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## Original Article

## Patterns of Retreatment by Radiotherapy

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## Abstract

**Aims:** To describe patterns of treatment for those who receive more than one episode of megavoltage radiotherapy (retreatment) by cancer type for better service planning and benchmarking.**Materials and methods:** Institutional databases of all patients who received their first megavoltage radiotherapy for any type of cancer at the Liverpool and Macarthur Cancer Therapy Centres (LM), New South Wales, Australia, Royal Brisbane and Women's Hospital (RBWH), Queensland, Australia and Radiotherapeutic Institution Friesland (RIF), Leeuwarden, the Netherlands, over the period 1991–2009 were examined. Radiotherapy retreatment was defined as any radiotherapy episode, to any body site, after an initial episode of radiotherapy, for the same cancer diagnosis. The total retreatment rate was defined as the number of retreatment episodes of radiotherapy divided by the number of cases in the cohort.**Results:** In total, 62 270 patients (RBWH 38581, LM 9654, RIF 14035) received 77 762 episodes of radiotherapy, giving a total retreatment rate of 0.25; 52 351 patients (84%) received only one episode of treatment and 9919 (16%) received two or more episodes of treatment. Overall retreatment rates for LM, RBWH and RIF were 0.24, 0.25 and 0.26, respectively. For the five most common cancer types treated, the median time between treatment episodes was longest for breast cancer (11.3 months), then head and neck cancer (9.7 months), colorectal cancer (7.2 months), prostate cancer (4.4 months) and lung cancer (4.1 months). Ninety-one per cent of all fractions were delivered in the first episode of treatment.**Conclusions:** The retreatment rate was very similar between the three facilities, suggesting agreement about the indications for retreatment.

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**Key words:** Radiotherapy service delivery; retreatment

## Introduction

Demand for radiotherapy capacity is determined by the number of new cases of cancer and the number of patients who require subsequent treatment courses (retreatment) in the course of their illness. Radiotherapy retreatment is defined as any radiotherapy episode, to any body site, after an initial episode of radiotherapy, for the same cancer diagnosis. The total retreatment rate is defined as the number of retreatment episodes of radiotherapy divided by the number of cases in the cohort.

Decision trees using evidence-based guidelines [1,2] and epidemiological data that document an indication for radiotherapy suggest that 52% of all newly diagnosed cases of cancer should receive radiation [2]. This estimate has been used to benchmark the adequacy of existing services and to estimate demand for radiotherapy services in Australia [3,4], Europe [5,6] and by the International Atomic Energy Agency and others [7] for the developing world. This approach has been developed further with the Malthus model, which incorporates local data on tumour type and stage distribution to model utilisation and attendances [8,9].

One limitation of utilisation models is that there is not a comparable benchmark for second and subsequent treatments. This is mainly due to a lack of basic longitudinal data about the incidence and time course of relapse events in a cancer patient's illness. Australian radiotherapy service plans [2,10–13] assume that 20–25% of patients will be

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retreated every year based on current practice [14]. However, reported retreatment rates in New South Wales, Australia in 2008 varied from 11 to 47% [15]. Two cross-sectional studies suggest that 18% of patients received multiple courses of radiotherapy [16,17].

A study of the database of all patients who received their first megavoltage radiotherapy for any type of cancer at the Liverpool and Macarthur Cancer Therapy Centres during the period 1997–2007 [18] showed that in 7853 patients, the proportion of treatment episodes that were retreatment was 26%. Another single institution study has recently reported a retreatment rate of 20% [19]. It was not known how generalisable these findings were to other departments. The aim of the present study was to examine patterns of retreatment in several large radiotherapy centres, both in Australia and internationally, as retreatment may be influenced by variation in the stage at diagnosis and treatment practices in different jurisdictions.

## Materials and Methods

### *Materials and Design*

For this study, radiotherapy retreatment was defined as any radiotherapy episode, to any body site, after an initial episode of radiotherapy, for the same cancer diagnosis. This definition was adopted in order to be able to model the demand for two or more episodes of radiotherapy from population-based data on cancer incidence.

Existing radiotherapy information databases at Liverpool and Macarthur Cancer Therapy Centres (LM), New South Wales, Australia, the Royal Brisbane and Women's Hospital (RBWH), Queensland, Australia and the Radiotherapeutic Institution Friesland (RIF), Leeuwarden, the Netherlands were examined to describe retreatment for patients treated by radiotherapy for cancer.

Although we wanted to collect more databases from various radiotherapy sites throughout the developed world, other databases that contained enough treatment data for the study end points or that covered the study period were not available.

LM currently has five linear accelerators and is the sole radiotherapy service in the southwestern region of Sydney for a population of 800 000. RBWH has five linear accelerators, providing a comprehensive radiation oncology service to southeast Queensland, which has a population of 2.8 million and is also served by three other smaller centres. RIF has five linear accelerators and covers the northern province of Friesland, covering a population of 800 000 inhabitants.

This was a retrospective analysis of the databases of patients who received their first treatment by megavoltage radiotherapy for all types of cancer over the period 1991–2009. Brachytherapy and radiosurgery were excluded because they were not routinely recorded in departmental databases. All centres were able to provide comprehensive patient, diagnosis and treatment data. Years of entry into the cohort and the duration of follow-up varied between facilities because of the availability of data. All patients

received a minimum of 2 years of follow-up. Non-melanomatous skin cancer was excluded because it may be difficult to determine the contribution of multiple primary lesions per patient. The databases contained patient demographic data, treatment dates and treatment sites. The data were originally collected for administrative and quality assurance purposes. The treatment sites were entered as free text and for this study were recoded into a limited number of sites (primary site, bone, brain, soft tissue and multiple) so that retreatment sites may be grouped for stratification and analysis. Multiple treatment sites that were part of a single treatment to a primary were recoded as 'primary'. For example, a breast treatment that covered the breast, axilla and supraclavicular fossa was recoded as 'primary' site. Records with the primary site treated after the first episode of treatment were hand-searched to determine if a second primary cancer was treated. Second primaries were recoded as primary treatments.

Multiple treatments to bone in the same episode were recoded as 'bone'. The code 'multiple sites' was only recorded when two or more of the following sites were treated in the same episode: brain, bone, soft tissue or primary. Because the database was linked to the linear accelerator record and verify system, all cases missing treatment site data were deleted as they were considered not to have been treated.

The treatment episode duration was defined as the time between the first and the last day of radiotherapy for that episode. The time between treatment episodes was defined as the time between the start of the first episode and the start of the next episode of radiotherapy because end dates of radiotherapy were not available from all three centres. If treatment start dates were within 7 days of each other, or if the previous end date was within 7 days of the start date, then the treatment episodes were counted as a single treatment episode.

The number of episodes of radiotherapy was calculated, the initial radiotherapy treatment being episode number 1. Note the distinction made in the results tables between the 'number of episodes' and the 'episode number'. The former refers to the observed number of treatment episodes; the latter refers to the time ordered sequence of treatment episodes of each patient.

Treatment intention was not available and dose, although recorded, proved difficult to analyse because it was not always easy to identify the correct doses to sum when multiple sites were treated at once, as occurs frequently for breast and head and neck tumours.

The mean number of retreatments was defined as the total number of retreatment episodes divided by the number of cases in the cohort. This will be the mean number of retreatment episodes per patient experienced over the patient-cohort's lifetimes under the assumption that no further retreatments occur after study close. The mean recurrence count (mean number of retreatment episodes per patient) initiated before the closing date of the study includes (in its denominator) patients who only received one episode of radiotherapy (with their recurrence count being 0). The mean recurrence count is a standard measure associated with cumulative incidence in recurrent event data analysis [20].

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