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Prostate cancer

Estimation of the optimal utilisation rates of radical prostatectomy, external beam radiotherapy and brachytherapy in the treatment of prostate cancer by a review of clinical practice guidelines

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ABSTRACT

Background and purpose: We aimed to construct an evidence-based model of optimal treatment utilisation for prostate cancer, incorporating all local treatment modalities: radical prostatectomy (RP), external beam radiotherapy (EBRT), and brachytherapy (BT); and then to compare this optimal model with actual practice.

Materials and methods: Evidence-based guidelines were used to construct a prostate cancer treatment decision-tree. The proportion of patients who fulfilled treatment criteria was drawn from the epidemiological literature. These data were combined to calculate the overall proportion of patients that should optimally have RP, EBRT and/or BT at least once during the course of their disease. The model was peer reviewed and tested by sensitivity analyses and compared with actual practice.

Results: Optimal utilisation rates, at some point during the disease course, were: RP, 24% (range 15–30%); EBRT, 58% (range 54–64%); BT, 9.6% (range 6.0–17.9%); and any RT, 60% (range 56–66%). Many patients had indications for more than one of these treatments, and at least one of these treatments was indicated in 76% of patients. The model was sensitive to patient preference estimates. Optimal rates were achievable in some health care jurisdictions.

Conclusions: Modelling optimal utilisation of all local treatment options for a particular cancer is possible. These optimal prostate cancer treatment rates can be used as a planning and quality assurance tool, providing an evidence-based benchmark against which can be measured patterns of practice.

In 2005, optimal utilisation rates of external beam radiotherapy (EBRT) in the treatment of prostate cancer were developed, demonstrating underutilisation of EBRT in Australia, UK, and USA but not Sweden [1]. This model is a decade old, and this and all other previous prostate EBRT models are fundamentally flawed as they were unable to access population-based data to account for stage, Gleason Score (GS) and PSA to accurately derive disease risk-groups [1–4]. These data subsequently became available from a population-based source, New South Wales Prostate Cancer Care and Outcomes Study (NSW PCCOS) [5] and are incorporated here, after D'Amico et al. [6]. Further, there have never been published estimates of optimal utilisation rates of the other major local treatment modalities for prostate cancer: radical prostatectomy (RP) and brachytherapy (BT). It is unknown if actual utilisation rates of these treatments are optimal. Indeed, there have been no publications addressing the optimal utilisation rates of surgery for any cancer site, and no attempts to combine all local treatments in the one model.

The aims of this study were to model the optimal utilisation rates of RP, EBRT, BT and combinations, in the treatment of prostate cancer, and compare with actual utilisation. The optimal utilisation rate is the proportion of prostate cancer patients, based on the best evidence, who should be treated with RP, EBRT and/or BT at least once during the course of their illness.

This manuscript is based on reports submitted to the Australian and New South Wales Health Departments assessing optimal BT and EBRT utilisation [7–9]. Results across all tumour sites have been summarised [10].

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Materials and methods

The methods previously described to determine optimal utilisation rates of EBRT in prostate cancer treatment and optimal utilisation of BT in gynaecological malignancies were applied to RP, EBRT and BT for prostate cancer. These methods have been fully detailed previously [1,9]. English-language evidence-based clinical practice guidelines published through to July 2012 were used to determine RP, EBRT and BT indications and contra-indications for the treatment of prostate cancer. The proportions of patients with a treatment indication were determined from epidemiological evidence. Sources were ranked by quality based on Delaney et al. [1]; the full hierarchy ranking quality of epidemiological data is shown in Supplementary Table 2. The epidemiological data used to quantify the treatment indications, together with the hierarchical quality of the data and comparison with that used in previous models, are tabulated in Supplementary Table 3. Treatment indications and the proportions of patients with these indications were used to construct a treatment decision-tree, using TreeAge Pro 2009. Each of the pati ent/tumour/treatment-related attributes that affected a treatment indication were represented in the decision tree by a branch. A panel of experts from across Australia formed a Court of Reviewers, for both the original models [1,7] and the current update [9]. They were invited to critique the recommendations, with the resulting comments reconciled (where possible) and incorporated into the model. The robustness of the utilisation tree and the magnitude of the potential sources of variation resulting from uncertainties in indications for treatment or in epidemiological data were modelled by one-way sensitivity analyses. The resulting model of optimal treatment utilisation was compared with actual patterns of practice drawn from the published literature and from population-based databases.

There were a number of issues in constructing a prostate cancer treatment decision tree incorporating RP, EBRT and BT. These are outlined in the Supplementary material, as are the guidelines and other references used.

Results

The combined RP/EBRT/BT optimal treatment decision tree for prostate cancer is shown in Supplementary Figs. 1–3. In total, 24% of prostate cancer patients have an indication, at least once and at some point during their disease course, for RP, 58% have an indication for EBRT (+/−BT), 9.6% for BT (+/−EBRT), 60% for any RT (EBRT without BT 50%, BT monotherapy 2.1%, combined BT/EBRT 7.5%), and 76% for any treatment, at some time during the course of their illness. Modelling only initial management and excluding subsequent treatment after initial treatment/active surveillance/watchful waiting, resulted in optimal initial treatment utilisation being: RP, 24%; EBRT, 51%; and BT 9.4%.

Sensitivity analyses were conducted (Figs. 4–6, Supplementary material) to assess the effect of uncertainties in evidence, epidemiological data and patient choice data. The resulting range in optimal utilisation was: RP, 24% (range 15–30%) (Fig. 4); EBRT, 58%, (range 54–64%) (Fig. 5); BT, 9.6% (range, 6.0–17.9%) (Fig. 6); and any RT (EBRT and/or BT), 60%, (range 56–66%). The greatest cause of uncertainty was estimates of patient preference, having tested an extreme range of up to 75% preference for any one treatment modality – it is likely that the true percentage of patients preferring a particular treatment option will be well with this range.

Actual utilisation rates in various jurisdictions, at any time during disease course, were (Table 1): RP, 13–44% (versus optimal 24%, range 15–30%); EBRT, 43–56% (versus optimal 58%, range 54–64%); and BT, 1.8–10.9% (versus optimal 9.6%, range 6.0–17.9%) [3,11–22].

Discussion

This evidence-based peer-reviewed modelling showed that for prostate cancer the optimal treatment utilisation rates were: RP, 24% (range 15–30%); EBRT, 58% (range 54–64%); BT, 9.6% (range 6.0–17.9%); and any RT, 60% (range 56–66%). At least one of these treatments was indicated in 76% of patients, meaning that approximately 1/4 of prostate cancer patients optimally would not benefit from treatment with surgery or RT at any time during the course of their disease. This is an update of our previous EBRT model [1], and is the first model incorporating the currently accepted risk groups and addressing RP and BT in prostate cancer.

This study has a number of limitations. For many of the prostate cancer treatment indications there was a paucity of high level evidence, highlighting the need for and difficulty in accumulating randomised data in this disease. Frequently, equivalent treatment options were all recommended by the published guidelines, and therefore patient choice studies were used in an attempt to assess preferences. The reasons behind the choice of preference study [23] used in this model are discussed in the Supplementary material, and uncertainty in this regard was modelled with sensitivity analyses, using extreme ranges in patient choice. The model proved highly sensitive to estimates of patient preference, but this is inescapable in the setting of equivalent treatment options. The sensitivity analyses performed showed that the magnitude of the uncertainty in the model due to patient preference estimates were far larger than uncertainty due to treatment indications/contraindications (Supplementary Figs. 4–6). Also, estimates of treatment need would vary in differing health care jurisdictions with differing prostate cancer epidemiology. Nevertheless, the similarity of our optimal EBRT estimate with those of other investigators, (Table 1), [1–4], produced by evidence-based modelling and by criterion-based benchmarking, suggests that the current model and hence the optimal estimates for RP and BT are also likely to be reasonably accurate.

The model has a number of uses. It demonstrates that it is possible to combine indications and contra-indications for all local treatments to model the optimal utilisation of all of these treatment options for a particular cancer. These benchmarks can be used to assist in planning treatment resource needs, as was the case for EBRT in Victoria [24] and Scotland [25]. Optimal prostate cancer treatment utilisation rates can be used as a quality assurance tool, providing an evidence-based benchmark against which can be measured actual patterns of practice [13,26]. In different health care jurisdictions there is a wide range in actual treatment utilisation rates, but despite this, optimal rates are achievable (Table 1). Actual RP utilisation rates were generally optimal or supra-optimal, whereas EBRT and BT rates were generally optimal or sub-optimal. Given the lack of definitive evidence for or against one or other treatment modality, and the known biases of clinicians, it may be that part of the explanation for these differences lies in differing referral pathways and clinician preferences [27]. An example may be drawn from British Columbia, in which 23% of patients had initial management with EBRT (compared with modelled optimal rate of 51%, range 47–57%). Only 15% of the 24% of patients who had RP had salvage/adjuvant EBRT, despite 47% having an indication. If all 47% of these patients had had salvage/adjuvant EBRT, actual utilisation of EBRT would have been 31%. Only 23% of these patients with an indication for salvage/adjuvant EBRT were seen by a radiation oncologist, implying problems with referral pathways as one cause of under-utilisation of EBRT [12]. One possible solution is the routine use of patient decision aids, which have been shown to reduce the influence of differing referral pathways and clinician biases on patient treatment preferences [28].