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Overview

Analysis of Global Radiotherapy Needs and Costs by Geographic Region and Income Level

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Abstract

Recent years have seen various reviews on the lack of access to radiotherapy often based on geographic regions of the world such as Africa, Asia Pacific, Europe, Latin America and North America. Countries are often defined by their national income per capita levels based on World Bank definitions of high income, upper middle income, lower middle income and low income. Within the world regions, there are significant variations in gross national income (GNI) per capita among the different countries, and even within similar income levels, large variations exist. This report presents the actual status of radiotherapy and analyses the current needs and costs to provide full access in the different regions of the world. Actual coverage of the needs ranges from 34% in Africa to over 92% in Europe to about double the needs in North America. In line with this, proportional additional investments and operational costs are as high as more than 200% in Africa to almost none in North America. Two world regions face substantial challenges: Africa, based on the important demands to build new capacity and subsequently to maintain operational capability; and Asia Pacific, due to its high population density, translating into large absolute needs in radiotherapy treatments and resources, and hence in associated costs. With the data highlighting a large variability of GNI/capita even within similar income levels in the various world regions, it is expected that additional investment in resources and costs may be more dependent on income level of the country than on the GNI group or the geographic region of the world.

Key words: Access; low- and middle-income countries; radiotherapy availability; radiotherapy costs; radiotherapy needs; world regions

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, 2017 fiscal year (http://data.worldbank.org/about/country-and-lending-groups). Data on population, number of cancer cases per country and per region, and number of cancer cases for each cancer site were obtained from GLOBOCAN 2012 (http://globocan.iarc.fr; http://globocan.iarc.fr/Pages/fact_sheets_population.aspx). Data on availability of radiotherapy equipment were obtained from the IAEA Directory of Radiotherapy Centres (DIRAC), publicly available online at http://dirac.iaea.org. We used an internally produced Excel sheet with data from December 2015.

Introduction

In recent years, a large body of evidence has emerged on the availability and needs of radiotherapy. In contrast to common expectations, considerable gaps in access to radiotherapy have not only been observed in low- and middle-income countries (LMICs) [1–6], but also in most European countries. Although the latter region is typically considered a high-income region where resources and access consequently should be optimal, important variations have been observed in available human and capital resources, translating into variable gaps in radiotherapy provision [7–12]. The most comprehensive, worldwide,

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analysis on the topic has been published by the Union for International Cancer Control's Global Task Force on Radiotherapy for Cancer Control (GTFRCC) [2].

These reports have used different sources for input data collection and computed the gap in access to radiotherapy using different methodological approaches. The Health Economics in Radiation Oncology (HERO) project from the European Society for Radiotherapy and Oncology used data from their own survey, obtained and validated in close collaboration with the national societies for radiotherapy in Europe [7–9] and reported the gap between the evidence-based optimal and the actually delivered radiotherapy treatments across Europe [11]. It was concluded that access to radiotherapy remains limited in many European countries, even some of the more affluent. Most other studies relied on data input from the Directory of Radiotherapy Centres (DIRAC), the International Atomic Energy Agency's (IAEA) voluntary global registry on radiotherapy resources [2,10,12,13]. In most instances, the actual needs were estimated as the additional number of capital (mostly linear accelerators; linacs) and/or human resources required to allow full coverage of radiotherapy in a subset of countries or certain regions, based on generally accepted definitions on resource throughput and using various assumptions on other parameters such as operating hours [10,12,14,15]. The GTFRCC report used a more refined time-driven activity-based costing (TD-ABC) approach that did not only allow computing investment and operational costs, but also provided insight into resource utilisation and shortfalls in coverage [2]. Although the number of additional machines needed varies between these reports, the overall conclusion is that around 50% of cases requiring radiotherapy in LMICs do not have access to treatment, and the figure of unavailable need rises to 90% in low-income countries (LICs).

Accurate data on the cost of radiotherapy remain scarce in today's literature. A recent systematic review of the available radiotherapy costing literature observed that only a minority of costing studies used conventional costing methodologies, which, together with the large heterogeneity in scope of the analyses and in inputs used and outputs reported, did not allow the presentation of a consistent picture of radiotherapy costs [16]. Moreover, only one of the studies in the review provided cost data for a range of different countries [17]. To date, the GTFRCC is the only report that has estimated the investment and operational costs for radiotherapy across the globe. To provide input to an investment model that would allow closing the gap in radiotherapy provision by 2035, the report focused on incremental costs to cover additional resources needed over the next 20 years [2].

Here we present the current radiotherapy needs in LMICs, together with the investment and operational costs for optimal coverage to date. Moreover, being aware that LMICs are spread around different regions in the world, we analyse the needs and costs on the proportion of low-, lower middle- (L-MIC), upper middle- (U-MIC) and high-income (HIC) countries in the different world regions.

Countries and Regions

Countries were classified according to the definitions of the World Bank for 2017 [18]. For the current 2017 fiscal year, low-income economies are defined as those with a gross national income (GNI) per capita, calculated using the World Bank Atlas method, of US$1025 or less in 2015; lower middle-income economies are those with a GNI per capita between US$1026 and US$4035; upper middle-income economies are those with a GNI per capita between US$4036 and US$12 475; high-income economies are those with a GNI per capita of US$12 476 or more. The World Bank includes 217 economies, of which 79 are categorised as HIC, 55 as U-MIC, 52 as L-MIC and 31 as LIC. Forty-three small countries in this list are not reported by GLOBOCAN or DIRAC, hence they were not included in the analysis. The final number of economies included was 174, divided into 53 HIC, 46 U-MIC, 45 L-MIC and 30 LIC.

The actual analysis was carried out by geographic regions, based on the definition of regions used by the IAEA Technical Cooperation Department. Europe includes the post-Soviet countries in Central Asia and contains 29 HICs, 14 U-MICs and six L-MICs. North America refers to Canada and the USA, and Asia Pacific includes the rest of Asia and Oceania, with 15 HICs, eight U-MICs, 18 L-MICs and three LICs. Latin America is formed by seven HICs, 15 U-MICs, five L-MICs and one LIC and Africa by nine U-MICs, 16 L-MICs and 26 LICs. Interestingly, the population of Asia Pacific is 41% bigger than all four other regions combined.

Courses, Resources and Costs

The actual situation, based on today's available resources, was evaluated and compared with the optimal situation, where resources would match the needs to treat all patients with an indication for radiotherapy. Resources in the latter situation are further referred to as 'total resources' and the associated costs as 'total costs'.

Two previously published models were used. The total number of radiotherapy courses needed to treat all patients with an indication for radiotherapy to date was calculated using the evidence-based estimation method (EBEST) from the Collaboration for Cancer Outcomes Research and Evaluation (CCORE) [19–21]. The TD-ABC model developed for the GTFRCC [2], based on former IAEA activity-based costing and staffing models [22,23] was used to compute the total resources needed to deliver these courses as well as to calculate the costs, actual and total investment and operational costs, and costs per course.

The main assumptions and input variables, which are largely in line with those used for the GTFRCC report [2], are described below.

Courses

Based on data from GLOBOCAN 2012 [24], the number of current radiotherapy indications, for external beam

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