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Overview

Need for Radiotherapy in Low and Middle Income Countries – The Silent Crisis Continues

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Abstract

About 57% of the total number of cancer cases occur in low and middle income countries. Radiotherapy is one of the main components of cancer treatment and requires substantial initial investment in infrastructure and training. Many departments continue to have basic facilities and to use simple techniques, while modern technologies have only been installed in big cities in upper-middle income countries. More than 50% of cancer patients requiring radiotherapy in low and middle income countries lack access to treatment. The situation is dramatic in low income countries, where the proportion is higher than 90%. The overall number of additional teletherapy units needed corresponds to about twice the installed capacity in Europe. The figures for different income level groups clearly show the correlation between gross national income per capita and the availability of services. The range of radiotherapy needs currently covered varies from 0% and 3–4% in low income countries in Latin America and Africa up to 59–79% in upper-middle income countries in Europe and Central Asia. The number of additional radiation oncologists, medical physicist, dosimetrists and radiation therapists (RTTs) required to operate additional radiotherapy departments needed is 43 200 professionals. Training and education programmes are not available in every developing country and in many cases the only option is sending trainees abroad, which is not a cost-effective solution. The implementation of adequate local training should be the following step after establishing the first radiotherapy facility in any country. Joint efforts should be made to establish at least one radiotherapy facility in countries where they do not exist, in order to create radiotherapy communities that could be the base for future expansion.
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Key words: Developing countries; low and middle income countries; radiotherapy availability; radiotherapy needs; radiotherapy utilisation; resources

Statement of Search Strategies Used and Sources of Information

The list and income classification of countries was taken from the World Bank, Country and Lending Groups, 2015 fiscal year (http://data.worldbank.org/about/country-and-lending-groups). Data on the population, number of cancer cases per country and per region, and the number of cancer cases for each cancer site were obtained from GLOBOCAN 2012 (http://globocan.iarc.fr/Pages/fact_sheets_population.aspx). Data on the availability of radiotherapy equipment were obtained from the International Atomic Energy Agency Directory of Radiotherapy Centres (DIRAC), publicly available online at http://nucleus.iaea.org/HHW/DBStatistics/DIRAC/ and at http://www-naweb.iaea.org/nahu/dirac/default.asp. We used an internally produced Excel sheet with data from December 2013.

Introduction

About 57% of the cancer cases worldwide occur in low and middle income countries (LMIC) according to GLOBOCAN 2012 [1]. Radiotherapy is one of the main components of modern cancer treatment and requires substantial capital investment, trained professionals in several disciplines, high precision equipment and a particular external and internal organisational structure. Most of the indications for radiotherapy are related to cancer treatment and it is not possible to set up a cancer control programme if radiotherapy is not available. Radiotherapy has experienced a fast technological advance in the last two decades, which has improved precision in treatment planning and delivery.

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On the other hand, this technological advance and improved precision require increased quality assurance needed to provide treatments safely. All these developments have been quickly implemented in developed countries at a full scale. Traditional two-dimensional radiotherapy has been replaced by three-dimensional conformal radiotherapy, intensity-modulated radiotherapy and image-guided radiotherapy. The remaining cobalt teletherapy machines have been largely replaced by linear accelerators (LINAC) with multileaf collimators and image guidance, capable of delivering intensity-modulated radiotherapy and volumetric modulated arc therapy. Today, cobalt machines represent only 7% of the external beam radiotherapy (EBRT) equipment in high income countries (HIC). The estimated demand for radiotherapy in developed countries and regions is in general supplied.

Several analyses of radiotherapy resources in LMIC at the regional level have been published [2–11]. When published, these reports were essential to understand the situation in developing countries and to present reference sources for comparison when carrying out new analyses.

This article gives an overview of the demand for radiotherapy in LMIC, with additional detail for different world regions, but it does not aim to make future projections. It presents a summary of the most relevant indicators used to calculate the number of machines needed, with an alternative one based on the number of fractions per machine. The problem of staffing and training in LMIC is also discussed.

Estimating the Need for Radiotherapy

Data Sources

Economies were classified according to the definitions of the World Bank for the current 2015 fiscal year. The list from the World Bank includes 214 economies, of which 139 are in the category of LMIC [12].

LMIC were grouped into regions, defined as per the division used by the International Atomic Energy Agency (IAEA) Technical Cooperation Department. Europe and Central Asia include LMIC from Europe and the post-Soviet countries in Asia. Asia and the Pacific refers to LMIC from the rest of Asia and Oceania. The other two regions are Africa and Latin America.

The number of existing machines was primarily obtained from the IAEA Directory of Radiotherapy Centres (DIRAC) as of December 2013, with the addition of Kosovo, South Sudan and the West Bank and Gaza and a minor correction of data in some countries [13].

The population and the number of cancer cases per region and country were taken from GLOBOCAN 2012, which presents data from 184 countries [1].

From the 139 LMIC on the World Bank list of economies, 15 small countries not reported by DIRAC or GLOBCAN were excluded from the analysis. The final number of countries included was 124, divided in 35 low income countries (LIC), 44 lower-middle income countries (L-MIC) and 45 upper-middle income countries (U-MIC).

Radiotherapy Utilisation (RTU) Calculation

A different RTU rate and the average number of fractions per radiotherapy course were obtained for each region using data from GLOBOCAN 2012 and the methodology and RTU factors for different cancer sites published by the Collaboration for Cancer Outcomes Research and Evaluation (CCORE) in their reports [14–16]. A retreatment rate of 25% was used with 3.3 fractions per course [16–18]. The optimal RTU tree for cervix cancer was the only one modified, and a detailed explanation is given in the brachytherapy section. The calculated RTU rates and the average number of fractions per course were 0.543 and 16.44 for Africa, 0.533 and 16.53 for Latin America, 0.501 and 15.95 for Europe–Central Asia and 0.495 and 16.29 for Asia–Pacific. Each set of factors was used to calculate the radiotherapy cases and the fractions for each country in each region.

Calculating and Reporting Radiotherapy Equipment Availability

A commonly used indicator for radiotherapy equipment availability is the number of teletherapy or megavoltage units per million population. It only needs a simple calculation based on easily available data, but it does not account for differences in cancer incidence and machine throughput. It will only be used in this overview for comparisons with old reports.

A benchmark of between 400 and 500 patients per treatment unit per year has been used to calculate machine throughput in several reports [11,19,20]. This benchmark does not make a distinction between long and short treatments and the assigned proportion of retreatments makes a big difference in the final results. The use of the average number of fractions for each cancer type, which in the end gives an average number of fractions for all cancer cases or treatment courses, is a step forward in terms of accuracy in the results. As the number of fractions in cases needing a second radiotherapy course is small, the relative weight of retreatments is smaller and more realistic [16]. This method makes the comparison between different operating hours on the machines easier. The benchmark of 450 patients per machine correlated well with the calculation based on average fractions, 25% of retreatment and 8 operating hours.

Some developed countries, like Canada and the UK, use extended working days or extended weeks to decrease waiting times. Cancer Care Ontario, in its report on Radiation Treatment Capital Investment Strategy from April 2012, recommends extending the treatment day to 12 h in larger centres and on 50% of the machines in smaller centres and to 10 h on the remaining 50% of machines [21].

The benchmark of 450 patients per machine, which corresponds to about 8 operating hours per day, seems adequate for HIC. For scenarios where radiotherapy demand is not satisfied, a treatment day of 10 h optimises the utilisation of equipment and decreases the number of machines needed. The working day could even be extended, but difficulties with transportation and auxiliary services at

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