# Mathematical models out-perform doctors in predicting cancer patients' responses to treatment

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Mathematical prediction models are better than doctors at predicting the outcomes and responses of lung cancer patients to treatment, according to new research presented today (Saturday) at the 2nd Forum of the European Society for Radiotherapy and Oncology (ESTRO).

These differences apply even after the doctor has seen the patient, which can provide extra information, and knows what the treatment plan and radiation dose will be.

"The number of treatment options available for lung cancer patients are increasing, as well as the amount of information available to the individual patient. It is evident that this will complicate the task of the doctor in the future," said the presenter, Dr Cary Oberije, a postdoctoral researcher at the MAASTRO Clinic, Maastricht University Medical Center, Maastricht, The Netherlands. "If models based on patient, tumour and treatment characteristics already out-perform the doctors, then it is unethical to make treatment decisions based solely on the doctors' opinions. We believe models should be implemented in clinical practice to guide decisions."

Dr Oberije and her colleagues in The Netherlands used mathematical prediction models that had already been tested and published. The models use information from previous patients to create a statistical formula that can be used to predict the probability of outcome and

responses to treatment using radiotherapy with or without chemotherapy for future patients.

Having obtained predictions from the mathematical models, the researchers asked experienced radiation oncologists to predict the likelihood of lung cancer patients surviving for two years, or suffering from shortness of breath (dyspnea) and difficulty swallowing (dysphagia) at two points in time: 1) after they had seen the patient for the first time, and 2) after the treatment plan was made. At the first time point, the doctors predicted two-year survival for 121 patients, dyspnea for 139 and dysphagia for 146 patients. At the second time point, predictions were only available for 35, 39 and 41 patients respectively.

For all three predictions and at both time points, the mathematical models substantially outperformed the doctors' predictions, with the doctors' predictions being little better than those expected by chance.

The researchers plotted the results on a special graph on which the area below the plotted line is used for measuring the accuracy of predictions; 1 represents a perfect prediction, while 0.5 represents predictions that were right in 50% of cases, i.e. the same as chance. They found that the model predictions at the first time point were 0.71 for two-year survival, 0.76 for dyspnea and 0.72 for dysphagia. In contrast, the doctors' predictions were 0.56, 0.59 and 0.52 respectively.

The models had a better positive predictive value (PPV) – a measure of the proportion of patients who were correctly assessed as being at risk of dying within two years or suffering from dyspnea and dysphagia – than the doctors. The negative predictive value (NPV) – a measure of the proportion of patients that would not die within two years or suffer from dyspnea and dysphagia – was comparable between the models and the doctors.

"This indicates that the models were better at identifying high risk patients that have a very low chance of surviving or a very high chance of developing severe dyspnea or dysphagia," said Dr Oberije.

The researchers say that it is important that further research is carried out into how prediction models can be integrated into standard clinical care. In addition, further improvement of the models by incorporating all the latest advances in areas such as genetics, imaging and other factors, is important. This will make it possible to tailor treatment to the individual patient's biological make-up and tumour type

"In our opinion, individualised treatment can only succeed if prediction models are used in clinical practice. We have shown that current models already outperform doctors. Therefore, this study can be used as a strong argument in favour of using prediction models and changing current clinical practice," said Dr Oberije.

"Correct prediction of outcomes is important for several reasons," she continued. "First, it offers the possibility to discuss treatment options with patients. If survival chances are very low, some patients might opt for a less aggressive treatment with fewer side-effects and better quality of life. Second, it could be used to assess which patients are eligible for a specific clinical trial. Third, correct predictions make it possible to improve and optimise the treatment. Currently, treatment guidelines are applied to the whole lung cancer population, but we know that some patients are cured while others are not and some patients suffer from severe side-effects while others don't. We know that there are many factors that play a role in the prognosis of patients and prediction models can combine them all."

At present, prediction models are not used as widely as they could be by doctors. Dr Oberije says there are a number of reasons: some models lack clinical credibility; others have not yet been tested; the models need

to be available and easy to use by doctors; and many doctors still think that seeing a patient gives them information that cannot be captured in a model. "Our study shows that it is very unlikely that a doctor can outperform a model," she concluded.

President of ESTRO, Professor Vincenzo Valentini, a radiation oncologist at the Policlinico Universitario A. Gemelli, Rome, Italy, commented: "The booming growth of biological, imaging and clinical information will challenge the decision capacity of every oncologist. The understanding of the knowledge management sciences is becoming a priority for radiation oncologists in order for them to tailor their choices to cure and care for individual patients."

**More information:** Abstract no: OC-0140, "Clinical 2 – Lung and Head & Neck cancer" session at 16.45 hrs (CEST) on Saturday 20 April, Auditorium.

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