

# Researchers use AI to analyze patient satisfaction

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Patient satisfaction can determine the probability of a patient to come back for further care, the likelihood of following discharge instructions, and overall health conditions, but artificial intelligence (AI) might be

able to improve satisfaction and health outcomes, according to a Penn State research team.

In collaboration with Geisinger, the researchers applied AI to machine learning algorithms to generate useful recommendations based on historical [health](#) care data documenting why patients leave a [hospital](#) feeling satisfied or dissatisfied. The study was published in the Institute of Electrical and Electronics Engineers' Journal of Biomedical and Health Informatics.

The team included lead author Ning Liu, a fall 2019 Penn State doctoral recipient in [industrial engineering](#) and current data scientist at Microsoft; Soundar Kumara, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering and Liu's doctoral adviser; and Eric S. Reich, director of business intelligence and advanced analytics in Geisinger's Steele Institute for Health Innovation. Reich is also a Penn State alumnus, who earned his bachelor of science in economics from the Smeal College of Business in 2002 and graduated as a Schreyer Honors Scholar.

"Patient health care is like a journey," Liu said. "They need to interact with multiple health professionals across different service units throughout the entire length of stay. It's important for providers to understand the needs of each patient group, like those receiving surgery, cancer treatments or emergency visits. We wanted to know what is most important for each group, and how do we interpret that from the data we receive?"

The anonymous [patient satisfaction](#) dataset used in the study was collected between 2009 and 2016. The dataset contained electronic health records data, covering various perspectives of hospital services and clinical information, as well as the results of a patient satisfaction survey that asked questions regarding hospital care and services and how

satisfied they felt after the care. The machine learning framework the researchers implemented translated the raw data into information that could be interpreted by AI and communicated as useful, actionable items to human users.

Results showed that variables related to the courtesy and respect of nurses and doctors and the communication between health professionals and patients significantly impacted patients' overall hospital experiences. According to the researchers, promptness and helpfulness in addressing patients' concerns or complaints was the most important component in patient-centered communication and was highly associated with improved patient satisfaction. Pain management quality was also critical to satisfaction: Patients receiving proactive and effective care for their pain tended to be more satisfied in general.

"A key performance indicator for hospitals is patient satisfaction," Kumara said. "So, the question becomes, 'how do we analyze and explain why patients rate a hospital the way that they do?'" In the context of hospitals, interpretability of data becomes critical. The major impact of the work lies in the AI models we have developed for interpreting the machine learning methodologies results. This work is among the first in this space."

Liu explained that many machine learning systems provide results without an explanation as to how they deduced their answers. For this study, the proposed method provided an interpretation of the data and model results, enabling others to better understand and trust the results they were given.

According to the researchers, the high interpretability of the proposed model potentially makes it valuable for various industries, not just health care.

"If you apply for a credit card and get denied, that credit card company has to tell you why," Liu. "For our model, it has to tell us how it got its answer. This makes it easier for others to understand the data, making it a powerful tool for hospitals and health care systems at large. This helps them implement change to improve patient satisfaction across various levels, from the top down to the individual unit workers."

Reich said that patient satisfaction has been shown to be strongly associated with greater compliance and increased treatment adherence, leading to improved [health outcomes](#). He noted that by encouraging patients to engage in their care and provide feedback via patient surveys, hospitals will be able to improve the care they provide.

"I think this work encourages future research in the world of patient satisfaction combined with advanced analytics," Reich said. "Health care systems can use these findings to drive targeted improvements in patient satisfaction to the point where we know if patients with a certain set of characteristics are getting their knee replaced, then we believe these are the top three items that are going to ensure the patient has a very positive experience. To discover the key drivers behind patient [satisfaction](#) is a critical initiator for improving the quality of patient-centered health care."

**More information:** Ning Liu et al, Gaining Insights into Patient Satisfaction Through Interpretable Machine Learning, *IEEE Journal of Biomedical and Health Informatics* (2020). [DOI: 10.1109/JBHI.2020.3038194](#)

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