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Utilization of radiotherapy

Determining the need and utilization of radiotherapy in cancers of the breast, cervix, lung, prostate and rectum: A population level study

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ABSTRACT

Purpose: Determining the appropriate rate of radiotherapy (RT) utilization is important for health care planning and resource allocation. The difference between the observed and the appropriate RT rate is influenced by the choice of a criterion based benchmarking (CBB) or evidence-based estimates (EBEST) measure. Our primary objective was to determine the utilization of radiotherapy for cancers of the breast (B), cervix (C), lung (L), prostate (P) and rectum (R) in Alberta (AB) Canada and to compare the observed RT rates to estimates of need derived from the criterion based benchmarking (CBB) and evidence-based estimates (EBEST).

Materials and methods: All incident cases of B,C,L,P and R cancers diagnosed in AB during 2004-8 (prior to the decentralization of provincial RT capacity) were identified from the Alberta Cancer Registry. Patients receiving RT within one year (RT-1y) of diagnosis were identified and the proportion receiving RT-1y was then calculated. Factors associated with RT utilization were analysed by region. Estimates of the need for RT were derived from CBB and EBEST methods in the literature.

Results: A total of $n = 68{,}164$ cancer cases were identified from the ACR. RT-1y rates (95% C.I.) were B: 51.5% (50.1–52.9), C: 48.9% (43.8–54.0), L: 37.1% (35.4–38.8), P: 26.9% (25.1–28.7) and R: 39.3% (36.5–42.1). Observed rates of RT in AB were lower than estimates derived using the CBB and EBEST estimates. Shortfalls varied across cancer sites according to whether a CBB or EBEST estimate was used ranging from a low of -0.3% in cancer of the cervix to a high of 30.3% in rectal cancer.

Conclusions: RT shortfalls exist in the utilization of RT in AB, Canada despite centralized cancer care and a publically funded health care system. Decisions to address shortfalls need to be mindful of how model selection can impact on findings.

Radiotherapy (RT) delivered either alone or in combination with surgery or chemotherapy is an integral part of cancer management. Despite its importance in treating a variety of cancers, the proportion of patients that receive RT has been observed to vary widely, suggestive of multiple factors influencing access to RT [1]. During initial management observed RT rates have ranged from 20% to 50% [2–6]. Lower rates could represent an underuse or shortfall in RT, whereas higher rates may indicate overuse. [7] Higher utilization rates have been associated with increased urbanization and proximity to radiotherapy centres. [4,6] A number of models have been constructed for estimating the proportion of cancer patients who should receive radiotherapy thereby defining the need for RT. Epidemiological-based measures such as the Evidence-based Estimate (EBEST) and Criterion-Based Benchmarking (CBB) models have been used to estimate the appropriate level of radiotherapy utilization. EBEST methods estimate the need for RT by tabulating the indications for treatment from guidelines and then identifying the proportion of cases with such indications from available epidemiologic data. [8] CBB based methods have estimated the need for RT for various cancers based on actual rates of utilization in regions where utilization of radiotherapy was assumed to be optimal [9–10].

In a recent study of RT utilization rates from Ontario, comparisons of the actual rates of RT with estimates of what the appropriate shortfall was (Shortfall (SF) = Estimated Need for RT – Observed RT Utilization) were noted across rectal, cervical, lung and prostate cancers using an EBEST approach and also in breast cancer if a CBB methodology was utilized [10]. There are also findings from British Columbia to suggest that observed RT rates had smaller shortfalls when referenced against a CBB approach or a Canadian EBEST method [11], whereas using Australian EBEST rates described by Delaney [12] and Barton [13] was associated with larger shortfalls.

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The challenge for health care providers and planners is to determine whether their population is appropriately receiving or utilizing RT and whether observed RT rates represent an unmet medical need for RT treatment. If there is an unmet need, the health care system should be duty-bound to address any identified RT utilization shortfalls. Ensuring equitable and sufficient access to radiotherapy is an important tenant of a universal health care system. In Alberta, Canada, cancer care is centralized and government funded. Between 2004 and 2008, RT was delivered from two large urban centres in Edmonton and Calgary. The influence of Alberta's centralized cancer system on access to cancer treatment and RT utilization is unknown. Patients residing in the two main health regions were at an access to care advantage, by having easier access to treatment than patients who lived away from these centres.

In Alberta, ensuring adequate delivery of RT has become a growing challenge especially given that almost 1/3 of the population resides outside the large urban centres, that the population is rapidly increasing (25% growth between 1991 and 2012), and that there is an increasing incidence of cancer in Alberta. There were over 17,000 new cases diagnosed in 2012 [14,15]. Evidence from British Columbia, Canada suggests RT rates vary between and within urban and rural areas. Furthermore, rates for patients in urban areas are closer to published estimates of need [16]. As a consequence, there were likely shortfalls in the delivery of RT in Alberta during the period examined and efforts to overcome barriers to RT [17] or capacity expansion are required to address the unmet need for RT among cancer patients. With the opening of two new community cancer centres with radiotherapy capacity in 2009 and 2013 it is likely that some of the problems found in this study would have been addressed.

This study was undertaken with the primary objective to measure observed RT rates within one year of diagnosis in Alberta prior to the opening of the two new centres, to compare those findings to estimates derived from the EBEST and CBB methodologies for cancers of the breast (B), cervix (C), lung (L), prostate (P) and rectum (R) and to validate those model estimates.

Materials & methods

Cases of breast (B), cervix (C), lung (L), prostate (P) and rectal (R) cancers diagnosed in patients (18 years and older) between 2004 and 2008 in Alberta, Canada and the SEER programme were included for analysis.

Sources of data

Alberta

The province has a population of about 3.6 million people, with 2.4 million living in the metropolitan areas of Edmonton and Calgary [18]. Study data were obtained from the Alberta Cancer Registry (ACR); gold-certified under the North American Associations of Cancer Registries. The ACR is legally mandated to record and maintain data on all new cancer cases and cancer deaths occurring in the province, including information about the type of cancer and patient demographics. Information on all incident cases of (B), (C), (L), (P) and (R) cancers diagnosed between was obtained from the ACR. Ethics board approval was obtained from Health Research Ethics Board, Calgary, Alberta (ID: 23843).

Surveillance, epidemiology and end results regions

The Survival Epidemiology and End Results programme is a population-based cancer information system that covers a total of 13 cancer registries and 28% of the U.S. population [19]. RT treatment within this dataset was also defined as any radiotherapy treatment within one year of diagnosis, and analysis was case-based. Patients with missing dates or incomplete data were excluded from analysis but constituted less than 1% of SEER cases.

Case ascertainment

Invasive (B), (C), (L), (P) and (R) cancer cases were identified from the ACR and SEER databases using the International classification of Diseases for Oncology 3rd Edition (ICD(O)3) coding of topography and the International classification for oncology coding of morphology [20]. Patients with missing year of birth, diagnosis or treatment were excluded (Alberta $n = 3$; SEER $n = 0$). Cases of undetermined histology were also excluded. In calculating the initial radiotherapy rates, we used all confirmed cases so as not to bias the analysis.

Cancer cases of interest were identified in the ACR between 2004 and 2008 and were electronically linked to RT booking and treatment databases between 2004 and 2009. This link was made as a quality assurance check to ensure that treatment information was not inadvertently excluded. The 2004–8 time-frame was chosen as it was prior to the decentralization of RT capacity to community clinics.

Factors associated with RT

Information on demographic, pre-diagnosis ACRG3 scores – a proxy for pre-diagnosis patient comorbidity, and health services' characteristics including SES data were collected.

ACRG3 scores

Aggregated clinical risk grouping (ACRGs) scores are a reasonable surrogate for traditional measures of comorbidity such as the Charlson index. ACRGs not only categorize individuals' illnesses but also address severity of illness. They present a method of including individual patient and disease factors that would otherwise be unavailable for research at the population level. ACRGs demonstrate face and content validity. ACRGs are similar in construct to the John's Hopkins' Aggregated Diagnosis Groups (ADGs). ADGs (using ICD-9 or ICD-10 diagnosis and procedure codes to generate classification category) have been validated against the Charlson index [21,22]. ACRG3 scores were collapsed into 4 categories of increasing comorbidity: 10–19 = 1, 20–49 = 2, 50–69 = 3 and 70–99 = 4 for risk outcome analysis using CRG Software V1.11 [23]. (ADD reference here on ACRG3 scores from our paper: Radiother Oncol. 2015 Oct; 117(1):71–6. doi: 10.1016/j.radonc.2015.08.027. Epub 2015 Sep 5.)

Classification of treatment

Initial radiotherapy. SEER's definition of initial RT as given within a documented first course of treatment and considered as part of initial management was used. RT given within 1 year of diagnosis (RT-1y) was determined and grouped by cancer site. This categorization does not speak to the intent of radiotherapy nor does it capture any retreatments.

RT utilization shortfalls

Shortfall (SF) = estimated need for RT (as defined by CBB or EBEST)-observed RT utilization

Analysis

RT rates were estimated for breast, cervical, lung, rectal or prostate cancer according to sex, age, zone of residence in Alberta, year of diagnosis, stage at diagnosis, SES and ACRG score. Stage information was obtained from the ACR. Multivariate logistic regression for the associated odds of receiving radiotherapy were assessed sepa-