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ORIGINAL ARTICLE

The need for radiotherapy in Europe in 2020: Not only data but also a cancer plan

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ABSTRACT

Background. Planning radiation oncology equipment and staffing is necessary in public healthcare systems in Europe.
Methods. Three different data inputs were considered: evidence-based indications for radiotherapy, the incidence of cancer, and the stage at diagnosis of each cancer type, both the latter using population-based data from cancer registries. The availability of these data and the implications for the estimation of the proportion of new cancer patients who would need radiotherapy treatment at least once during the course of the disease is reviewed.
Results. Depending on the frequency of cancers and the stage at diagnosis, it has been estimated that between 47% and 53% of incident cases among European countries would require external beam radiotherapy. When the actual data of utilization is compared with the evidence-based target, only one country in Europe has achieved full coverage.
Conclusion. It is argued that these should be considered the optimal proportions of cancer patients, but a more realistic policy target could be set at 80% or higher of the optimal proportion. This realistic target also takes into account the inherent uncertainties in the assessment of evidence, and other factors that influence clinical decision-making in cases of multi-morbidity or patient preferences. Other factors are associated with problems that should be dealt with in the framework of a cancer plan, such as accessibility, preference bias in physician evaluation of the indication or shortage of resources, and the impact of the reimbursement system. Finally, it is argued that a cancer plan is the framework for achieving policy targets in the appropriate coverage of the evidence-based indications for radiation oncology forecasts.

Radiotherapy requires important investments in both equipment and human resources; in health care, it is one of the best examples supporting the need for long-term planning [1]. Although radiation oncology accounts for a relatively low percentage of the total cost of cancer care, these investments do have an impact on the budget [2], necessitating the performance of a cost estimation. This endeavor is complex and challenging, all the more so given the progressive changes in available technologies, which are increasingly specialized and labor intensive [2]. In addition to assessing the projected economic impact of radiation oncology, it is also important to review the best evidence on clinical indications for radiotherapy, so that expected demand may also be considered within a rational planning process. In this paper, we will discuss the planning requirements, from data to realistic targets for radiotherapy investments, within the framework of a national cancer plan, in order to better position radiation oncology in the global framework of cancer control policy.

Data out there: Something is better than nothing

In order to assess the demand for radiotherapy, three different sources of data are traditionally required: 1) the proportion of cases diagnosed with cancer that will require a radiotherapy treatment at least once in the course of the disease; 2) the incidence of new cancer cases over a specific time period in the country; and 3) the stage distribution of these cases.

Regarding the first dataset, there are two basic approaches to obtaining the inputs. The first is to

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benchmark reference regions with optimal resources and utilization of radiotherapy, where it is possible to assess the number of new cancer cases that receive at least one treatment with radiotherapy. This approach requires having a population database with records for all patients diagnosed and treated in a specific region, and being able to differentiate the initial treatment from retreatments. This methodological approach has been successfully used in countries, such as Canada [3,4], and perhaps its greatest advantage is its close relationship to the practical application of clinical criteria. A key point is the selection of the 'optimal' region for comparison; usually this is a well equipped territory with the highest proportional use of radiotherapy, easy access and no waiting list.

The second option is an evidence-based approach that analyses the indications for radiotherapy in scientific literature and clinical guidelines, and then develops a decision model for all tumor sites to establish what proportion of patients will need radiotherapy. This approach can be applied to all tumors and tumor sites, using transparent criteria that can be implemented in a variety of settings with different mixes of cancer types. Three different groups have published this kind of evidence-based decision model. A Canadian group has published reviews of evidence for selected tumor sites [5,6], while the Australian Collaboration for Cancer Outcomes Research and Evaluation (CCORE) project has published a model based on a systematic review of clinical guidelines [7]. Both in the original model from 2003 and in the update for 2012, all tumor sites with incidence over 1% were included, as well as the total proportional demand for radiotherapy among all cancer sites [8]. Finally, the Malthus project [9] in the UK covers all cancer sites and allows for local, need-based planning. Other projects have used these models to estimate the resources and demand for radiotherapy in Europe, including one promoted by ESTRO, which opted to use the CCORE decision trees as the source for evidence-based data due to the global approach both by tumor site and for all tumors. It should be noted, however, that when this project began, the Malthus model was not yet available [10,11].

Interestingly, the three evidence-based approaches all produce different estimates of optimal radiotherapy utilization, which can be explained by differences in the literature and time period considered, as well as the sources of data used in case of unavailable evidence. In almost every case, the CCORE approach results in slightly higher proportional estimates of radiotherapy utilization compared to the Malthus data and the benchmarking approach [12–14]. This fact should be carefully considered when predicting future need for radiotherapy: a variability of about 10% per tumor site and for all tumors is possible simply due to the source of evidence and the estimation approach used. For instance, using Australian epidemiological data, the CCORE model predicted that 48.3% of all new cancer cases would have a clinical indication for radiotherapy at least once during the course of the disease [9], while the Malthus project, using epidemiological data from England, predicted its need in 40.6% of incident cases [14]. This variability reinforces the need to use a systematic, methodological approach for predicting radiotherapy demand, with the understanding that the final proportion of radiotherapy utilization could vary according to the evidence-based indication selected, which in any case should be considered an 'optimal' estimate of need.

Other data requirements include cancer incidence by country or by reference territory. There are currently about 160 cancer registries in Europe with experience collecting data on cancer incidence and survival. The EU-funded EUROCOURSE project reported population coverage of 15–55% among the larger member states (with the exception of the UK, which has 100% coverage), and 80–100% among member states with fewer than 20 million inhabitants [15], mostly through regional registries. Based on data provided by these registries and the mortality database, it is possible to project the country incidence from 2012 up to 2020 (and even up to 2035), an exercise already carried out by the European Cancer Observatory [16] and the Globocan Project (see the respective web sites: www.eco.iarc.fr and www.globocan.iarc.fr).

The projections take into account the demographic trends for the year of interest while keeping constant the incidence rates from 2012, generating an estimate of the expected changes in incidence. For the EU-28, the estimated cancer incidence for both sexes in 2012 was 2 635 222 cases, while in 2020 it is projected to reach 2 930 485—an increase of 11.2% due solely to demographic changes. Interestingly, this increase will be concentrated among people aged 65 or older (with a 16% rise in incidence in this age group, compared to an expected increase of just 4.1% among Europeans under 65). This kind of data, which is available for every European country, highlights the relevance of the ageing process in Europe and its impact on cancer.

The population of candidates for radiotherapy can also be expected to rise in accordance with these demographic trends. Figure 1 use Eurostat data to show the percentage of population by age group in EU member states, from 1960 and projected up to 2080. Considering that one of the most important factors associated with cancer incidence is age, the relevance of demographic trends is clear. Today,

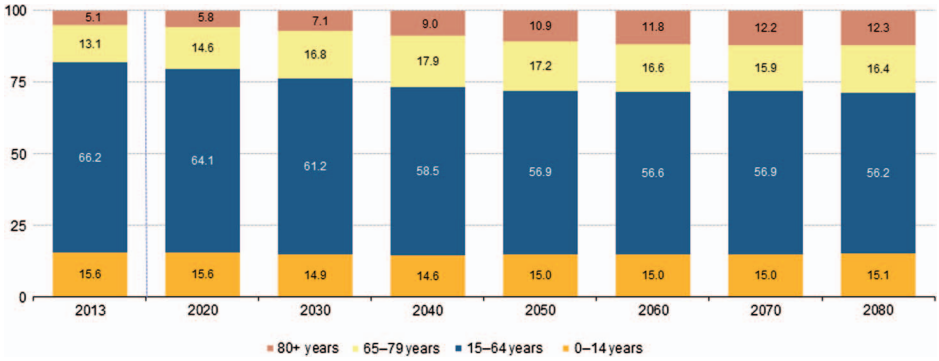

Figure 1. Age groups in European Union: projections until 2080.

population ageing is most apparent in Western and Northern Europe, but it will increasingly have an impact on Southern and Eastern Europe as well. While projections for 2020 are usually based on demographic trends, changes in the life expectancy of the European population due to decreases in smoking among males and observed reductions in cardiovascular mortality [17] will also affect the clinical presentation of future cancer patients [18,19,20], who will be more likely to have a range of comorbid conditions related to older age that complicate clinical decision making.

The third set of data required is stage at diagnosis, which is essential in determining prognosis. The problem with obtaining this data is that many cancer registries only collect stage for some tumors (at best) because of difficulties in ascertaining it from clinical records and lack of funding for the resources required. There is a need to improve the usefulness of cancer registries through collection of this information, as well as other relevant data, such as type of treatment and comorbidity. However, only a few registries have this data readily available. EUROCOURSE has documented this situation and proposed measures to improve it (www.eurocourse.org) [15,16].

Despite some caveats, there is data available for all steps of an evidence-based needs assessment for radiotherapy. Cancer incidence at a country level can be reasonably projected up to 2020 based on current demographic trends, and there are some population-based cancer registries with good data on stage at diagnosis. All in all, European countries are able to assess the need for radiotherapy in 2012 and make a feasible projection for 2020, although all countries should make efforts to improve the quality, coverage and availability of data upon which such estimations are based.

Need for radiotherapy in Europe: National needs should be assessed using national data

ESTRO has promoted the Health Economics in Radiation Oncology (HERO) project, which aims to assess the need for radiotherapy in Europe, along with the infrastructure and staff needed to deliver it, using an evidence-based approach. As mentioned above, the approach chosen was the CCORE model, which was applied to the estimated incidence for 2012 and the stage at diagnosis of five population-based cancer registries (Australia, Belgium, Greater Poland region in Poland, the Netherlands and Slovenia). The outcome was the proportion of new cancer cases per country that would have an indication for radiotherapy in 2012; methodological details of this analysis and its main results have been reported in previous papers [20,21]. The results of this analysis are presented in Table I by country and with a range of values due to the application of staging data from five cancer registries. Several observations relevant to assessing the need for radiotherapy in these national contexts arise:

1. Under reasonable assumptions, it is feasible to assess the demand for radiotherapy at a country level using a combination of evidence-based indications and population-based data on incidence and stage at diagnosis.
2. When considering all cancer sites together, the use of national incidence and stage data modify the proportion of patients with an indication for radiotherapy treatment by approximately 5%, with a much higher impact derived from the variation in the frequency of cancer and lower impact from changes in stage at diagnosis.
3. This assessment does not include retreatments carried out on the same patient for the same primary tumor during the course of the disease, which could have an impact on the future demand for treatments. Although there is no clear estimate of this impact, one analysis published using hospital data reported that 24% of patients received more than one course of radiotherapy treatment [22], also unpublished data from an HERO survey in Europe confirmed this estimate as an average of

Table I. Estimated proportion of patients with an evidence based indication by country.

Country	OUP (%)	
	Min.	Max.
Albania	52.6	54.3
Austria	49.0	50.3
Belarus	48.5	50.3
Belgium	53.2	54.8
Bosnia Herzegovina	52.8	54.4
Bulgaria	51.3	53.0
Croatia	51.2	52.7
Cyprus	51.0	52.3
Czech Republic	48.5	50.2
Denmark	52.8	54.3
Estonia	49.1	50.8
Finland	52.1	53.4
France	51.9	53.3
FYR Macedonia	52.6	54.3
Germany	50.1	51.6
Greece	52.5	54.2
Hungary	50.3	51.9
Iceland	50.7	51.8
Ireland	51.5	52.9
Italy	48.2	49.3
Latvia	49.9	51.4
Lithuania	49.9	51.5
Luxembourg	50.6	52.0
Malta	51.9	53.3
Moldova	50.2	52.1
Montenegro	52.2	53.8
Netherlands	52.3	53.9
Norway	49.0	50.5
Poland	52.0	53.4
Portugal	49.7	51.1
Romania	50.0	51.8
Russian Federation	47.0	48.6
Serbia	52.2	53.8
Slovakia	48.2	50.2
Slovenia	49.6	51.3
Spain	49.7	51.1
Sweden	51.4	52.8
Switzerland	50.6	52.0
Ukraine	50.2	52.1
United Kingdom[a]	53.0	54.4
Global	50.2	51.7

Source: Borras [22]. [a]Scotland not included. OUP: optimal utilization proportion (range of percentages with the lowest and highest proportion according to stage at diagnosis from population based cancer registries).

selected Radiation Oncology Departments. If we added this percentage to the needs estimate, as done in other analyses [23,24], it would have a remarkable impact on the need for radiotherapy in Europe. Moreover, the uptake of new technologies will most likely also increase the probability of retreatments. These variables require further research that can improve our ability to analyze the future needs for radiotherapy.

4. Indicators for assessing the need for radiotherapy should be based on national cancer incidence, taking into account the specific incidence of each tumor. This approach is feasible and will increase the credibility of the targets in terms of infrastructure and staffing recommended by national societies or cancer control plans in discussions with national health policymakers.

It is important to note that the ESTRO-HERO project has identified a shortage of data at national level in several countries [25,26]. There is a lack of data on equipment, staff and patients receiving treatment, and this is a serious drawback when comparing expected and actual demand. The continuous availability of these data at national level should be a priority for all involved in cancer planning as well as for scientific societies.

From optimal to actual use of radiotherapy: Implications for policy targets

When actual utilization of radiotherapy is compared to the optimal utilization predicted (Figure 2), data show that only one country has achieved full coverage. This is true even among countries considered to have a good level of resources and which have already undertaken a cancer planning process, such as Denmark and the Netherlands.

The disparity between actual and optimal levels of utilization raises questions regarding whether the 'gold standard' of evidence-based indications should be the basis for policy targets in radiotherapy planning, or whether more realistic goals are needed. Our perspective is that we need to set reasonable targets that help pave the way to optimal use, keeping in mind the uncertainties which might make the 'optimal' proportions of radiotherapy utilization inappropriate. Some facts that support a more prudent approach include the following:

1. As discussed above, there are differences in optimal utilization levels depending on the methodology used, with CCORE usually resulting in slightly higher proportions. This should be considered along with the uncertainties inherent to assessing evidence.
2. Patterns of care studies on radiotherapy have observed that the actual use of radiotherapy is lower than optimal in countries with good outcomes according to population-based survival. The differences could be due to several factors: variations in access to radiotherapy, especially due to geographic location and socioeconomic disparities; patient-related factors, such as comorbidity or personal preferences; physician bias (depending on the specialty or other factors, physicians may or may not

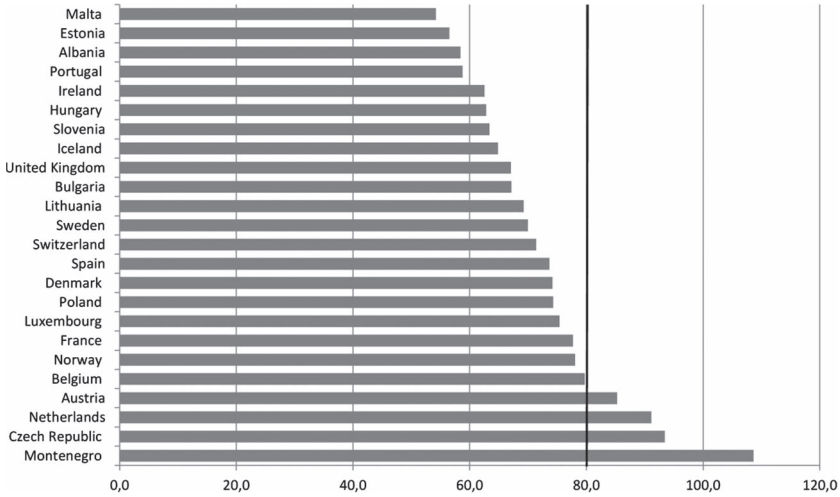

Figure 2. Comparison between actual and optimal utilization of radiotherapy by country. Source: Borras et al. [22].

adhere to the clinical indication for radiotherapy); and healthcare-related aspects, such as resource shortages and waiting lists, that could affect utilization rates or reimbursement [2,21]. An additional aspect to be mentioned here is the relevance to have more of such pattern of care studies carried out with a population-based perspective in European countries. They will be very useful in order to explain the variations observed in the ESTRO-HERO underuse of radiotherapy.

3. There is a general expectation that many healthcare treatments should report reasonable adherence levels, usually within a range of 80–110% of the targets outlined in evidence-based clinical guidelines. It has been shown, for instance, that there is an increased risk of mortality when adherence to oral endocrine therapy for breast cancer dips below this level [27]. If this approach is sensible for clinical care, could we not also apply these criteria to planning for minimum resource requirements in a cancer control plan? (Obviously, the target utilization would be for policy purposes, not for clinical treatment of individual patients.)

Accepting this kind of policy approach should not imply neglecting efforts to improve the factors that limit optimal utilization levels. Three points deserve special comment:

1. First, waiting lists are traditionally associated with resource shortages and are usually the most pertinent area in need of policy attention. Radiation oncologists should continuously monitor delays in order to assess both gaps in coverage and improvements resulting from investments in equipment. All actions to limit waiting times should be focused at a policy level; considering the experiences of different countries, only a global planning effort aimed at coping with resource shortage and accessibility problems can improve a situation that has been common in many European countries. Shortages can be overcome with a rational planning and policy prioritization, usually after waiting lists have been systematically documented and discussed [28,29]. In turn, achievable policy targets should be established to promote a realistic use of limited resources.
2. The second aspect worth mentioning is physician bias with regard to evidence-based indications for radiotherapy, usually attributable to physicians' preference for recommending what they know best when different therapeutic options are available. This tendency adds weight to cancer societies' arguments in favor of establishing multidisciplinary teams as the cornerstone organizational approach to a good quality cancer care, defined as the 'alliance of all medical and health care professionals related to a specific tumor disease whose approach to cancer care is guided by their willingness to agree on evidence-based clinical decisions and to coordinate the delivery of care at all stages of the process, encouraging patients at their turn to take an active role in their care' [30]. This statement was intended to orient health services in coping with the complex challenges of cancer care, such as multi-modal treatments, emerging areas of need (e.g. geriatric oncology), comorbidities, and patient preferences for different possible therapies. In this context, organized mechanisms for shared decision making are

increasingly important, and multidisciplinary teams stand out as a way to facilitate discussion of different therapeutic options among all the involved professionals, in turn reducing the occurrence of physician bias.

3. Finally, some 'sentinel' tumors merit special monitoring to identify gaps between actual and optimal use of radiotherapy due to the high benefit reported by this treatment. One classic example could be head and neck tumors as well as specific approaches, such as preoperative radiotherapy in rectal cancer.

All in all, a reasonable initial policy target for radiotherapy planning in the coming years would be to reach at least 80% of the optimal use (Figure 2), applied without waiting times and geographic disparities. Improvements in waiting times, indications for radiotherapy among multidisciplinary teams, and special monitoring of radiotherapy utilization in sentinel tumors could all be useful indicators to evaluate the progress made in these contexts and may provide evidence for progressively adapting the target over time.

Not only data but also a cancer plan

Experiences in different European countries suggest that in order to cope with the challenges posed by needs assessment for radiotherapy in Europe in the coming years, it will be necessary to move beyond data, through an organized cancer plan. Securing enough resources for radiotherapy is not just about money. Indeed, as shown by recent analyses exploring the association between GNI and IMRT equipment [25] and staffing [26], there is more to it than just a simple correlation between Gross National Income (GNI) and resource availability for radiotherapy. The results of a cluster analysis, aggregating the countries studied in different groups using measures of proximity, are presented in Table II considering the relation between GNI and resources. As can be observed, there is no perfect association between resource availability and economic development, hence policy matters when it comes to decisions about radiotherapy. It is necessary to set feasible policy targets in the framework of a cancer plan, taking into account all relevant factors (including long-term human resources training) in order to assess the needs and implementation of radiotherapy in a specific country. Targets for full coverage of the demand should be achievable, based on realistic assumptions and national data.

As cancer care shifts from a disease management paradigm to a patient-centered approach, the attention paid to different considerations is increasing. Multi-morbidities and patient preferences could influence therapeutic decisions, while adherence to treatments could also become a problem. Meanwhile, long-term survivorship, quality of life, adverse effects and late consequences from disease are also increasingly relevant concerns that affect patient management [31]. Within this new paradigm, radiation oncology has a role to play within the framework of a multidisciplinary team, requiring a long-term forecast for the updated equipment and trained staff needed to address the new demands of cancer care. To achieve all of these objectives, it is necessary to have a cancer plan.

Table II. Cluster analyses of the GNI, MV and IMRT from different European countries.

Cluster		IMRT (%)	GNI/n	MV units/mil inh
1	Luxembourg, Norway, Switzerland	95.3	80.7	6.6
2	Austria, Belgium, Denmark, Finland, The Netherlands, Sweden	87.3	50.8	7.6
3	France, Iceland, Ireland, Spain, UK	60.6	37.1	6.2
4	Albania, Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Lithuania, Malta, Montenegro, Poland, Portugal, Slovenia	41.8	13.4	3.4

Source: Grau et al. [26].

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