Radiotherapy and Oncology xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Original article

A prospective study comparing the predictions of doctors versus models for treatment outcome of lung cancer patients: A step toward individualized care and shared decision making ☆

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ARTICLE INFO

Article history:
Received 6 February 2014
Received in revised form 14 April 2014
Accepted 18 April 2014
Available online xxxx

Keywords:
Prediction models
Lung cancer

ABSTRACT

Background: Decision Support Systems, based on statistical prediction models, have the potential to change the way medicine is being practiced, but their application is currently hampered by the astonishing lack of impact studies. Showing the theoretical benefit of using these models could stimulate conductance of such studies. In addition, it would pave the way for developing more advanced models, based on genomics, proteomics and imaging information, to further improve the performance of the models.

Purpose: In this prospective single-center study, previously developed and validated statistical models were used to predict the two-year survival (2yrS), dyspnea (DPN), and dysphagia (DPH) outcomes for lung cancer patients treated with chemo radiation. These predictions were compared to probabilities provided by doctors and guideline-based recommendations currently used. We hypothesized that model predictions would significantly outperform predictions from doctors.

Materials and methods: Experienced radiation oncologists (ROs) predicted all outcomes at two timepoints: (1) after the first consultation of the patient, and (2) after the radiation treatment plan was made. Differences in the performances of doctors and models were assessed using Area Under the Curve (AUC) analysis.

Results: A total number of 155 patients were included. At timepoint #1 the differences in AUCs between the ROs and the models were 0.15, 0.17, and 0.20 (for 2yrS, DPN, and DPH, respectively), with *p*-values of 0.02, 0.07, and 0.03. Comparable differences at timepoint #2 were not statistically significant due to the limited number of patients. Comparison to guideline-based recommendations also favored the models.

Conclusion: The models substantially outperformed ROs' predictions and guideline-based recommendations currently used in clinical practice. Identification of risk groups on the basis of the models facilitates individualized treatment, and should be further investigated in clinical impact studies.

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Background

It is widely recognized that clinical decision making is not straightforward for most oncological treatments. Diagnostic procedures provide an increasing amount of information, and the number of treatment options for individual patients are also growing. In addition, patient preferences can differ considerably and should also be taken into account.

Decision Support Systems (DSSs) can provide clinicians and patients with patient-specific information about which patients are most likely to benefit from a given treatment and which ones are most likely to experience the harmful side effects of a treatment. Although their development and use are still in their infancy, there is an increasing interest for using DSSs in medicine and, specifically, in oncology [1]. DSSs have the potential to greatly impact patient management and clinical practice. Individualized prognos-

An abstract related to this study has been presented at the annual meeting of the European Society of Therapeutic Radiology and Oncology (ESTRO) (April, 2013).

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http://dx.doi.org/10.1016/j.radonc.2014.04.012
0167-8140/

tic information will not only stimulate shared decision making, but also facilitate adaptation of treatment, allow for more rational choices between treatment options, and stimulate innovations of clinical trial design. Figs. 1 and S1 show clinical applications in which active patient participation, treatment adaptation, and treatment choice are integrated in a decision tree and guided by predictive models. However, considering the abundant number of published predictive models and the astonishing absence of impact studies, which are required to assess changes in patient management, a study that bridges this gap is needed [2]. Therefore, we decided to investigate whether patient-specific prognostic information obtained from predictive models has added value as compared to information provided by the treating doctor or guideline-based recommendations.

We previously developed and validated models to predict three important outcomes for lung cancer patients: overall survival, dyspnea and dysphagia [3–5]. In general, predictions based on statistical rules or models are at least as reliable as, and typically more reliable than, the predictions of human experts if based on the same information [6]. Indeed, studies focusing on survival prediction of terminally ill cancer patients have shown that predictions of doctors tend to be too optimistic, unreproducible, and inaccurate [7–12]. For lung cancer patients, this information is not yet available. Also, the most widely used system to stratify lung cancer patients into risk categories, the TNM staging system, has limitations when used for lung cancer patients treated with chemoradiation [13]. Finally, studies investigating doctors' predictions of severe treatment-induced side-effects in lung cancer patients are currently lacking.

The purpose of this prospective study was, thus, to compare predictions for two-year death rate (2yrD), severe acute treatment-induced dysphagia and severe acute treatment-induced dyspnea of lung cancer patients, based on statistical models, to (A) predictions made by the radiation oncologists (ROs) after they had seen the patient, and (B) guideline-based recommendations. The models were previously developed and externally validated [3–5,14]. We hypothesized that these models would significantly outperform the prediction made by ROs.

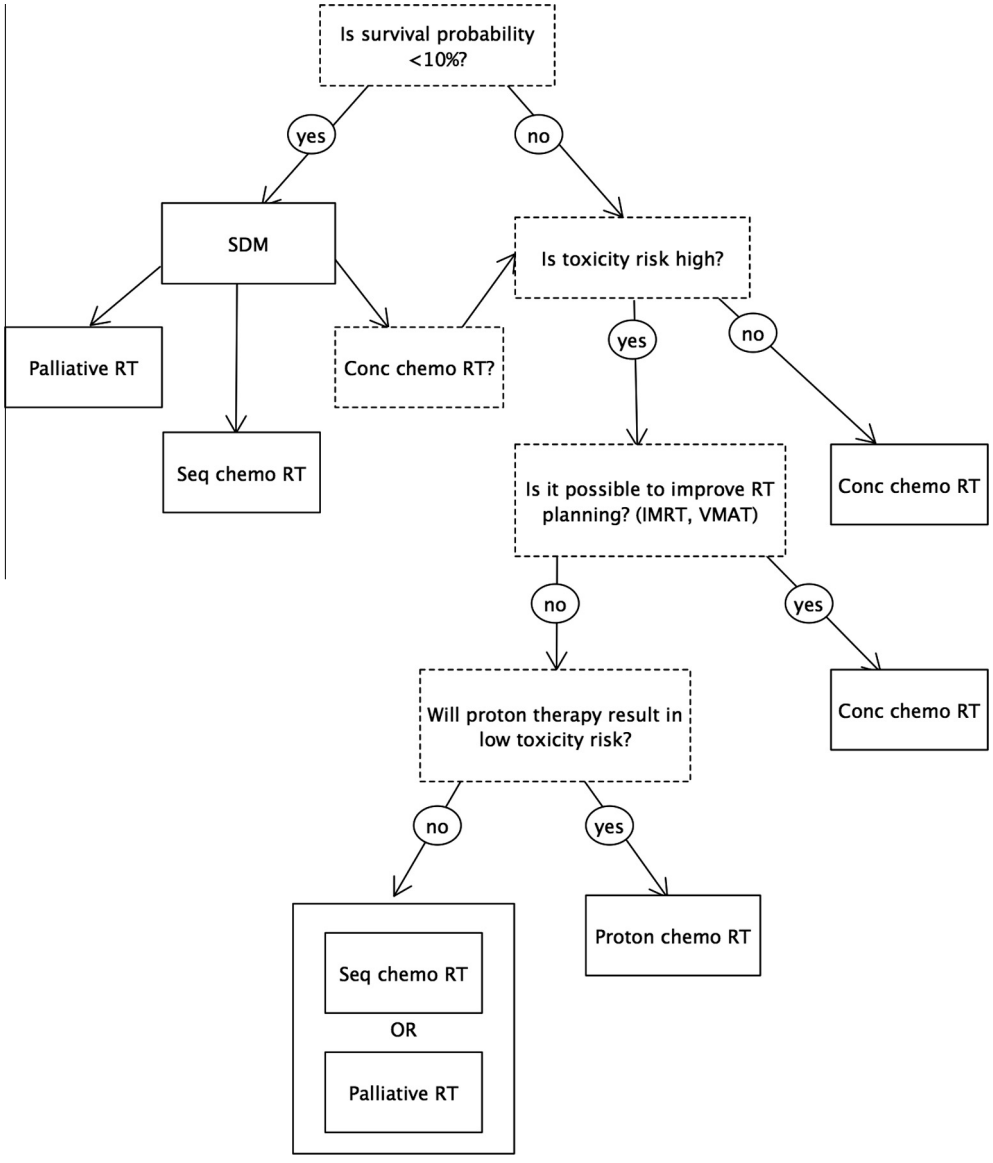

Fig. 1. Clinical application of a Decision Support System for stage III NSCLC patients. Shared decision making (SDM), adaptation of treatment (improved radiotherapy planning) and choice of treatment options (either concomitant or sequential chemo radiotherapy and palliative radiotherapy) are integrated in a decision tree based on previously developed and validated prognostic models.

Please cite this article in press as: Oberije C et al. A prospective study comparing the predictions of doctors versus models for treatment outcome of lung cancer patients: A step toward individualized care and shared decision making. Radiother Oncol (2014), http://dx.doi.org/10.1016/j.radonc.2014.04.012