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Artificial intelligence predicts radiation therapy side effects for patients with head and neck cancers

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For the first time, a sophisticated computer model has been shown to accurately predict two of the most challenging side effects associated with radiation therapy for head and neck cancer. This precision oncology approach has the potential to better identify patients who might benefit from early interventions that may help to prevent significant weight loss after treatment or reduce the need for feeding tube placement. Findings were presented at the 61st Annual Meeting of the American Society for Radiation Oncology (ASTRO).

"In the past, it has been hard to predict which patients might experience these side effects," said Jay Reddy, MD, Ph.D., an assistant professor of radiation oncology at The University of Texas MD Anderson Cancer Center and lead author on the study. "Now we have a reliable machine learning model, using a high volume of internal institutional data, that allows us to do so."

Machine learning is a branch of artificial intelligence that uses statistical models to analyze large quantities of data, uncovering patterns that can predict outcomes with a high degree of accuracy. Used by the tech industry to allow speech and facial recognition, "spam" filtering and targeted advertising, machine learning has been an emerging topic of interest for medical researchers seeking to translate large amounts of data into knowledge that can support clinical decision making.

Dr. Reddy and his team developed models to analyze large sets of data merged from three sources: electronic health records (Epic), an internal web-based charting tool (Brocade) and the record/verify system (Mosaiq). The data included more than 700 clinical and treatment variables for patients with head and neck cancer (75% male/25% female, with a median age of 62 years) who received more than 2,000 courses of radiation therapy (median dose 60 Gy) across five practice sites at MD Anderson from 2016 to 2018.

Researchers used the models to predict three endpoints: significant weight loss, feeding tube placement and unplanned hospitalizations. Results from the best-performing model were then validated against 225 subsequent consecutive radiation therapy treatments. Models with a performance rate that met a pre-specified threshold of area under the curve (AUC) of 0.70 or higher were considered clinically valid. (An AUC score of 1.0 would mean the model's predictions were 100% accurate, while a score of 0.0 would mean the predictions were never accurate.)

Approximately 53,000 people are diagnosed with head and neck (oral cavity or oropharyngeal) cancers each year in the United States. These cancers are more than twice as common in men as in women, and typically diagnosed later in life (with an average age of diagnosis of 62 years). Head and neck cancers, when diagnosed early, are typically treated with radiation therapy or surgery. Later-stage cancers are treated with a combination of radiation therapy and chemotherapy. A patient may also be treated first with surgery, followed by radiation therapy alone or by a combination of radiation and chemotherapy.

Radiation therapy is effective at treating head and neck cancer by slowing or stopping the growth of new cancer cells. However, it may also damage oral tissue and upset the balance of bacteria in the mouth, causing adverse side effects such as a sore throat, mouth sores, loss of taste and dry mouth. When sore throats are severe, they can make it difficult for the patient to eat and may lead to weight loss or require the temporary insertion of a feeding tube. Nearly all patients with head and neck cancer experience some negative effects of treatment.

"Being able to identify which patients are at greatest risk would allow radiation oncologists to take steps to prevent or mitigate these possible side effects," said Dr. Reddy. "If the patient has an intermediate risk, and they might get through treatment without needing a feeding tube, we could take precautions such as setting them up with a nutritionist and providing them with nutritional supplements. If we know their risk for feeding tube placement is extremely high—a better than 50% chance they would need one—we could place it ahead of time so they wouldn't have to be admitted to the hospital after treatment. We'd know to keep a closer eye on that patient."

The models predicted the likelihood of significant weight loss (AUC = 0.751) and need for feeding tube placement (AUC = 0.755) with a high degree of accuracy.

"The models used in this study were consistently good at predicting those two outcomes," said Dr. Reddy. "You could rerun those models with a new patient or series of patients and get a number saying this adverse effect is likely to happen or not to happen."

For example, said Dr. Reddy, using their model, clinicians could potentially plug in information related to a specific patient—such as age, gender, type of cancer and other distinct variables—and the model might tell them, "Eighty percent of people like you with this clinical profile get through treatment without a feeding tube. It may not be perfect, but it's better than having no understanding at all."

The model fell short of predicting unplanned hospitalizations with sufficient clinical validity (AUC = 0.64). Redoing the analyses with more "training" data for unplanned hospitalizations could improve accuracy in predicting this side effect as well, said Dr. Reddy. "As we treat more and more patients, the sample size gets bigger, so every data point should get better. It's possible we just didn't have enough information accumulated for this aspect of the model."

While the machine learning approach can't isolate the single-most predictive factor or combination of factors that lead to negative side effects, it can provide patients and their clinicians with a better understanding of what to expect during the course of treatment, said Dr. Reddy. In addition to predicting the likelihood of side effects, machine learning models could potentially predict which treatment plans would be most effective for different types of patients and allow for more personalized approaches to radiation oncology, he explained.

"Machine learning can make doctors more efficient and treatment safer by reducing the risk of error," said Dr. Reddy. "It has the potential for influencing all aspects of radiation oncology today—anything where a computer can look at data and recognize a pattern."

The abstract, "Applying a machine learning approach to predict acute radiation toxicities for head and neck cancer patients," will be presented in detail at ASTRO's 61st Annual Meeting in Chicago.

Provided by American Society for Radiation Oncology

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