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Estimating the need for palliative radiotherapy for non-small cell lung cancer: A criterion-based benchmarking approach

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ABSTRACT

Background and purpose: Estimates of appropriate treatment rates are required for monitoring and improving access to cancer care. Optimal utilization rates for palliative radiotherapy (PRT) for patients with non-small cell lung cancer (NSCLC) remain undefined. We aim to estimate the appropriate PRT rate for the general NSCLC population.

Materials and methods: Ontario's population-based cancer registry identified patients with NSCLC who died of their disease between 2006 and 2010. Multivariate analysis identified factors affecting PRT use, enabling us to define a benchmark population with unimpeded access to PRT. Proportion of cases treated in the last 2 years of life (PRT_{2y}) was standardized to overall population characteristics. Benchmarks were compared to province-wide PRT_{2y} rates.

Results: Availability of RT at the diagnosing hospital was the dominant determinant of increased PRT utilization. Patients diagnosed at hospitals with on site RT were therefore designated the benchmark population. The standardized benchmark for PRT_{2y} was 56%, compared to the province-wide rate of 49%. The gap between actual and optimal rates varied across patient ages, treatment indications, and geographic regions.

Conclusions: Approximately 56% of patients who die of NSCLC in Ontario need PRT, but many are never treated.

Lung cancer is the leading cause of cancer death [1]. Despite improvements in treatment outcomes, 85% of patients ultimately die of their disease [2]. Palliative radiation therapy (PRT) for advanced non-small cell lung cancer (NSCLC) is an effective and cost-effective treatment that improves quality of life [3–14]. PRT is effective in controlling hemoptysis, cough, and dyspnea in patients with locally advanced cancer; pain in patients with bone metastases; and neurological symptoms in selected patients with brain metastases [15–20].

There is evidence that PRT use varies widely among different regions and among different hospitals within the same health system. Furthermore, PRT use may be affected by health system-related factors that are unrelated to the patient's need for treatment [18,19]. Optimizing the outcomes of advanced NSCLC requires that PRT should be available to every patient who would be expected to benefit [20]. The first step toward achieving this objective is to establish the appropriate rate of PRT use for NSCLC.

Two approaches have been used to define optimal utilization rates in cancer care [21–23]. The Epidemiological Evidence-Based (EBEST) method involves establishing the indications for RT based on systematic literature review, and then estimating the frequency of each indication in the population based on epidemiological information [22,23]. While this method may be used estimate the need for PRT in the initial management of cancer based on specific indications, it cannot be used to establish the lifetime need for PRT, because population-based registries do not usually compile the longitudinal information about the status of the patient necessary to estimate the frequency of occurrence of indications for PRT [19].

The empirical criterion-based benchmarking (CBB) method can be used to estimate optimal treatment rates where there is insufficient epidemiological data available to permit the use of EBEST [23]. The fundamental principles applied in formulating the CBB concept are derived in business, where benchmarking is defined as "measuring products against the toughest competitors" [19,24]. By analogy, benchmarks for the appropriate rate of use RT are established by measuring the rates achieved in communities that meet predetermined criteria for optimal access to RT and optimal decision-making about the use of RT [24].

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The primary objective of the present study was to establish the appropriate rate of use of PRT for NSCLC. Our secondary objective was to measure the shortfall between benchmarks and actual rates of PRT use in the population of the Canadian province of Ontario.

Materials and methods

Study context

Ontario has a universal, publically funded health care system. There is no parallel private sector. Patients make no direct payments for RT. The provincial cancer agency, Cancer Care Ontario (CCO) oversees 14 regional cancer centers, which are the only providers of RT for the 13.8 million residents in Ontario. Each RT center is integrated with a general hospital. Of the largest 58 diagnosing hospitals, 14 had RT on site, 19 had no RT but radiation outreach clinic(s) and 25 had no RT or radiation clinic [25]. All RT centers engage in outreach, with wide variation in scope, including involvement in peripheral clinics, remote audiovisual patient consultation, and multidisciplinary cancer conferences (MCCs) [25].

Routes of referral for PRT for lung cancer are diverse, predominantly through respirologists, medical oncologists, general internists, family practitioners, and thoracic surgeons [26]. There were no long waiting lists for RT during the study period [27].

Data sources and study population

The Ontario Cancer Registry (OCR) is a population-based registry that collects demographic and clinical information on >95% of cancer cases diagnosed in Ontario [28,29]. The study population included 20,663 patients with microscopically confirmed NSCLC in the OCR, who died of lung cancer between 2006 and 2010 (eSupplement Fig. 1). Hospital separation records from the Canadian Institute of Health Information, electronic RT records from Ontario's RT centers, and community level household income data from Statistics Canada [30] were linked to the OCR (eSupplement Fig. 2).

Classification of hospitals

Hospitals were classified as: hospitals with RT on site; multisite hospitals managed as a single unit with RT at one site only; and hospitals with no RT on site [23]. The diagnosing hospital was defined as the first hospital attended by the patient within 30 days of diagnosis. If the patient did not attend a hospital, the institution that reported the diagnosis to OCR was designated as the diagnosing hospital. Provincial cancer centers have catchment areas including hospitals where the majority of patients who receive RT are diagnosed.

Measures for the use of PRT

The primary outcome was the proportion of NSCLC patients who received PRT for any indication at least once in the 2 years prior to death (PRT_{2y}). Secondary measures include PRT_{2y} for thoracic disease, bone metastases, brain metastases, and other indications. We also report the total number of courses of PRT per thousand cancer deaths. A "course" of RT was defined as all fractions delivered to a specific anatomical region, without interruption of >7 days. The intent of treatment was recorded in 98.3% of RT courses. In the remainder, intent was imputed based on fraction size, total dose, and number of fractions [19]. The purpose of PRT was sub-classified based on body region irradiated [31,32].

Criterion-based benchmarking

Logistic regression was used to identify socioeconomic and health system-related barriers to PRT use, to identify a benchmark sub-population of patients with unimpeded access to RT. PRT_{2y} in the benchmark population was measured, and standardized to the distribution of patient-related factors in the general population to provide an estimate the appropriate rate [33]. Shortfalls between actual and estimated appropriate RT rates were calculated as:

% shortfall = (benchmark rate − actual rate)/benchmark rate × 100%

This quantity represents the unmet need for RT.

Results

Characteristics of the study population

In total, 20,663 patients with NSCLC died of their cancer between 2006 and 2010. This represents 16% of 127,547 cancer deaths in Ontario during this period. Table 1 (column 1) describes the characteristics of the study population. The distribution of histologies is described in eSupplement Fig. 1.

Indicators of PRT use

Patients were followed backwards from the date of death to determine whether they had received PRT. Fig. 1 illustrates how the proportion of patients identified as having received PRT increased with follow-back time: 46.7% of patients received PRT at least once in the last year of their life, and 49.0% within the last two years of life. At 20 years, the observed rate of use of PRT increased to 49.9%. Although PRT_{2y} slightly underestimates the true rate, it was chosen as our primary indicator of PRT use, because it can be measured without the need for a long historical record of RT use.

Factors associated with the use of PRT

Overall, 49% of the study population received PRT at least once in the last two years of life. Only 13.2% of these patients had previously received radical or adjuvant RT. Table 1 (column 2) describes the characteristics of the 10,117 patients who received PRT, and column 3 shows the utilization rates of PRT for different subgroups. Column 4 shows the results of the logistic regression of factors associated with PRT use. As expected, PRT rates were significantly lower in older patients and those with a very short life expectancy. However, socioeconomic and health system-related factors unrelated to patients' need for RT were also associated with PRT utilization; residents of poorer communities, those who lived farther away from the nearest RT center, and those diagnosed at a hospital with no RT on site were significantly less likely to receive PRT.

The large impact of the availability of RT at the diagnosing hospital is illustrated in Fig. 2, which shows PRT_{2y} at each of the 58 Ontario hospitals that diagnosed at least 250 cases of cancer/year. Standardized, hospital-specific rates of PRT_{2y} ranged from 25.4% to 62.0%. All hospitals with RT on site were in the top two quintiles, with rates between 53.3% and 59.9%.

Stratified analysis of factors associated with PRT use in patients diagnosed at hospitals without RT facilities and in those diagnosed at hospitals with RT facilities showed that socioeconomic status and distance from the nearest RT center were strongly associated with PRT_{2y} in patients diagnosed at hospitals without RT on site (eSupplement Table 2). In contrast, these factors had no significant impact on PRT_{2y} in patients whose cancer was diagnosed at hospitals with RT on site (eSupplement Table 2).

The benchmark population

Patients whose cancer was diagnosed at a hospital with an RT facility on site were therefore selected as the benchmark

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