2. Background and Current Situation

2.1 Status of Radiological Services in the World

The status of imaging and radiation therapy services varies from country to country. The data available on the subject are often not reliable. Nevertheless, for this analysis the information published periodically by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) is quite useful (*5, 6*).

UNSCEAR has classified the countries in four categories, according to levels of health care. In order to avoid confusion with the concept of ***levels of care*** in the organization of health services (*4*), in this publication the term "category" is used in place of "levels," which UNSCEAR uses to classify groups of countries according to their ratio of physicians per 1,000 population. Category I includes countries in which there is at least 1 physician per 1,000 population. Category II encompasses those that have 1 physician per 1,000-3,000 population; category III, those that have 1 physician per 3,000-10,000 population; and category IV, those that have 1 physician per 10,000 population or more. For 1990, the estimates of the population falling into each of these groups were: category I, 1,350 million; category II, 2,630 million; category III, 850 million; and category IV, 460 million. This classification takes account of the association observed between numbers of physicians per unit of population and numbers of radiation treatments or examinations in that same population unit. It should be noted, however, that the association between the number of physicians per unit of population and the number of radiology units is not absolute; hence, the availability of radiology services may be greater or lesser than the category classification of a country would indicate.

2.1.1 Imaging Services

The data from the UNSCEAR report for 1993 (*5*) indicate that the distribution of facilities that provide radiology services in the world is very uneven. The number of these facilities per 1,000 population is 20 to 1,000 less in category-IV countries than in category-I countries. The latter group of countries, which have approximately 25% of the world's population, account for 70% of ***x-ray*** diagnostic exams and 90% of the patients who receive radiation therapy and nuclear medicine treatments. In the industrialized countries, most of which fall into category I, between 200 and 1,280 ***x-ray*** examinations per 1,000 population are performed each year. In contrast, approximately two-thirds of the world's population lacks access to diagnostic imaging services. With regard to the developing countries, which fall into categories II-IV, the following statistics are worth noting:

- Approximately 80%-90% of all ***x-ray*** machines, radiologists, and radiographers are located in a few large cities.

- In most rural and marginal urban areas people have no access whatsoever to diagnostic imaging services.

- At any given time, about 30%-60% of the imaging equipment that does exist is not in working order.

- Imaging services in most hospitals in large cities are overburdened, and patient waiting times for radiological examinations are long.

- Many simple ***x-ray*** examinations are performed in university or referral-level hospitals because there is no other alternative.

- Diagnostic imaging procedures are often performed without due regard to whether they are really necessary, whether they will yield the required diagnostic information, and whether they will be correctly performed, including limitation of the patient ***dose*** to acceptable levels.

- In most countries, medical students receive little or no practical training in radiology services before they embark upon their professional careers.

- Quality is variable, ranging from very good or excellent in some large hospitals to poor in many other hospitals.

- The cost of radiodiagnostic services is rising, yet no studies have been conducted to determine the association between this trend and control of diseases or recovery of health.

Tables 2.1, 2.2, and 2.3 provide information about numbers of ***x-ray*** examinations performed, machines, and categories of service. The figures presented in these tables are based on data from the UNSCEAR reports for 1988 (*6*) and 1993 (*5*). Although a trend toward improvement of population coverage at the global level may be discerned, it is not clear whether this is due to a real improvement or to differences in the quality of data collection for the two reports. Shifting of some countries between the categories may also have had some influence on the figures. One noteworthy trend is the relative decrease in population coverage for the lowest category (category IV) of services.

Table 2.1
Approximate Number of X-Ray Machines, *X-Ray* Examinations, and Resulting *Doses*, Worldwide, 1987

Category of Services[a]	Population (millions)[b]	*X-Ray* Machines (thousands)[b]	Population per Machine	Annual Examinations per 1,000 Population	Annual *Collective Effective Dose* Equivalent (10^3 man Sv)
I	1,300 (25)	330 (78)	4,000	800	1,300
II	1,759 (35)	88 (19)	20,000	150	350
III	1,220 (24)	15 (3)	80,000	50	85
IV	730 (15)	4 (1)	180,000	< 30	22
World Total	5,000 (100)	440 (100)	11,000	280	1,760

Source: UNSCEAR, 1988 (*6*).

a Category I, one or more physicians per 1,000 population
Category II, one physician per 1,000-3,000 population
Category III, one physician per 3,000-10,000 population
Category IV, one physician per > 10,000 population

b The numbers between parentheses are percentages

Table 2.3 provides information on sales of ***x-ray*** equipment, including ***computed tomography (CT) scanners***, by geographic region. The figures indicate that close to 90% of the sales occur in three regions (Europe, Japan, and the United States of America), which together account for only 23% of world's population.

With regard to ultrasound, the equipment currently available is smaller, less costly, and easier to operate, and use of diagnostic ultrasound has become increasingly widespread at all ***levels of care*** within health care systems. This diagnostic technique has replaced a large number of x-ray and nuclear medicine procedures, such as obstetric radiology, liver scanning, and cholecystography. In many developing countries, important applications may be found for sonography in the diagnosis of various parasitic diseases, such as amebiasis and schistosomiasis, as well as in the diagnosis of tumors and other lesions located in the abdomen.

Table 2.2
Approximate Number of *X-Ray* Machines, *X-Ray* Examinations, and Resulting *Doses*, Worldwide, 1990

Category of Services[a]	Population (millions)[b]	*X-Ray* Machines (thousands)[b]	Population per Machine	Annual Examinations per 1,000 Population	Annual *Collective Effective Dose* Equivalent (10^3 man Sv)
I	1,350 (26)	470 (65)	2,900	860	1 300
II	2,630 (50)	230 (32)	11,000	140	290
III	850 (16)	15 (2)	57,000	70	40
IV	460 (9)	2 (0.3)	230,000	< 9	20
World Total	5,290 (100)	720 (100)	7,000	300	1,600

Source: UNSCEAR, 1993 (5)

[a] Category I, one or more physicians per 1,000 population
Category II, one physician per 1,000-3,000 population
Category III, one physician per 3,000-10 000 population
Category IV, one physician per > 10,000 population

[b] The numbers between parentheses are percentages

Table 2.3
World Market for *X-Ray* and *CT* Equipment, 1991 (5)

Geographic Regions	Percent of Revenues[a]	Population Size (millions)[b]
Europe	26.5	852
Japan	23.3	124
United States	45 9	251
Rest of world	7.3	4,158

Sources:

[a] *Medistat*, 1992, B (7)

[b] *World Population Projections 1990*, New York, United Nations; 1991

Nuclear medicine is an important complementary diagnostic imaging technique, which at the more complex technological levels is used to corroborate ***x-ray*** and ultrasound studies. It is most useful for measuring biochemical reactions and for functional studies, rather than for anatomical imaging, an area in which it is gradually being replaced by alternative methods that offer better image quality, such as ultrasound and computed tomography. According to WHO estimates, nuclear medicine services of some kind—ranging from a single department to fully developed population coverage—are available in approximately 50% of the developing countries.

In category-I countries, the principal use for nuclear medicine is examinations of bone, lung, and cardiovascular systems, while in the countries in categories II, III, and IV, it is used mainly for thyroid, kidney, bone, and liver studies.

Generally speaking, the total number of nuclear medicine examinations has tended to increase over time, as has the age of the persons receiving these examinations, who are older than the general population.

In the industrialized countries, the most frequently used ***radionuclide*** is technetium-99m, as a result of which the population ***collective dose*** in these countries is lower. In the developing countries, the most frequently used ***radionuclide*** is iodine-131, which is the largest contributor to total ***collective dose*** from nuclear medicine in these countries and also an important contributor to ***collective dose*** worldwide. Altogether, nuclear medicine examinations contribute about one-tenth as much as ***x-ray*** examinations to the total worldwide ***collective dose***. Table 2.4, which is based on the 1993 UNSCEAR report (*5*), provides information on the number of nuclear medicine examinations and the associated ***collective dose***.

Table 2.4
Approximate Number of Nuclear Medicine Examinations and Resulting *Collective Effective Doses*, Worldwide

Category of Services[a]	Population (millions)	Annual Examinations per Thousand Population	Annual *Collective Effective Dose* (10^3 man Sv)
I	1,350	16	130
II	2,630	0.5	20
III	850	0.3	6
IV	460	0.1	4
Total Average	5,290	4.5	160

Source: UNSCEAR, 1993 (*5*).

[a] Category I, one or more physicians per 1,000 population
Category II, one physician per 1,000-3,000 population
Category III, one physician per 3,000-10,000 population
Category IV, one physician per >10,000 population

In view of expected future needs for diagnostic imaging, the new imaging modalities such as ultrasound, computed tomography, and magnetic resonance imaging are raising a number of issues in developing countries (*7*). The collaboration of institutions that have special expertise in the planning of services and facilities, training, ***quality assurance***, and evaluation of images and results will be invaluable. A related area in which collaboration among centers in the developing countries may be more important than collaboration with developed countries is that of rationalization (*8, 9*) and optimization (*10*) of the combination of imaging modalities. In any health care system, there is a spectrum of imaging requirements and needs of associated equipment, which may range from the most basic, such as the WHO Basic Radiological System (WHO-BRS) or its updated version, (the WHIS-RAD), or a simple ultrasound unit, to the most complex, such as computerized tomography or magnetic resonance imaging. Appendices I-A and I-B list summaries of specifications for the WHIS-RAD and the ultrasound units, respectively. The issues that must be addressed have to do with the clinical decision-making process that leads to the performance of imaging examinations and the optimum combination of diagnostic imaging modalities in a health care system.

2.1.2 Radiation Therapy Services

After cardiovascular diseases, cancer is currently considered to be the most serious health problem in the industrialized countries. According to WHO (*11*), cancer affects 9 million people and causes 5 million deaths annually. In developed countries it is the second most common cause of death, and epidemiological evidence points to the emergence of a similar trend in developing countries. The principal factors contributing to this disease pattern are the increasing proportion of elderly people (among whom cancer is more prevalent) in most populations, the greater ability of medical science to control once-fatal communicable diseases, and the rising incidence of certain forms of cancer, notably lung cancer resulting from tobacco use. It is probable that 300 million new cases of cancer and 200 million deaths from the disease will occur in the next 25 years, almost two-thirds of them in developing countries.

Thanks to medical advances, one-third of all cancers are now preventable and another one-third, if diagnosed early enough, are potentially curable. Moreover, appropriate palliative care of the remaining one-third of cancer patients can bring about substantial improvements in the quality of life.

It is estimated that radiation therapy, alone or in conjunction with surgery or chemotherapy, is required for more than half of all cancer patients. According to the UNSCEAR report (*5*), the frequency of treatment with teletherapy and brachytherapy is estimated at around 2.4 per 1,000 population in countries classified in category I. For categories II, III, and IV, the figures would be the equivalent of 25%, 4%, and 2%, respectively, of the estimate for category I. With increases in life expectancy, there will be greater demand for cancer therapy, and as the countries develop, they will be able to acquire more equipment. This will mean wider use of radiation therapy.

Yet, in many countries appropriate technology (*12*) and the human resources needed to provide accurate ***dose*** calculations, treatment planning, and good patient care are lacking. Table 2.5 shows the results of a recent assessment of the availability of high-energy radiation therapy facilities (cobalt-60 or higher energy) in the various regions of the world (*13*).

Table 2.5
High-Energy Radiation Therapy Resources by WHO Region

WHO Region	**Countries with High-Energy Radiation Therapy Facilities**	**Number of High-Energy Radiation Therapy Facilities**	**Approximate number of High-Energy Machines in Developing Countries, 1993**
Africa[a]	12	14	30
Americas[b]	23	250	550
Eastern Mediterranean	20	40	70
Europe[c]	35	500	350
South East Asia	7	80	170
Western Pacific[d]	11	200	450

a Does not include South Africa
b Does not include Canada or the United States
c Does not include the former Soviet Union
d Does not include China

These figures indicate that in some parts of the world, such as the large regions of Africa and South East Asia, there may be only one high-energy radiation therapy machine for 20-40 million people, and one machine may be used to treat more than 600 new patients per year. Many cancer patients have no access to radiotherapy services.

The major factor that currently limits radiation therapy in the developing world and that will stand in the way of meeting future needs is the shortage of equipment and personnel for operation and maintenance. People in many areas of Africa and South East Asia have virtually no access to this beneficial treatment modality. Essential services must therefore be developed. (See Appendix I-C).

In other parts of the world, including many countries of Latin America where radiotherapy has been available for many years, international cooperative efforts must be directed toward improving the delivery of treatment. All these efforts must be intensified as the importance of cancer as a public health priority becomes increasingly evident to the responsible authorities.

2.2 Imaging and Radiation Therapy Services in Latin America and the Caribbean (*14*)

2.2.1 Overview

A review of the Region's health systems shows that few countries have well-defined policies for the development of resources for imaging and radiation therapy that take into account both the public and private components of their health services. Any policy definitions that exist in the countries tend to be at the institutional level and do not apply to the sector as a whole. Consequently, in Latin America and the Caribbean the incorporation of major technological advances in the area of medical imaging and radiation therapy has not been a regulated process, which has led to notable imbalances among the various categories of health establishments.

This situation is closely linked to the political and economic changes that have taken place in the Region in the last decade. The downsizing of the State and privatization, coupled with the lack of policies for promoting balanced investments in the sector, have favored the importation of imaging and radiation therapy equipment primarily for use in private hospitals and other private facilities. In a number of countries, these circumstances have limited technological capabilities and weakened public services, with negative repercussions for the population served by these establishments. Indeed, the lack of coherent policies in the area of imaging and radiation therapy services development has added a new dimension to inequity in health care because it has meant that large segments of the population with limited economic means are denied access to the diagnostic and therapeutic resources of present-day medical technology.

The failure to adopt policies for the development of these services has also had an adverse impact on the selection and acquisition of equipment, which may be inappropriate for the type of service or the diagnostic or therapeutic modality required in the particular epidemiologic situation. Either the resources and equipment are inadequate to respond to the needs of the community, or, at the other extreme, they exceed the demand for services.

In the final analysis, decisions regarding the selection of technology should be based on criteria of cost-efficiency, effectiveness, and suitability for dealing with the prevailing problems and on safety considerations—that is, the equipment and its use should not generate additional ***risks*** or dangers. The regulation and supervision of these processes is the responsibility of the ministries of health. Except in a few instances, government agencies in the Latin American and Caribbean countries have not arranged to receive the input of an interdisciplinary group of consultants, which is indispensable in this area. In addition to health planners and administrators, such groups should include medical physicists, specialists in diagnostic radiology and radiation therapy, maintenance engineers, and others as appropriate. In only a small number of countries has the technology selection process been carried out with the participation of such an interdisciplinary group and been duly regulated. In most cases, several different institutions are involved, and it is usually difficult to get them to coordinate their actions.

Policies on diagnostic and therapeutic resources that utilize ***ionizing*** and non-***ionizing radiation***, given their nature, should include definitions and directives to regulate their use and also to protect both the general population and ***workers*** who are exposed to radiation ***sources*** on the job.

In many Latin American countries, responsibility for compliance with radiation protection standards is shared by two agencies. Health agencies, such as the ministries of health, are usually in charge of controlling and monitoring radiation ***sources*** for medical use. As a rule, however, these agencies have limited physical resources and staff, and the latter are sometimes untrained in the latest technologies. Typically, the health agency is responsible for monitoring ***x-ray*** equipment used for medical or dental purposes. Meanwhile, control of radiation therapy and nuclear medicine is often exercised by nuclear energy agencies, which are also responsible for monitoring nuclear reactors used for power, production, and research purposes; linear ***accelerators*** for both medical and industrial use; and ***radionuclides*** used in industry (for example, irradiators for the sterilization of products), in research (for example, tracers), and in medicine (teletherapy, brachytherapy, and nuclear medicine). The atomic energy agencies in these countries tend to enjoy much more political and economic support than their counterparts in the health area, and often their personnel are trained in the industrialized countries, which provide sizable contributions to support their activities.

The Latin American countries that have dual regulation are Argentina, Brazil, Chile, Cuba, Mexico, and Venezuela. The countries in which radiation regulation is done exclusively by the ministry of health are Costa Rica and Panama. In Bolivia, Chile, the Dominican Republic, Ecuador, Guatemala, Peru, and Uruguay total responsibility for monitoring of the use of ***ionizing radiation*** rests with an atomic energy agency. The other countries, which all use radiation ***sources***, lack infrastructure for radiation protection, even though in some cases a law assigns this responsibility to the ministry of health or a nuclear energy commission.

In the Caribbean area, only Barbados, Guadeloupe, and Martinique have laws that specifically address the subject of radiation protection.

2.2.2 Organization and Coverage of Imaging and Radiation Therapy Services

The mere existence of a health service, especially diagnostic imaging and radiation therapy, does not give an indication of the extent to which the population is covered. An accurate interpretation of the coverage provided by these services needs to also take into account such criteria as relative selectivity, the differential suitability of one or another type of diagnostic technique for particular pathological conditions, and the ways in which these techniques complement each other.

Evaluation of the coverage provided by imaging and radiation therapy services in the Latin American and Caribbean countries should be based on an analysis of the equipment and human resources available and their adequacy *vis-à-vis* the needs of the population. It should also look at the use of clinical management protocols, the resultant statistics, and the existence of programs for ***quality assurance***, radiation protection, and maintenance. However, because of the lack of appropriate data, the information that the countries generate on the coverage of imaging and radiation therapy continues to equate such coverage with the proportion of the population served by health units or establishments. For example, the 1993 UNSCEAR report indicates that for the period 1985–1990 the average number of ***x-ray*** machines per 1,000 population in the world ranged from 0.0042 to 0.35; the annual number of radiological examinations (not including dental x-rays), from 9 to 860 per 1,000 population; the number of patients treated with teletherapy and brachytherapy, from 0.05 to 2.4 per 1,000; the number of nuclear medicine diagnostic exams, from 0.1 to 16 per 1,000; and the number of patients treated with radiopharmaceuticals, from 0 to 0.4 per 1,000. Figures for several countries in the Region are given in Table 2.6.

Data on the physical availability of services are frequently supplemented with figures on activities that correspond roughly to utilization indexes. These figures should be interpreted with caution, since, for example, the reports of radiology services do not necessarily distinguish between films exposed, exams performed, or persons attended, nor do they take into account the quality of the image or the effectiveness of the study. These inconsistencies make it difficult to determine the true coverage, and they also hinder comparative analyses, even within the same country.

Table 2.6 (*14*)*
Annual Number of Radiological Examinations, Radiation Therapy Treatments, Nuclear Medicine Examinations, and Radiopharmaceutical Treatments per 1,000 population, 1985-1990, Region of the Americas

Category and Country	Radiological Exams	Radiation Therapy Treatments		Nuclear Medicine Exams	Treatments with Radio-pharma-ceuticals
		Teletherapy	Brachytherapy		
Category I[a]					
Argentina	—	—	0.2	11.5	0.16
Canada	1.050	2.9	—	12.6	0.88
Cuba	620	0.2	0.05	—	—
USA	800	—	—	25.7	—
Category II[b]					
Barbados	160	0.6	0.2	1.0	0.15
Brazil	93	—	—	1.7	—
Ecuador	53	0.08	0.02	0.8	0.0065
Jamaica	—	0.1	0.07	2.0	0.005
Nicaragua	13	—	—	—	—
Peru	15	0.1	0.04	0 2	0.011
Category III[c]					
Belize	83	—	—	—	—
Dominica	180	—	—	—	—
Saint Lucia	130	—	—	—	—

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Source: UNSCEAR, 1993 (*5*)

a Category I, one or more physicians per 1,000 population
b Category II, one physician per 1,000-3,000 population
c Category III, one physician per 3,000-10,000 population

Table 2.7, compiled by the PAHO Regional Program on Radiological Health, lists the ***radiation generators*** and cobalt therapy units in use in 1994. No comparable information is available on ***unsealed sources*** of radiation for nuclear medicine or ***sealed sources*** for brachytherapy. Partial information on the latter for the countries of the Caribbean, compiled in 1991, appears in Table 2.8.

Table 2.7
Medical Radiation *Sources* in Latin America and the Caribbean, 1994

Country	X-Ray Units (excluding dental)	Co-60 Units	Linear *Accelerators*
Anguilla	2	0	0
Antigua	4	0	0
Argentina	12,000	85	23
Bahamas	5	0	0
Barbados	20	1	0
Belize	12	0	0
Bolivia	1,458	5	0
Brazil	18,000[a]	109	60
British Virgin Islands	1	0	0
Chile	1,350	14	5
Colombia	1,500	24	6
Costa Rica	190	3	0
Cuba	1,000	11	1
Dominica	6	0	0
Dominican Republic	180	4	0
Ecuador	811	8	0
El Salvador	136	3	0
Grenada	3	0	0
Guatemala	95	6	0
Haiti	20[a]	2	0
Honduras	87	3	0
Jamaica	30[a]	2	0
Mexico	10,000[a]	78	20
Netherlands Antilles	8[a]	1	0
Nicaragua	50	1	0
Panama	216	3	0
Paraguay	100[a]	3	0
Peru	1,286	10	3
St Kitts & Nevis	3	0	0
St. Lucia	14	0	0
St. Vincent & the Grenadines	4	0	0
Trinidad & Tobago	20[a]	0	0
Uruguay	350[a]	14	1
Venezuela	3,000	27	16

[a] Estimate

Table 2.8
Brachytherapy in the Caribbean Countries, 1991

Country	*Source Activity* (mCi)[a]			
	Ra-226	Cs-137	Co-60	Ir-192
Barbados	—	530	—	10 Ci/3 mo[c]
Cuba	—	—	—	—
Dominican Republic	398 + 116[b]	387	—	—
Guadeloupe	—	988	—	1,750 mCi
Haiti	205[b]	—	2.5 Ci[c]	—
Jamaica	1,705	~1,000	—	—
Martinique	—	623	—	14 cm wires 10 mCi/cm
Trinidad & Tobago	141[b]	510 + 377[b]	—	—

[a] 1 mCi = 37 MBq
[b] Removed from the country
[c] High *dose* rate afterloading equipment
[d] Low *dose* rate afterloading equipment, no longer in use

2.2.2.1 Availability of Imaging Services (*14*)

The availability and utilization of imaging equipment vary widely, as does its complexity. For example, in Argentina, Brazil, Colombia, Costa Rica, Mexico, and Venezuela, the numbers and the variety of radiological studies performed in university and regional hospitals are comparable to those done in similar centers in more developed countries. In large countries with high levels of urbanization, the main hospital centers tend to be private, and these establishments have more modern and sophisticated imaging services.

In countries with intermediate-sized populations, the range of diagnostic equipment and services available is usually not as great. A study conducted in Honduras in July 1992 illustrates this type of situation (Table 2.9). The survey of diagnostic imaging centers revealed a heavy concentration of equipment and specialized personnel in the capital and in one regional center; in comparison, figures were much lower in the other cities. This pattern is repeated in a number of countries of the Region, and it helps to explain why the population gravitates to the large urban centers, where they can find, in some form, the care they need. The small and intermediate establishments tend to be poorly equipped and understaffed.

From the data in Table 2.9 it is possible to identify other typical situations of the geographical distribution and organization of the services. Personnel dosimetry services were found in only two of the seven facilities visited in

Honduras; three had partial provisions for ***quality control***, while four had no such programs at all; and three of the centers did not have any identifiable organization responsible for maintenance programs.

The distribution of imaging facilities differs dramatically among areas within the countries which points to serious breakdowns in the planning process. A survey of institutions that provide chest radiography in Argentina showed that in Santa Fe Province, which had nearly 2.5 million inhabitants in 1990, there were 900 medical centers with 1,500 medical ***x-ray*** machines. 1,200 dental ***x-ray*** machines, 12 ***computed tomography (CT) scanners***, 2 magnetic resonance imaging units, 12 conventional radiation therapy units, 6 cobalt-60 units, and 1 linear ***accelerator***. This broad availability of services contrasts sharply with the situation in other provinces: Santa Cruz, for example, with less than 200,000 people, had 30 conventional ***x-ray*** machines, 1 mammography unit, and 1 ***CT scanner***.

In the English-speaking Caribbean countries, which have small populations, imaging resources are located mainly in the capitals. Table 2.10 gives data on resources in public health facilities in Barbados, Dominica, and Saint Lucia based on a 1991 study of the availability of services. The organization of the individual services tends to be fairly homogeneous, although some of the same problems seen in other subregions are also observed here, especially with regard to maintenance, the availability of qualified staff, and the limited development of ***quality assurance*** programs.

An important advance has been the development by WHO of the Basic Radiology System (BRS) (*15-19*), designed to improve the availability of radiology services. The units are capable of performing more than three-fourths of all ordinary radiological examinations, including those done in teaching hospitals. Even though the system is very easy to use, its adoption by health services has fallen short of expectations. In 1997 there were only 39 of these units in nine countries of the Americas.

Table 2.9 (*14*)*

Summary of Diagnostic Radiology Departments Visited in Honduras, July 1992

Indicators	**Teaching Hospital, Tegucigalpa**	**San Felipe Hospital, Tegucigalpa**	**Santa Teresa Hospital, Comayagua**
Population covered (No. of persons)	Total country	Total country	80,000
No. of *x-ray* units			
Radiographic (fixed)	4 + 4 [N]	3	1 + 1 [N]
Fluoroscopic	1 + 3 [N]	1	1
Mammographic	1 [R]	—	—
Skull	1	—	—
Radiographic (mobile)	8 ?	1	1
Automatic processors	1 + 1 [N]	1	Manual only
Ultrasound units	1	1	—
No. of radiologists	4	3 [P]	—
No. of radiology technicians	24	4	5
No. of patients/year	62,605	23,000	—
No. of x-ray exams/year	84,074	—	10,380
No. of films/year	113,763	26,000	—
Type of film	Kodak (blue)	—	Fuji
Type of screen	Dupont Quanta III	—	Wolf
No of sonograms	3,727	—	—
Maintenance service	Dept. of Biomedicine	—	—
Personnel dosimetry service	Pocket dosimeters	No	No
Structural *shielding*	Room 5 window lacks lead	Good ?	Good ?
Lead aprons (A), gloves (G)	8 A	—	No
Quality control program	Films only	No	Films

continues on the next page

R = Need repair P = Part-time N = Not working, not in use

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Table 2.9 *(continuation)*

Indicators	Area Hospital, La Paz	Anti-Cancer League, San Pedro Sula	M. Catarino Rivas Hospital, San Pedro Sula	Western Hospital, Santa Rosa de Copán
Population covered (No. of persons)	80.000	350,000	400,000	340,000
No. of imaging units				
Radiographic (fixed)	1	1	3 + 1 [N]	2
Fluoroscopic	—	1 [N]	1 + 2 [N]	1 [N]
Mammographic	—	—	—	—
Skull	—	—	1	—
Radiographic (mobile)	1 [N]	—	1 + 1 [N]	2
Automatic processors	Manual only	Manual only	1 + 1 [N]	Manual only
Ultrasound units	—	—	1 [N]	—
No. of radiologists	—	1 [P]	2	—
No. of radiology technicians	2	1	15	6
No. of patients/year	2,212	—	25,896	10,970
No. of x-ray exams/year	3,000	—	41,000	—
No. of films/year	3,120	—	—	15,616
Type of film	Fuji	—	Fuji	Fuji, Konika
Type of screen	Ilford	—	Universal	Kodak
No of sonograms	—	—	—	—
Maintenance service	Ministry	Francisco Santiso	Dept. of Biomedicine	—
Personnel dosimetry service	No	Pocket dosimeters	No	No
Structural *shielding*	Window lacks lead	Good ?	Good ?	Walls and windows lack lead
Lead aprons (A), gloves (G)	No	No	8A	3A + 1G
Quality control programs	No	No	Processor	No

[N] = Not working, not in use [P] = Part-time

Table 2.10 (*14*)*
Summary of Diagnostic Imaging Services, Caribbean Subregion, 1991

Indicators	Barbados		Saint Lucia	Dominica
Population	240,000		150,000	71,000
No. of imaging units:	Public	Private		
Photofluorographic	1^{N}	—	1^{D}	—
Radiographic (fixed)	$4 + 1^{R} + 1^{N}$	2	$2 + 1^{O} + 2^{P} + 1^{N}$	$2 + 1^{N}$
Fluoroscopic	$1 + 1^{R}$ + 1 mobile	2	$2^{R} + 1^{O}$	1^{R}
Mammographic	1	1	$1^{O} + 1^{P}$	-
Radiographic (mobile)	3	—	1 + 1 (R or D)	2^{N}
Portable	—	1	1	1
Processors (automatic)	$3 + 2^{N} + 2^{R}$	>3	$3 + 1^{D}$	1
Ultrasound	2	2 + 5 (GYN)	$1 + 1^{R} + 1^{D} + 1^{O}$	2 public + 1 private
CT scanner	1	1	1^{P}	—
Dental	≥1	—	None public	$1^{R} + 4$
No. of radiologists	3 + registrar	2	1^{O}	0 (1 available for consultation)

continues on the next page

^{N} = Not in use ^{D} = To be discarded ^{R} = Need repair ^{O} = On order ^{P} = Planned

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Table 2.10 *(continuation)*

Indicators	Barbados		Saint Lucia	Dominica
Population	240,000		150,000	71,000
	Public	Private		
No. of radiographers	19 + 3	2	$2 + 2^{L}$	3
No. of assistant/student radiographers	—	—	$2 + 1^{L} + 1^{O}$	1
Technique charts/written protocols	Yes	—	Yes (St. Jude)/ No (Victoria Hosp.)	No
No. of patients/year	35,246	—	6,600 (St. Jude) + 9,700 (Victoria) = 16,300	10,816
No. of radiological exams/year	39,178	—	6,924 (St. Jude) + 12,120 (Victoria) = 19,000	12,860
No. of films/year	93,100	—	7,500 (St. Jude) + >24,000 (Victoria) = >30,500	>24,154

^{L} = May be leaving ^{O} = On order

continues on the next page

Table 2.10 *(continuation)*

Indicators	**Barbados**		**Saint Lucia**	**Dominica**
Population	240,000		150,000	71,000
	Public	Private		
Type of film (excluding mammo)	Kodak, Dupont, OG	Kodak, Dupont	Fuji/Dupont Cronex IV	Curix/Kodak/ Fuji/Dupont
Type of screen (excluding mammo)	Fuji Medium speed, Cronex VII+IV, Lanex	Kodak, Dupont	Fuji G-4 (400 speed), Fuji G-8 (200 speed) Quantum II, Quantum Detail, Par speed	Optex-Hi plus (200 speed)
Maintenance services	Local/Medicaraibe	—	Local/Witico/P. St. Dennis/Medicaraibe	Local/Martinique (Philips only)
Personnel dosimetry services	Siemens/planning own	—	Landauer/Gardray (USA)	SCPRI [o]
Structural ***shielding***	OK	—	OK, needs additional in renovated areas	OK
Lead aprons/gloves	Yes	—	6/4 (St. Jude), 5/2 (Victoria)	3
Gonadal shields/other	Yes	—	Yes/4	1 + thyroid + glasses
Pediatric restraining devices	Yes	—	No	No
Resuscitation carts	Yes	—	Yes	No
Quality assurance	Yes	—	No	No

[o] = On order

Table 2.11 (*14*)*

Radiation Therapy Resources, Countries of Central America, circa 1992

	Costa Rica	El Salvador	Guatemala	Honduras	Nicaragua	Panama
Centers	2	2	2	2	1	2
Cobalt-60 units	3	3	5	3	—	2
Activity (Ci) (1993)	6,000–6,250	—	3,500 (average)	1,900–5,000	—	2,200–6,000
Brachytherapy *sources*						
Ra-226 (mg)	42–275	—	—	95–492	160	—
Cs-137 (mg Ra eq)	35–525	—	350	12–180	25-58 GBq	—
Radiation therapists	2	5	5	3	1	4
Radiation therapy technicians	—	12	12	7	2	3
Medical physicists	2	1	—	1	—	1
Quality control	Limited	No	No	1 center yes 2 centers no	No	Yes

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2.2.2.2 Availability of Radiation Therapy Services

Radiation therapy equipment and services are very unevenly distributed in the Latin American and Caribbean countries. As of 1994 there were approximately 500 cobalt-60 units, 10 cesium-137 units, and 124 linear ***accelerators***. The services tend to be concentrated in the larger countries of South America (especially Argentina, Brazil, Colombia and Venezuela) and in Mexico. A similar pattern prevails in the countries of the English-speaking Caribbean: the most well-equipped services are found in Barbados, Jamaica, and Trinidad and Tobago. The Radiation Therapy Department at Queen Elizabeth Hospital in Barbados also provides these services to patients from other countries, although the long waiting lists indicate that there is difficulty in meeting the demand. This is a practical arrangement, since the other countries do not have large enough populations to justify the cost of investing in and operating their own services of this kind. The improvement of coverage by such means depends on agreements signed between countries, as well as cooperation between institutions in the development of joint programs.

Table 2.11 gives data on the availability of radiation therapy services in the countries of Central America. The availability and type of equipment are generally similar throughout the subregion, but the same cannot be said of certified personnel. The largest numbers of radiation therapists work in Costa Rica and Guatemala; qualified radiation therapy technicians are only found in Honduras; and the only medical physicists work in Costa Rica (2), El Salvador (1), and Honduras (1).

2.2.2.3 Availability of Nuclear Medicine Services

The availability of nuclear medicine services in the Region reflects even greater disparities. In some of the countries—for example, Nicaragua and a few of the island nations in the Caribbean—***radionuclides*** are not used at all for medical purposes. At the other end of the spectrum, Argentina has 600 nuclear medicine centers, over 180 ***gamma cameras***, 30 ***single photon emission computed tomography*** (***SPECT***) units, and 1 ***positron emission tomography*** (***PET***) unit, as well as radioimmunoassay services.

Table 2.6 gives data on the utilization of nuclear medicine in the Region, including Canada and the United States of America.

2.2.3 *Quality Assurance* and *Control* Activities

Problems often cited in connection with the organization and operation of imaging and radiation therapy services include excessive number of studies, use of complex equipment and overqualified personnel for simple examinations, unsuitable conditions in the facilities that affect the quality of the studies, lack of standards for radiation protection, lack of clinical protocols, and others. These problems reflect managerial and administrative shortcomings and the absence of effective ***quality assurance*** programs. Activities to address these problems are only beginning in most of the countries, and they tend to focus on specific issues rather than approach the situation comprehensively.

However, several important initiatives have emerged, among them the establishment in 1992 of a Pilot Center for Radiological Physics within the Hospital of the Central University of Venezuela in Caracas. This center was created in collaboration with the Secondary Standards Dosimetry Laboratory of the Venezuelan Institute for Scientific Research. In 1994, the National Center for Radiological Physics was established within the Autonomous National University of Honduras in Tegucigalpa, and post-graduate programs in medical physics were initiated in the Clinical University Hospital of San Martín, associated with the University of Buenos Aires, Argentina. These centers, with technical support from the Pan American Health Organization, seek, as one of their central objectives, to promote the practice of radiological physics as a fundamental component of diagnostic radiology, radiation therapy, and nuclear medicine services. For this purpose, they offer a number of educational activities, including seminars, workshops, and courses, as well as in-service training for clinical specialists, physicists, dosimetrists, and technologists.

Quality assurance programs, which are intended to optimize the quality of radiological images and guarantee the accuracy and precision of radiation therapy treatments, may need to be formalized by regulatory provisions or laws in order to be successful. In 1991, Argentina adopted regulations for a law that created the Advisory Commission on Mammography at the national and provincial levels and set detailed standards for the performance of examinations. The standards establish the technical specifications of the installations and the training required by the medical staff; there is also a ***quality control*** program that includes the determination of patient ***doses***. The Argentine Mammography Standards appear in Appendix II-A.

In 1994, the United States of America enacted the Mammography Quality Assurance Standards Act, which requires all United States institutions to have strict ***quality assurance*** programs with clinical, technical, and physical components. The most important points of this law are reproduced in Appendix II-B.

The application of such standards requires well-organized supervisory mechanisms as well as the technical and administrative means to ensure enforcement. Action is needed in both these areas in most of the countries of Latin America and the Caribbean.

2.2.4 Available Resources

The structural changes that have taken place in the health systems of many countries have affected the configuration and availability of physical resources and equipment. In a number of cases budgetary limitations have prevented the needed upgrading of imaging and radiation therapy equipment, with the result that these services now lag behind technologically. Except in new establishments, the equipment in most of the diagnostic radiology services dates back to the 1970s and has become obsolete, leading to reduced productivity, decreased efficiency, and higher cost and poor quality. This frequently observed situation is a legacy of the lack of policy definitions cited at the beginning of the present section.

The biomedical equipment in use in the health establishments, especially the diagnostic imaging equipment, typically represents an enormous range of commercial brands. Because of this diversity, replacement parts are more difficult and more costly to get and maintenance becomes extremely complicated to carry out. The absence or poor performance of equipment maintenance programs continues to constitute the main problem in many of the hospital-based diagnostic radiology departments and radiation therapy centers throughout the Region.

These maintenance problems—which affect the physical plant along with diagnostic, therapeutic, and film processing equipment—together with shortages of supplies, are the most frequent causes of interrupted services. The problems stem primarily from limited budgets and from structural weaknesses in the health systems, which tend to give very low priority to management and administration. Another factor is the shortage of human resources trained in various types of maintenance. Even though a growing number of countries have well-trained technicians, engineers, and other professionals, there are still problems in the geographical and institutional distribution of this personnel.