray departments in hospitals, and medical and dental departments in the countries of this Region in the evaluation and eventual improvement of the radiation safety of patients and of medical and auxiliary personnel exposed to ionizing radiation in the course of diagnostic or therapeutic procedures.

From 14 February to 7 November 1969, the WHO Technical Offices in X-rays visited ten countries of the Eastern Mediterranean Region.

During the stay in these countries he has visited 154 institutions which included medical schools, hospitals, cancer centres, tuberculosis clinics, dental schools, dentists, and private physicians (Table I); surveyed and measured field radiation levels on a total of 334 X-ray installations (Table II); instructed and demonstrated practical means of reducing dose levels to 744 X-ray operators which included radiologists, physicists, and technicians (Table III); repaired, adjusted, and recalibrated approximately 50 X-ray units; instructed dark-room personnel on processing methods leading to improvement of film quality; discussed with public health and hospital administrators the need for introducing radiation protection legislation and for establishing film-badge services; and at construction sites advised responsible authorities on the design and construction of adequate premises to accommodate new X-ray installations.

Observations

The main shortcomings observed were:

2.1 human deficiencies
2.2 technical deficiencies

2.1 Human Deficiencies

The medical and para-medical personnel the Technical Officer normally met were (Table III) radiologists, radiation health physicists, X-ray engineers, and X-ray technicians.

Of the 104 radiologists met, approximately forty were expatriate doctors employed on government contracts. It is difficult to estimate precisely the shortage of radiologists. It is likely however, that the number of radiologists required is twice the number presently available.

In the ten countries visited, only five qualified radiation health physicists are available. No information could be obtained on the number of health physicists undergoing training abroad.

Radiological health inspectors do not exist in these countries.

Only four x-ray engineers are employed by their respective governments in the ten countries visited by the WHO Technical Officer. A few commercial firms keep qualified engineers on their staff in a few countries.

Training schools for X-ray technicians are operating in four of the countries visited and an attempt at training assistant X-ray technicians is now starting in a fifth one.

Approximately one third of the 634 X-ray technicians met have attended training courses varying in duration from six months to two years. As the diagnostic radiology departments are heavily dependent on the activities of this category of personnel, at least twice the number presently available is required to adequately cope with the current workload.

Low standards of exposure control and collimation were prevalent in the radiograms performed by technicians or non-radiologists. Considerable effort in improving this situation should be made and educational programs directed to this end are of great importance. Fluoroscopic examinations were often carried out by non-radiologists and even by X-ray technicians. Referring physicians often request radiological examinations without sufficient reasons, thus the yield in terms of diagnostic information is very little and patients are unnecessarily exposed to radiation.

Where radiologists are not available and other medical officers must perform radiological examinations, an adequate radiological training should be required from them.

2.2 Technical Deficiencies

2.2.1 Radiological

Sixty-five percent of the X-ray units surveyed lacked one or more of the following safety features: (Table IV)

- adequate filtration
- beam no larger than needed to cover the X-ray film
- adequate operator's protection
- adequate protection of neighbours and all other personnel (Table IV)

A number of these defects were actually rectified in the course of the visit. In most cases this could be done at small cost. Only in a few cases did the Technical Officer advise to stop further operation of the X-ray units as the

defects were highly dangerous from the point of view of radiation and/or electrical safety.

2.2.2 Electrical

Approximately 40% of the X-ray units seen were connected to electrical mains supply which could not provide the required power. It was also noticed that the X-ray units were connected to the same lines as other high consumers of electricity (elevators, sterilizers, etc.) thus being subject to gross power fluctuations. Most of the electric outlets (plugs) in wards where portable units are connected (bedside radiography) lacked a proper earth wire, thus exposing operators and patients to electrical hazards.

2.2.3 Dark Rooms

About 40 to 50% of the dark rooms have serious defects. Among the most frequently seen: lack of ventilation, light leaks, unprotected electrical fixtures, no safe-lights or incorrect filter used. Some do not have running water.

More than 80% of the dark rooms lacked one or more of required accessories, i.e., thermometers, timers, driers. Damaged cassettes, intensifying screens, hangers were often seen.

Discussion

The analysis of the data contained in this report leads to some considerations on the adequacy of:

1. Radiological Services (Table V)
2. Radiation Protection (Tables IV, VI, VII)

1. Radiological Services

Table V shows in a very striking way the insufficiency of radiological services in the ten countries so far surveyed.

There is an average of 72,000 people (range 11,250 to 317,000) for each diagnostic X-ray unit, as compared with 1,000 people/unit in the United States.

The estimated average film consumption in the countries surveyed, 0.063 films/person-year, represents only one-fortieth of the average film consumption in the U.S.A. (2.46 films/person-year).

This should be kept in mind in order to place the radiation hazards to the population at large into a proper perspective.

2. Radiation Protection

We have seen in Table IV that only 48% of the operators and 58% of all other personnel occupationally exposed to ionizing radiation could be adequately protected by suitable structural or movable shielding, lead-glass screens, distance, etc. And yet only one-fourth of the operators (physicians, radiographers) in the ten countries surveyed (Table VI) are equipped with personnel monitoring devices. Since the number of people occupationally exposed (operators and all other personnel) is much larger, the personnel being monitored represents only a small proportion (perhaps less than 10%) of those exposed to ionizing radiation. In the U.S.A. about one-third of the personnel occupationally exposed are equipped with personnel monitoring devices.

Table VII pools the results of the survey of 334 installations in ten countries showing the percentage of units complying with some of the most essential radiological safety features.

Conclusions and Recommendations

The insufficiency of radiological services both in personnel and equipment in some of the countries surveyed is obvious.

The careful study of this report leads to evident conclusions regarding some of the remedial measures that should be taken without delay. They are as follows:

A. Stepping Up Training:

1. Of radiologists and radiological physicists.
2. Of X-ray technicians, through national courses.
3. Of X-ray technician-tutors and of technicians specialized in the maintenance and repair of X-ray equipment.
4. Of radiological health inspectors.

B. Promulgating Radiation Health Legislation:

Empowering the Ministries of Health:

1. To establish a system of registration, inspection, and licensing of X-ray, radioisotope teletherapy, and unsealed radioisotope sources and their users.
2. To promulgate rules, codes of practice, and regulations for the safe use of radiation sources.

C. Setting Up or Expanding National Services

1. For monitoring of personnel occupationally exposed to ionizing radiation.
2. For radiological health inspections.

TABLE I

TYPE AND NUMBER OF INSTITUTIONS VISITED

Country	Private Physician	Dentist	Hospital	Tuber-culosis Clinic	Total
1)	-	-	4	-	4
2)	-	-	7	1	8
3)	-	-	18	3	21
4)	-	-	6	2	8
5)	10	-	7	2	19
6)	3	1	23	1	27
7)	-	-	21	3	24
8)	-	-	15	4	19
9)	2	2	5	1	10
10)	-	-	12	2	14
Total					154

TABLE II

TYPE OF INSTALLATION SURVEYED

Country	Dental	Fixed Rad.	Fluoro.	Therapy	Portable	Photo-fluoro.	Combined Rad. and Fluoro.	Other	Total
1)	-	2	-	-	-	2	5	-	9
2)	1	-	1	-	-	2	7	-	11
3)	1	6	4	-	1	3	21	-	36
4)	-	-	1	2	2	2	9	1	17
5)	-	6	4	4	1	2	22	-	39
6)	1	7	-	4	-	2	38	-	52
7)	-	7	17	2	7	2	29	-	64
8)	-	2	5	6	16	4	23	1	57
9)	4	2	1	2	4	1	6	-	20
10)	2	3	3	3	3	-	14	1	29
Total									334

TABLE III

Country	Radiologists	Physicists	X-ray Operators
1)	1	0	22
2)	0	0	27
3)	12 (f)	0	79
4)	10	2	42
5)	15	0	92
6)	27	1+1 WHO	107
7)	14	1	120
8)	10 (f)	0	92
9)	6	1	30
10)	9 (f)	0	23
Total	104	6	634

TABLE IV

Country	A			B			C			D			Total units surveyed	% of units in which one or more of A,B,C,D, features were missing
	Filtration adequate			Beam no larger than needed to cover X-ray film			Operator can be adequately protected			All other personnel within permissible limits				
	Yes	No	% Compl.	Yes	No	% Compl.	Yes	No	% Compl.	Yes	No	% Compl.		
1)	6	3	66.5	4	4	50	6	3	67	4	4	50	9	50
2)	3	8	27	6	5	54.5	5	6	45	3	8	27	11	73
3)	28	8	78	26	3	89	24	12	67	26	12	68.5	36	33
4)	9	8	53	9	2	82	11	6	65	16	1	94	17	47
5)	12	27	31	17	10	63	21	18	53	28	9	76	39	69
6)	20	31	39	39	6	87	29	23	56	47	4	92	52	61
7)	7	52	12	28	13	68	29	35	45	29	35	45	64	88
8)	13	44	23	27	13	68	23	34	40	12	38	33	57	77
9)	9	11	45	11	5	69	6	14	30	13	6	68.5	20	70
10)	9	20	31	15	3	83	6	23	21	5	24	17	29	83
Total	116	212	35 (Av.)	182	64	74 (Av.)	160	174	48 (Av.)	183	141	56 (Av.)	334	65 (Av.)

TABLE V

RADIOLOGICAL SERVICES

Country	Population (1)	Estimated no. of diagnostic X-ray units	Population per diagnostic X-ray unit	No. of physicians (2)	No. of physicians per X-ray unit e:c	No. of radiologists	No. of radiographers	No. of operators/ unit g+h:c	Estimated annual X-ray film consumption	Estimated no. films/ person-year
1)	260,000	15	17,333	117	7.8	1	22	1.5	98,500	0.378
2)	2,755,000	20	137,750	86	4.3	0	27	1.3	171,500	0.062
3)	23,782,000	75	317,093	320	4.3	12	79	1.2	464,500	0.019
4)	2,251,000	20	112,550	505	25.0	10	42	2.6	182,750	0.081
5)	5,724,000	50	114,480	978	19.5	15	92	2.1	266,250	0.046
6)	2,588,000	230	11,252	2,025	8.8	27	107	0.58	574,250	0.221
7)	4,463,000	100	44,630	666	6.7	14	120	1.3	590,250	0.132
8)	1,675,000	100	16,750	530	5.3	10	92	1.0	519,500	0.310
9)	620,000	40	15,500	460	11.5	6	30	0.9	165,250	0.266
10)	5,100,000	35	145,714	84	2.4	9	23	0.9	30,500	0.015
Total	49,218,000	685	71,851 (Av.)	5,771	8.4 (Av.)	104	634	1.08 (Av.)	3,113,250	0.063
USA	200,000,000	206,560 (3)	970 (Approx.)	387,422 (3)	1.83			1.5 (3)	506,000,000 (4)	2.446

(1) Demographic Yearbook, 1966, UN.
(2) World Health Statistics Report, Vol. 21, No. 2-3, 1968, WHO.
(3) Lawrence R. Fess, Summary of Diagnostic X-ray Statistics Relating Facilities, Equipment, and Personnel by Healing Arts Professions, Radiological Health Data and Reports, Vol. 10, No. 9, Sept. 1969, pp. 379-380.
(4) John H. Knowles, Radiology - A Case Study in Technology and Manpower, New England Journal of Medicine, 280, 1271-1278, (19).

TABLE VI

PERSONNEL MONITORING
(Film-Badges)

Country	Total No. of Operators	Personnel Monitored	%
1)	23	0	0
2)	27	0	0
3)	91	21	23
4)	52	52	100
5)	107	0	0
6)	134	68	51
7)	134	16	12
8)	102	6	6
9)	36	23	63
10)	32	2	6
Total	738	188	26

TABLE VII

MAIN RADIOLOGICAL SAFETY FEATURES

Pooled Results of Ten Countries
(% Units Complying)

EQUIPMENT	Filtration adequate	35.4
	Beam no larger than needed to cover film	74
	Tube housing leakage within normal limits	100
	Table top dose < 10 R/min	96
	Fluorescent screen interlocked with tube	91
	Fluoroscopic shutters adequate	92
	Lead glass on fluorescent screen adequate	97
OPERATORS	Operator can adequately be protected	48
	Exposure of all other personnel within permissible limits	56