How long will patient live? Deep Learning takes on predictions

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End of life care might be improved with Deep Learning. An AI program in a successful pilot study predicted how long people will live.

George Dvorsky in *Gizmodo* and others reported on their work.

The Stanford University team is using an algorithm to predict mortality, and their goal is to improve timing of [end-of-life care](#) for [critically ill patients](#). While 80 percent of Americans prefer to spend their final days in their home, only 20 percent do just that.

An acute-care hospital is more likely to be the setting; more than 60 percent of the final-days deaths in the US happen there. not at home, with [patients](#) getting aggressive care.

(For better End-of-Life Care, though, as a Stanford research scientist put it, "families get a chance to talk about what they want to happen before they become critically ill and they end up in the ICU.")

The team described their [work](#) in their paper, "Improving Palliative Care with Deep Learning," which is up arXiv. The paper was submitted in November. The authors are Anand Avati, Kenneth Jung, Stephanie Harman, Lance Downing, Andrew Ng and Nigam Shah. Authors' Stanford affiliations ranged from Department of Computer Science, the Center for Biomedical Informatics Research, Department of Medicine and Stanford University School of Medicine.

The algorithm was not developed to replace doctors but rather to provide a tool to improve the accuracy of prognoses. As Jeremy Hsu, *IEEE Spectrum*, wrote, "as a benign [opportunity](#) to help prompt physicians and patients to have necessary end-of-life conversations earlier."

One can think of it as a triage tool for improving access to palliative care, one of the authors, Stephanie Harman, clinical associate professor of medicine at Stanford University and a co-author of the new study, told *Gizmodo*.

Gizmodo clarified what palliative care means. "Typically, when a patient is not likely to [live](link) beyond a year, their treatment is moved to a palliative care team, who try to make the patient's last days or months as free from suffering as possible. To that end, they work to manage a patient's pain, nausea, loss of appetite and confusion, provide psychological and moral support, while respecting the social, cultural, and spiritual needs of the patient and their family."

Palliative timing in and of itself may present problems. if admitted too early, it places an unnecessary strain on the healthcare system, said Dvorsky, and if too late, the patient misses out on this stage of care.

Then what is wrong with humans' predictions of mortality? Short answer, prediction-making is hard. Complex factors for doctors to assess range from family history to response to drugs to the nature of the affliction.

Dvorsky in *Gizmodo* said, "Sometimes doctors are spot on, but other times they can be off by several months (if not years), both in terms of predicting death too late or too early."

The researchers made use of Deep Learning. Hsu described Deep Learning as the technique that uses neural networks "to filter and learn from huge amounts of data."

The network trained on electronic health record (EHR) data from previous years. "Our model is an [18-layer](link) Deep Neural Network that inputs the EHR data of a patient, and outputs the probability of death in the next 3-12 months."

(They trained the model on data from the Stanford Hospital EHR database; this has data of over 2 million patients.)

Reports said the algorithm performed quite well. Dvorsky noted however what AI developers call the "black box" problem—when a machine comes up with an answer or solution to a problem, but without an obvious method of how it got there.

Hsu, meanwhile, said that "Fortunately, the reasoning behind the deep learning model's mortality predictions does not particularly matter in this case. The palliative care team is primarily concerned with accurately identifying patients who could benefit from their attention, as opposed to needing to know exactly why the algorithm predicts a given patient might die within a year."

 More information: Improving Palliative Care with Deep Learning, arXiv:1711.06402 [cs.CY] arxiv.org/abs/1711.06402

Abstract

Improving the quality of end-of-life care for hospitalized patients is a priority for healthcare organizations. Studies have shown that physicians tend to over-estimate prognoses, which in combination with treatment inertia results in a mismatch between patients wishes and actual care at the end of life. We describe a method to address this problem using Deep Learning and Electronic Health Record (EHR) data, which is currently being piloted, with Institutional Review Board approval, at an academic medical center. The EHR data of admitted patients are automatically evaluated by an algorithm, which brings patients who are likely to benefit from palliative care services to the attention of the Palliative Care team. The algorithm is a Deep Neural Network trained on the EHR data from previous years, to predict all-cause 3-12 month mortality of patients as a proxy for patients that could benefit from palliative care. Our predictions enable the Palliative Care team to take a proactive approach in reaching out to such patients, rather than relying on referrals from treating physicians, or conduct time consuming chart reviews of all patients. We also present a novel interpretation technique

which we use to provide explanations of the model's predictions.

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