

Natural Language Processing

An OSF Innovation Case Study

THE OPPORTUNITY

Based on nationwide guidelines, there are specific medications that should be used to treat patients suffering from heart failure with a reduced ejection fraction (EF), causing symptoms of fatigue, shortness of breath and swelling. However, EF values, measured in percentages, are typically buried in doctors' notes and test results, making it difficult for other physicians to easily obtain the information they need to treat their patients with the correct medications.

THE SOLUTION

OSF HealthCare developed the Heart Failure Council to use innovative methods to reduce mortality and re-hospitalization among this population. Working with the Advanced Analytics team, a part of OSF Innovation, a Natural Language Processing (NLP) model was developed to intuitively read and pull all EF numbers for heart failure patients into the electronic medical record (EMR) system, giving clinicians an easily accessible historical view of a patient's heart health.

THE IMPACT

There were initially 56,000 ejection fractions as whole numbers in the EMR. These were from echocardiograms (echoes) previously performed at OSF, dating back to 2014. After the NLP program was initiated, an additional 152,000 EF values were mined, giving clinicians the ability to assign a reduced, borderline or preserved phenotype to twice as many patients in the heart failure registry. It also identified 2,500 additional people with low EF values who were not included in the registry since they had no diagnosis of heart failure. As a result, clinicians have been able to easily pinpoint heart failure patients with historically low EF values and ensure those individuals receive the medications they need.



OSF HEALTHCARE

OSF HealthCare, headquartered in Peoria, is owned and operated by The Sisters of the Third Order of St. Francis, and consists of nearly 21,000 employees in 126 locations, including 13 hospitals, 11 Centers for Health and 15 OSF PromptCares throughout Illinois and Michigan. More at osfhealthcare.org.

OSF INNOVATION

Launched in 2016, OSF Innovation is the overall umbrella initiative for the planning, structure, goals and services OSF HealthCare uses to innovate for the improvement and transformation of health care.

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EASILY TRACKING EF VALUES

OSF HealthCare developed the Heart Failure Council to focus on reducing mortality and hospital readmission rates among heart failure patients. With that came the need to develop a better way to identify individuals suffering from heart failure with a reduced ejection fraction (EF).

A low EF indicates a patient's heart isn't pumping out enough blood to the rest of the body, causing fatigue, shortness of breath or swelling. Nationwide guidelines recommend patients with a history of any EF at or below 40% should be prescribed certain medications to help their hearts function better. However, finding an individual's EF metric is difficult, as it's typically buried in doctors' notes and test results.

The Council worked with Advanced Analytics, a part of OSF Innovation, to develop a Natural Language Processing (NLP) model that intuitively reads and pulls all EF numbers for heart failure patients into the electronic medical record (EMR) system.

BUILDING AN NLP PROGRAM

Physicians historically document the EF of heart failure patients in written notes and tests from echocardiograms (echoes) that are saved in a large database. The problem is the information is mixed in with a lot of other internal and external data, so there was no easy way to determine if a patient had been diagnosed with reduced EF in the past.

"Unfortunately, when a patient's EF is found to be in the normal range, physicians don't continue treating them with the medications that stabilized that individual's heart," said Dr. Parker McRae, a change agent for Cardiovascular Quality Improvement at OSF HealthCare. "Having an easily displayed historical view of a patient's EF will help clinicians make better decisions on treatment."

Working with Dr. McRae, Advanced Analytics developed an NLP model that was trained on a sample of more than 1,000 hand-annotated echo notes. It also uses a machine learning technique known as "named entity recognition" designed as a convolutional neural network to find EF scores. Those values are then extracted according to rules defined by Dr. McRae and stored in the clinical databases of OSF HealthCare.

To validate model performance, Dr. McRae dove into a sample of 500 echoes and manually separated EF scores from the text. The trained NLP model was then applied to the same 500 notes that Dr. McRae abstracted. The model exactly matched Dr. McRae about 97% of the time and the identification of an EF at or less than 40% matched 99.7% of the time.

"The NLP model is essentially an automated and highly accurate replica of Dr. McRae's decision-making capabilities for the specific task of abstracting EF scores from echo notes," said Jason Weinberg, a data scientist with the Advanced Analytics team.

VALUE AND IMPACT

There were initially 56,000 ejection fractions as whole numbers in the EMR. These were from echoes previously performed at OSF, dating back to 2014.

After the NLP program was initiated, an additional 152,000 EF values were mined from all the way back to 2007, giving clinicians the ability to assign a reduced, borderline or preserved phenotype to twice as many patients in the heart failure registry.

It also identified 2,500 additional people with low EF values who were not included in the registry since they had no diagnosis of heart failure.

As a result, 11 OSF facilities charged with identifying heart failure patients with low EF scores have seen the use of guided direction medication treatment (GDMT) increase by nearly 100% for two primary heart failure medications. There's been a nearly 600% upturn in clinicians prescribing all three GDMT medication classes in combination. This is expected to improve the outcomes of these patients.

"A doctor can now pull up a patient's medical chart and see within the Results Review tab that their EF was measured seven times over their life. The provider then has a longitudinal view of the patient's heart health and can make an informed decision on medication prescriptions."

—DR. PARKER MCRAE, CHANGE AGENT, CARDIOVASCULAR QUALITY IMPROVEMENT, OSF HEALTHCARE

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