

# Machine learning-triggered reminders improve end-of-life care for patients with cancer

January 12 2023

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Electronic nudges delivered to health care clinicians based on a machine learning algorithm that predicts mortality risk quadrupled rates of

conversations with patients about their end-of-life care preferences, according to the long-term results of a randomized clinical trial published by Penn Medicine investigators in *JAMA Oncology* today. The study also found that the machine learning-triggered reminders significantly decreased use of aggressive chemotherapy and other systemic therapies at end of life, which research shows is associated with poor quality of life and side effects that can lead to unnecessary hospitalizations in their final days.

For patients when cancer advances to an incurable stage, some may prioritize treatment that will extend their life as long as possible, and others may prefer a care plan that's designed to minimize pain or nausea, depending on the outlook for their disease. Talking to patients about their prognosis and values can help clinicians develop care plans that are better aligned to each individual's goals, but it's essential that the discussions happen before patients become too ill.

"This study demonstrates that we can use informatics to improve care at [end of life](#)," said senior author Ravi B. Parikh, MD, an oncologist and assistant professor of Medical Ethics and Health Policy and Medicine in the Perelman School of Medicine at the University of Pennsylvania and associate director of the Penn Center for Cancer Care Innovation at Abramson Cancer Center. "Communicating with [cancer patients](#) about their goals and wishes is a key part of care and can reduce unnecessary or unwanted treatment at the end of life. The problem is that we don't do it enough, and it can be hard to identify when it's time to have that [conversation](#) with a given patient."

Parikh and colleagues [previously demonstrated](#) a machine learning algorithm could identify patients with cancer who are at high risk for death within the next six months. They paired the algorithm with behavioral-based "nudges" in the form of emails and text messages to prompt clinicians to initiate serious illness conversations during

appointments with high-risk patients. The [preliminary results](#) of the study, published in 2020, showed that the 16-week intervention tripled the rates of these conversations.

The study represents an important step for [artificial intelligence](#) in oncology, as the first randomized trial of a machine learning-based behavioral intervention in [cancer care](#). The study included 20,506 patients treated for cancer at several Penn Medicine locations, with a total of more than 40,000 patient encounters, making it the largest study of a machine learning-based intervention focused on serious illness care in oncology.

The findings published today showed that after a 24-week follow-up period, conversation rates nearly quadrupled, from 3.4 percent to 13.5 percent, among high-risk patients. The use of chemotherapy or targeted therapy in the final two weeks of life decreased from 10.4 percent to 7.5 percent among patients who died during the study. The intervention did not have an impact on other end-of-life metrics, including hospice enrollment or length of stay, inpatient death, or end-of-life intensive care unit use.

Notably, the increase in conversations about goals of care also was observed in patients who weren't flagged by the algorithm as high-risk, suggesting the nudges caused clinicians to change their behavior across their practice. The increase was observed in all patient demographics, but was larger among Medicare beneficiaries, which suggests that the intervention may help rectify a disparity in conversations about serious illness.

Building on the results of this study, the research team expanded the same approach to all oncology practices within the University of Pennsylvania Health System and are currently analyzing those results. Additional plans for the research include pairing AI algorithms with a

prompt for early palliative care referral and using the algorithm for patient education.

"While we significantly increased the number of dialogues about serious illness taking place between patients and their clinicians, still less than half of patients had a conversation," Parikh said. "We need to do better because we know [patients](#) benefit when their health care clinicians understand each patient's individual goals and priorities for care."

**More information:** Long-term Effect of Machine Learning–Triggered Behavioral Nudges on Serious Illness Conversations and End-of-Life Outcomes Among Patients With Cancer, *JAMA Oncology* (2023). [DOI: 10.1001/jamaoncol.2022.6303](https://doi.org/10.1001/jamaoncol.2022.6303)

Provided by Perelman School of Medicine at the University of Pennsylvania

Citation: Machine learning-triggered reminders improve end-of-life care for patients with cancer (2023, January 12) retrieved 28 March 2023 from <https://medicalxpress.com/news/2023-01-machine-learning-triggered-end-of-life-patients-cancer.html>

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