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Original article

Radiotherapy utilization in developing countries: An IAEA study

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ABSTRACT

Background: The planning of national radiotherapy (RT) services requires a thorough knowledge of the country's cancer epidemiology profile, the radiotherapy utilization (RTU) rates and a future projection of these data. Previous studies have established RTU rates in high-income countries.
Methods: Optimal RTU (oRTU) rates were determined for nine middle-income countries, following the epidemiological evidence-based method. The actual RTU (aRTU) rates were calculated dividing the total number of new notifiable cancer patients treated with radiotherapy in 2012 by the total number of cancer patients diagnosed in the same year in each country. An analysis of the characteristics of patients and treatments in a series of 300 consecutive radiotherapy patients shed light on the particular patient and treatments profile in the participating countries.
Results: The median oRTU rate for the group of nine countries was 52% (47–56%). The median aRTU rate for the nine countries was 28% (9–46%). These results show that the real proportion of cancer patients receiving RT is lower than the optimal RTU with a rate difference between 10–42.7%. The median percent-unmet need was 47% (18–82.3%).
Conclusions: The optimal RTU rate in middle-income countries did not differ significantly from that previously found in high-income countries. The actual RTU rates were consistently lower than the optimal, in particular in countries with limited resources and a large population.
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In developed countries, approximately half of cancer patients have an indication for radiotherapy [1]. Countries that experience the need for radiotherapy infrastructure expansion – often painfully expressed in waiting lists – usually embark on a national strategy for a planned development of their radiotherapy capacity. In this scenario, knowing the radiotherapy utilization (RTU) rates in a country is necessary to inform planning models for future radiotherapy services. This planning requires a thorough knowledge of the national cancer epidemiology profile and a realistic future projection of these data [2,3].

The oRTU rate is the proportion of all cancers with an indication for radiotherapy. In the "Collaboration for Cancer Outcomes Research and Evaluation" (CCORE) model [1] used here, an indication for radiotherapy was defined as a clinical scenario for which radiotherapy is recommended as the treatment of choice because there is evidence that it has a superior clinical outcome compared to alternative treatment modalities including no treatment. The superiority of radiotherapy over other treatment options could be due to better survival, local control, and quality of life or toxicity profiles. In clinical situations where radiation therapy had an equal outcome to other treatment options such as surgery or chemotherapy, all the treatment options were included in the model, and a sensitivity analysis was conducted to determine the range of proportion of patients for whom radiotherapy may be indicated. An evidence-based computation model was used based on data from high-income countries.

Estimates of RTU in developed countries *based on expert opinion* have found that the desirable RTU rate was in the order of 50% [4–6]. Patients in low-middle-income countries (LMICs) usually present with more advanced disease. This fact coupled with

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limited access to oncology surgery, result in higher demand for radiotherapy compared with high-income countries (HICs).

In this first study looking at RTU rates in nine middle-income countries following an evidence-based method, the aim was to estimate the actual RTU and compare it with the optimal, to determine the gaps in service provision in these countries.

The objectives of the study were to: (1) estimate the optimal radiotherapy utilization (oRTU) rate; (2) measure the actual rate of radiotherapy utilization (aRTU) in the same countries and (3) assess the characteristics of patient populations, disease profiles, and treatments administered in the participating countries.

Methods

Countries were selected for this study according to the following criteria: (1) middle-income nations as per the World Bank classification of economies based on a Gross National Income (GNI) per capita (Atlas method) of U$S 1.026 – 12.475 in the fiscal year 2012 [7], when the study was initiated. (2) Countries located in the four IAEA regions; Africa, Asia, Europe and Latin America. (3) Countries with existing and operational radiotherapy centre(s), (4) with an operational cancer registry, and (5) where a reliable and motivated coordinator could be identified. The countries selected for the study were Costa Rica, Ghana, Malaysia, Philippines, Romania, Serbia, Slovenia, Tunisia, and Uruguay. Table 1 shows the level of robustness, availability and methods for cancer incidence data as per the Globocan-2012 classification. The table also shows the level of economic development (GNI-per capita) and the existence of an operational cancer control plan.

In the CCORE methodological approach, indications for radiotherapy for each cancer site were derived from evidence-based published treatment guidelines issued by reputed national and international organizations. An optimal radiotherapy utilization tree was developed for each cancer site by combining clinical scenarios and epidemiological data using TreeAge Pro™ software. Patients requiring radiotherapy were counted only once even if they subsequently developed repeated indications for radiotherapy.

The distribution of tumour types for each country was taken from estimations of the International Agency for Research on Cancer (IARC) in their database Globocan-2012 [8]. This database lists 27 cancer types and the total. The list does not include sarcomas (except Kaposi's sarcoma), cancers of unknown primary (CUP) site or "other" categories.

The aRTU rate was calculated as the ratio of the number of new notifiable patients (no retreatments) treated with radiotherapy in 2012 in each country, to the total number of cancer patients diagnosed in the same year. Country coordinators reported separately the total number of new and carryover patients receiving radiotherapy in the index year 2012. They gathered the data from all operational RT centres in their respective countries.

The radiotherapy case-mix profile for each country was determined by prospectively registering 300 consecutive patients receiving radiotherapy at a leading RT centre in each country, capturing detailed data on patient, disease and treatment characteristics from this sample. Country coordinators conducted this prospective data collection filling an 18-item questionnaire for each one of 300 consecutive patients receiving radiotherapy in their respective centres (Appendix I). This form was completed for each patient on treatment and forwarded to the IAEA Data Management Centre. The year 2012 was selected as the index year for calculations to allow correlation of the case-mix and radiotherapy data with estimates of cancer incidence from the Globocan-2012 database.

Table 1
Economic development, cancer incidence data and cancer control plans in the 9 target countries.

1.	2.	3.	4.	5.	6.	7.	8.
Country	GNI per capita 2018 (US$)	Availability and methods of cancer incidence data	National cancer control strategy/plan	National cancer registry	Scope	Coverage	Last year of data
Costa Rica	11 824	High quality national data or high quality regional (coverage greater than 50%) Rates projected to 2012	Yes	Yes	Population-based	National	2010
Ghana	1 513	Frequency data. Age/sex specific rates for "all cancers" were partitioned using data on relative frequency of different cancers (by age and sex)	Yes	Yes	Hospital-based	Subnational	2012
Malaysia	9 508	High quality regional (coverage lower than 10%) Estimated as the weighted average of the local rates	Yes	Yes	Population-based	Subnational	2011
Philippines	2 951	High quality regional (coverage between 10% and 50%) Estimated as the weighted average of the local rates	Yes	Yes	Population-based	Subnational	2003
Romania	9 522	Regional data (rates) Estimated from national mortality estimates by modelling, using incidence mortality ratios derived from recorded data in local cancer registries in neighbouring countries	Yes	Yes	Population-based	Subnational	2010
Serbia	5 426	High quality regional (coverage between 10% and 50%) Estimated from national mortality estimates by modelling, using incidence mortality ratios derived from recorded data in local cancer registries in neighbouring countries	No	Yes	Population-based	Subnational	2010
Slovenia	21 650	High quality national data or high quality regional (coverage greater than 50%) Rates projected to 2012	Yes	Yes	Population-based	National	2010
Tunisia	3 688	High quality regional (coverage lower than 10%) Estimated as the weighted average of the local rates	No	Yes	Population-based	Subnational	2004
Uruguay	15 220	High quality national data or high quality regional (coverage greater than 50%) Most recent rates applied to 2012 population	Yes	Yes	Population-based	National	2008

Sources:
Column 2: GNI per capita: World Bank https://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD?view=chart.
Column 3: IARC/WHO Globocan-2012, Estimated cancer incidence, mortality and prevalence in 2012.
Columns 4–8: WHO Cancer Country Profiles 2014 – http://www.who.int/cancer/country-profiles/en/#P.

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