Clinical Oncology xxx (2016) 1–12

Contents lists available at ScienceDirect

Clinical Oncology

journal homepage: www.clinicaloncologyonline.net

Overview

The Benefits of Providing External Beam Radiotherapy in Low- and Middle-income Countries

M.L. Yap [*†], T.P. Hanna [*‡], J. Shafiq [*], J. Ferlay [§], F. Bray [§], G.P. Delaney [*†], M. Barton [*]

[*] *Ingham Institute for Applied Medical Research, University of New South Wales, Liverpool, New South Wales, Australia*
[†] *Liverpool and Macarthur Cancer Therapy Centres, Western Sydney University, Campbelltown, New South Wales, Australia*
[‡] *Division of Cancer Care and Epidemiology, Queen's University Cancer Research Institute, Kingston, Ontario, Canada*
[§] *International Agency for Research on Cancer, Lyon, France*

Received 2 September 2016; received in revised form 7 November 2016; accepted 7 November 2016

Abstract

More than half of all cancer diagnoses worldwide occur in low- and middle-income countries (LMICs) and the incidence is projected to rise substantially within the next 20 years. Radiotherapy is a vital, cost-effective treatment for cancer; yet there is currently a huge deficit in radiotherapy services within these countries. The aim of this study was to estimate the potential outcome benefits if external beam radiotherapy was provided to all patients requiring such treatment in LMICs, according to the current evidence-based guidelines. Projected estimates of these benefits were calculated to 2035, obtained by applying the previously published Collaboration for Cancer Outcomes, Research and Evaluation (CCORE) demand and outcome benefit estimates to cancer incidence and projection data from the GLOBOCAN 2012 data. The estimated optimal radiotherapy utilisation rate for all LMICs was 50%. There were about 4.0 million cancer patients in LMICs who required radiotherapy in 2012. This number is projected to increase by 78% by 2035, a far steeper increase than the 38% increase expected in high-income countries. National radiotherapy benefits varied widely, and were influenced by case mix. The 5 year population local control and survival benefits for all LMICs, if radiotherapy was delivered according to guidelines, were estimated to be 9.6% and 4.4%, respectively, compared with no radiotherapy use. This equates to about 1.3 million patients who would derive a local control benefit in 2035, whereas over 615 000 patients would derive a survival benefit if the demand for radiotherapy in LMICs was met. The potential outcome benefits were found to be higher in LMICs. These results further highlight the urgent need to reduce the gap between the supply of, and demand for, radiotherapy in LMICs. We must attempt to address this 'silent crisis' as a matter of priority and the approach must consider the complex societal challenges unique to LMICs.

Key words: Developing countries; global oncology; low- and middle-income countries; outcome benefits; radiotherapy; radiotherapy utilisation

Statement of Search Strategies Used and Sources of Information

We searched Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to present. The search terms used were 'radiotherapy' and 'low and middle income'/'developing countries'. References were restricted to English language only. References from previously published key articles were also identified. Abstracts were reviewed and manuscripts obtained. Data on cancer incidence in each country in the world for the year 2012 were obtained from the GLOBOCAN 2012 project, developed by the International Agency for Research on Cancer and available at http://globocan.iarc.fr/Default.aspx. Projected cancer incidence data for the years 2015–2035 were also obtained from the online tools available in GLOBOCAN. The radiotherapy demand model was previously developed by the Collaboration for Cancer Outcomes, Research and Evaluation (CCORE) and is available online (tinyurl.com/pwkua34). The radiotherapy population benefits model was also developed by CCORE and is in the process of publication. The income group classification of each country was based on the World Bank, Country and Lending Groups, 2012 fiscal year (http://data.worldbank.org/about/country-and-lending-groups).

Author for correspondence: Mei Ling Yap, Ingham Institute for Applied Medical Research, 1 Campbell Street, Liverpool 2170, NSW, Australia. Tel: +61-8738-9121; Fax: +61-8738-9130.
E-mail address: mei.yap@sswahs.nsw.gov.au (M.L. Yap).

http://dx.doi.org/10.1016/j.clon.2016.11.003
0936-6555/

Introduction

In 2012, there were 14.1 million new cases of cancer worldwide, with over half of these occurring in low- and middle-income countries (LMICs) [1]. The global incidence is projected to rise rapidly, most markedly in LMICs.

LMICs have markedly poorer cancer survival compared with high-income countries (HICs). A study comparing cancer survival across three continents [2] found that 5 year cervical cancer survival in Uganda was 13% compared with 79% in South Korea. About 80% of disability-adjusted life years lost due to cancer globally are in LMICs, yet only 5% of the world's cancer care resources are devoted to LMICs. This disparity has been previously termed the '5/80 cancer disequilibrium' [3]; it has also been recently shown that economic downturns have a negative effect on cancer survival, and this is of particular concern in countries currently functioning without universal health care [4].

Radiotherapy is a core component of cancer care and has been shown to be cost-effective [5,6]. Atun *et al.* [7] estimated that an investment in radiotherapy services over a 20 year period would result in a net economic benefit of US $265.2 million across all low-income countries, $38.5 billion in lower middle-income countries and $239.3 billion in upper middle-income countries. Despite this, there remains a huge deficit in radiotherapy services in LMICs [8,9], with the provision of resources inversely proportional to a country's gross national income (GNI) [6].

The closing of this gap in radiotherapy services could have significant local control and overall survival benefits for cancer patients in LMICs. The potential benefits derived from radiotherapy across major cancer types have not been estimated in these regions. This paper thus aims to estimate the local control and survival benefits of guideline-based use of radiotherapy for cancer patients in individual LMICs, relative to the scenario of zero usage. We also aim to project these benefits up to the year 2035.

Materials and Methods

Global Cancer Incidence

The estimated cancer incidence for 27 cancer types was obtained from 184 countries in the world and for the aggregated category 'all cancers excluding non-melanomatous skin cancers' for the year 2012 from the GLOBOCAN 2012 online database developed by the International Agency for Research on Cancer (IARC). The methods and data sources used to develop GLOBOCAN have been previously described [1,10]. Cancer incidence projections for the years 2015, 2020, 2025, 2030 and 2035 were obtained by country across the 27 cancer types from GLOBOCAN, as previously described [11].

Radiotherapy Demand Model

In order to calculate the number of patients requiring radiotherapy according to guidelines and the estimated benefits from radiotherapy in each individual LMIC, we applied two previously described models to the unique cancer case mixes in each country.

First, we applied the Collaboration for Cancer Outcomes Research and Evaluation (CCORE) optimal utilisation model to each country's cancer incidence for each of the 27 cancer types. This model, first published in 2004 [12] and updated in 2013 [13], estimates the proportion of patients with an indication for external beam radiotherapy. An indication for radiotherapy is defined as a clinical situation in which radiotherapy is the treatment of choice, based on evidence that it has a superior outcome compared with other treatment modalities and where the patient is deemed suitable to undergo radiotherapy. The model utilises evidence-based treatment guidelines issued by major national and international organisations to define radiotherapy indications, and the highest level of available epidemiological evidence to calculate the incidence of each indication. The radiotherapy utilisation rate (RTU) therefore represents the proportion of cancer cases that would have an indication for external beam radiotherapy, if radiotherapy were prescribed according to published evidence-based guidelines.

Radiotherapy Population Outcome Benefits Model

We then applied the CCORE radiotherapy population benefits model to the cancer incidence in each LMIC. This previously described model is built on the optimal RTU model and estimates the outcome benefit of each indication for external beam radiotherapy in regards to 5 year local control and overall survival [14,15]. The model is based on the best available evidence identified through systematic review and meta-analysis. The radiotherapy population benefit describes the additional proportion of cancer patients achieving a benefit due specifically to guideline-recommended radiotherapy, compared with no use of radiotherapy for radical indications or from postoperative radiotherapy over surgery alone for adjuvant indications. These benefits are thus distinct from the contribution of other treatment modalities to cancer outcomes. The benefit of concurrent radio-sensitising chemotherapy was included if it was indicated according to guidelines. We assigned the 'other cancers', consisting of cancers such as unknown primary, as well as other rare cancers, a local control and survival benefit of 0%. The RTU model does not include indications for brachytherapy but the benefits model incorporates the benefits of brachytherapy when inseparable from external beam radiotherapy benefit, such as for cervix cancer.

Application of the Demand Models to Global Cancer Incidences

The RTU for each of the individual 28 cancer types, including 'others', was multiplied by the corresponding number of cases in each country. The sum of these formed estimates of the number of cancer patients in each country requiring radiotherapy sometime during their disease pathways. The RTU for each individual country was

Please cite this article in press as: Yap ML, et al., The Benefits of Providing External Beam Radiotherapy in Low- and Middle-income Countries, Clinical Oncology (2016), http://dx.doi.org/10.1016/j.clon.2016.11.003