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Overview of radiotherapy resources in Latin America: a survey by the International Atomic Energy Agency (IAEA)

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Abstract

Background and purpose: An analysis of the resources for radiotherapy in Latin America was done to establish a baseline to help plan future development in the region.

Patients and methods: The data from 19 countries were obtained during three International Atomic Energy Agency (IAEA) regional meetings. The survey covered radiotherapy centres, major equipment and personnel. The centres were categorised into four different levels. Data were related to economic and population indices.

Results: Four hundred and seventy centres were identified in 18 countries. Centres were divided into 4 levels: half were included in level 1, 25% in level 2 and 18% in level 0 (stand alone teletherapy machines). Human resource represents 933 radiation oncologists, 357 physicists and 2326 radiation therapy technologists. In general, availability of equipment and personnel was related to economic status of the country.

Conclusions: Although there is a shortfall of equipment, the major restriction to patient service is an insufficient number of specialists in 16 of the 18 countries. An upgrade of standards in many centres is required to offer a comprehensive radiation oncology service. The information provided in this paper represents a useful base to plan future development in terms of equipment installation and training programs.

Keywords: Radiotherapy; Developing countries; Equipment and supplies; Health care facilities; Manpower and services; Economics

1. Introduction

Latin America is a wide region that includes part of North America, and all of Central America, South America and the Caribbean region. Most of the 41 countries are independent, and only a few are part of France, the United Kingdom, the Netherlands and the United States of America. All types of climate are present from tropical to polar. The population was of 516 millions inhabitants in 2000 [1–5]. Ninety seven percent of the population speaks Spanish or Portuguese, 64% speaks Spanish and 33% Portuguese, two languages fully intelligible between them [1–5]. Religion and cultural characteristics are uniform through out all the region, due to Spanish and Portuguese colonization.

The International Monetary Fund (IMF) defines all Latin American countries as 'other emerging market and developing countries' [4], having a gross national income (GNI) per capita of less than US$ 10,000. Great contrasts are present, from 3 modern mega polis with 10–20 millions (Buenos Aires, Sao Paulo, Mexico City) to deserts and isolated regions.

Colonisation in the 16th century has brought to Latin America similarities, as common official languages, culture and religion, but there remain great differences in climate and socio-economic conditions.

This paper analyses the radiotherapy capacities in the region.

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2. Materials and methods

Meetings of three groups of radiotherapy professionals were convened by the IAEA in Montevideo, Uruguay from 24 March to 4 April 2003 to enumerate the resources available and the common deficiencies in radiotherapy in the Latin American region. Thirty-seven government nominated representatives in the fields of clinical radiation oncology and medical physics of 19 countries in the region attended.

The resources were addressed by documenting the number of radiotherapy centres, the equipment available, personnel, specialist education institutions and the source of funding of the existing centres. Centres were classified into groups: level 1 having teletherapy, brachytherapy, treatment planning system, immobilisation, a radiation oncologist and at least part-time services of a medical physicist; level 2 required further to have simulator imaging, the ability to make field-specific blocks and a full-time medical physicist; level 3 had additionally one of IMRT, stereotactic radiotherapy or intra-operative radiotherapy. Department with less than level 1, e.g. stand-alone teletherapy units were classified as level 0. Stand-alone brachytherapy units in gynaecological departments were not regarded as centres but the equipment in these was included as a national resource.

Equipment and personnel numbers were analysed and related to known benchmarks such as megavoltage machines/million population and GNI per capita [7]. Population statistics were derived from the World Factbook 2000 [9], from the United Nations Economic Commission For Latin America and the Caribbean (CEPAL-ECLAC) [1–5] and the United Nations Population Fund (UNFPA) [10] documents. Insufficient data were available on patient numbers treated to derive results on patient load per oncologist or per machine.

The education resources in radiotherapy were evaluated by enumerating the number of training institutions, means of accreditation and time for specialisation.

No effort was expended on determining the exact geographical distribution of the departments in the three largest countries, Argentina, Brazil or Mexico.

3. Results

The 19 countries reviewed were Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela. The total population of these countries are 516 million persons with 70% being concentrated in 4 countries; Brazil (175 million), Mexico (102 million), Colombia (44 million) and Argentina (38 million) [1–10]. The least populous countries reviewed, with about 3 million persons in each, were Panama and Uruguay [1–10]. Haiti had neither functional radiotherapy services nor expertise and was excluded from the infrastructure statistics.

3.1. Radiation oncology centres

A total of 470 radiotherapy centres were documented in 18 countries, as seen in Table 1. Haiti, which has a solitary non-functional radiotherapy centre in the process of being

Table 1
Population, total number of radiation oncology departments, megavoltage machines, and relationships between population/departments and machines/population in each country

Country	Population[a]	Centres	Cobalts[b]	LINACs[c]	Million/centre	Mv/million
Argentina	38	89	72	54	0.43	3.32
Bolivia	8.7	6	5	1	1.45	0.69
Brazil	175	151	112	158	1.16	1.54
Chile	15.6	22	15	16	0.71	1.99
Colombia	43.8	38	39	17	1.15	1.28
Costa Rica	4.2	3	3	3	1.40	1.43
Cuba	11.3	9	10	2	1.26	1.06
Dom. Rep	8.7	3	3	1	2.90	0.46
Ecuador	13.1	8	7	5	1.64	0.92
El Salvador	6.5	2	3	0	3.25	0.46
Guatemala	12	6	6	2	2.00	0.67
Haiti	8.7	0	0	0		
Mexico	101.8	75	82	20	1.36	1.00
Nicaragua	5.3	1	1	0	5.30	0.19
Panama	3	3	2	4	1.00	2.00
Paraguay	5.8	4	4	2	1.45	1.03
Peru	26.8	12	9	8	2.23	0.63
Uruguay	3.4	8	9	5	0.43	4.12
Venezuela	25	30	14	16	0.83	1.20
Total	516.7	470	396	314	1.10	1.37

[a] Population in millions.
[b] Cobalt 60 machines.
[c] Linear accelerators.

rebuilt and re-equipped, was not included. Predictably, the majority (75%) of departments were in the 4 most populous countries. However, as a measure of service provision, only 5 countries, Argentina, Chile, Panama, Uruguay and Venezuela had better than one centre per million population.

Of the 470 centres, 51% were of level 1 standard and 25% of level 2. Level 3 was reached in 14 centres (3%) and 9 specialised units devoted to stereotactic radiotherapy were recorded. The balance of 85 centres (18%) were stand-alone teletherapy machines (level 0) of which 5 were not in use, awaiting refurnishment. Level 0 centres were significantly over represented (>28%) in Argentina, Bolivia, Ecuador, El Salvador, Mexico and Paraguay and at the 20% level included Colombia, Peru and Venezuela.

Although both orthovoltage and megavoltage teletherapy machines are present, only megavoltage machines were documented for a total of over 700 in these countries. Slightly more than half (401–56.5%) were cobalt teletherapy machines while the balance were linear accelerators. El Salvador and Nicaragua had no linear accelerators. In contrast, over 50% of the megavoltage machines were linear accelerators in Brazil, Chile, Paraguay and Venezuela.

Data on brachytherapy equipment were obtained from 12 countries. Over 260 sets of manual afterloading of caesium and some radium are available in these countries. Caesium LDR and MDR afterloading were represented by 23 and 11, three- and six-channel units, respectively. Iridium HDR units have rapidly found favour and 103 of these units are installed, 61 of these in Brazil.

Simulators are present only in 91 of the 470 centres (19%). Treatment planning systems are available in 211 centres (45%).

3.2. Personnel

There are 933 qualified radiation oncologists recorded. While many of the senior radiation oncologists received training abroad, the majority are now trained within the region. Of the 18 countries, twelve have a postgraduate radiotherapy training infrastructure in 35 institutions. Argentina, Brazil and Cuba conduct training at 5 or more institutions. Overall training period is 3 or 4 years (mean 3.25 years), but, with additional time requirements within the discipline prior to registration, the mean time to qualify rises to 4.25 years.

Thirteen countries provided a breakdown of medical physicists according to their degrees. Of the 357 medical physicists, 241 had a degree specifically in medical physics (Argentina 60, Brazil 176 and Chile 5). The balance of 116 medical physicists were of MSc level or better for 36 and 80 of BSc level. Formal training as opposed to on-job-training is available in at least 22 training centres in 7 of the 18 countries. It was less clear-cut what qualification was required for the about 2300 radiotherapy technologists.

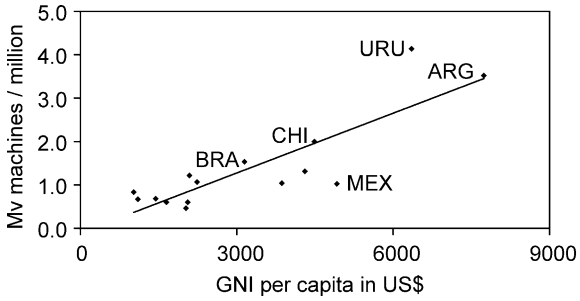

Fig. 1. Relationship between megavoltage machines and gross national income.

3.3. Service providers

The private sector is a considerable force accounting for 207 (44%) of the centres. This is not necessarily synonymous with high quality therapy as many private therapy centres are of level 0 or 1.

The health sector accounted for 181 (39%) of centres. Cuban and Nicaraguan services were entirely in the health sector while in Brazil this accounted for 80% of the services rendered. The health sector in the remaining countries funded less than 35% of the centres.

The Social Security sector, not accessible to all population groups, accounted for 17 (3.6%) of centres. The remainder of the centres were operated by non-governmental charitable organizations, the universities, municipalities or the military.

3.4. Gross national income per capita

The GNI per capita in US$ has been related to service provision, as measured by megavoltage machines per million population in a previous publication and is shown in Fig. 1 [7–10]. Notable deviations from the regression line are Uruguay with better than predicted services and Mexico with poorer services.

4. Discussion

Of all cancer in South and Central America and the Caribbean, the 19 countries reviewed have 96% of all the cancer cases. New cancer cases per year were expected to have risen from 600,000 to 790,000 in the region in the decade 1990–2000, an increase of 30% [2].

Deficiencies in service are commonly attributed to a shortfall of equipment, which is the case of Africa [6]. Around 100 more teletherapy machines are needed according to IAEA-TECDOC 1040 [3], which implies an increase of 14%. However, a similar pattern of insufficient specialists (Fig. 2) is the major constraint in 16 of the 18 countries as was found for the Asia and Pacific region [8]. Six hundred and forty two more radiation oncologists are needed, which means an increase of 69%. In the case of the physicists

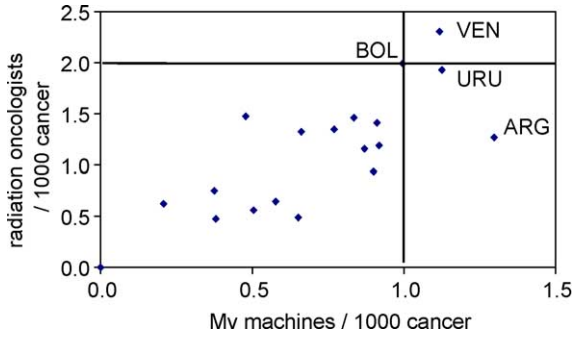

Fig. 2. Relationship between radiation oncologists and megavoltage machines per 1000 cancer cases (only about a half of these might need radiotherapy).

the number of new specialists would be 627, with an increment of 176%. Two thousand and five hundred more radiation technologists are needed, an increment of 109%. Fig. 2 shows that most of the countries have less than one radiation oncologist and one teletherapy machine per 1000 cancer cases.

Level 2 centres represent 25% of the total number of institutions. The combination of level 0 (18%) and level 1 centres (51%) total 69% not having simulation or custom blocking at least. The policy in some small countries like Nicaragua is to concentrate their efforts in only one centre. If resources are scarce it is better to have one level 2 centre with more than one teletherapy machine than to have two level 1 centres. Reinforcement of existing institutions is a better solution rather than proliferation of sub-optimal ones.

Another point is that every country should have at least a local program for training RTTs to a regionally acceptable standard, and if possible also to prepare Radiation Oncologists and Medical Physicists.

5. Conclusions

Efforts have to be made to maintain and increase the installed capacity and to improve the quality of the centres (18% Level 0), but also to increase the number of professionals devoted to Radiotherapy, as local conditions exist to implement regional and local training programs.

Acknowledgements

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