Cleveland Clinic Innovations

Predicting Hypertension Control Using Machine Learning

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PRODUCT

System for effective management of hypertensive patient medication and dosage.

INDICATION

Clinical decision support for chronic disease management

VALUE PROPOSITIONS

Identify patients with a higher probability of control within twelve (12) months of treatment

Accelerate control by offering tailored medication(s) and dose(s)

Exceed established measures of cost-effectiveness

PUBLICATION

Mroz, T., Griffin, M., Cartabuke, R., Laffin, L., Russo-Alvarez, G., Thomas, G., Smedira, N., Meese, T., Shost, M. and Habboub, G., 2024. Predicting hypertension control using machine learning. Plos one, 19(3), p.e0299932.

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PROBLEM/OPPORTUNITY

Hypertension is a global killer. The condition defined as blood pressure (BP, mmHg) >= 130 systolic or >= 80 diastolic, affects nearly 1.3 billion people worldwide. Nearly 700 million are uncontrolled. According to the CDC, nearly 116 million adults in the US have hypertension of which ~58% are uncontrolled. This result of rampant uncontrolled BP is over nearly 500,000 deaths per year at a cost of ~$130 billion annually.

Therapeutic inertia is one of the leading causes of uncontrolled hypertension. This is a failure to either initiate or intensify therapy to reach therapeutic goals associated with control. At its core, inertia is influenced by the wrong medication, the wrong dose, poor education, and poor adherence. Each of these have a compounding effect that lowers the probability of achieving control.

SOLUTION/PRODUCT

The multidisciplinary team developed advanced models that predict the probability that a patient will be controlled and suggest medications and doses that would have the most immediate impact on timely control.

Before building the application, clinicians in Primary Care, Pharmacy Care, Nephrology, and Hypertension and Cardiovascular Specialty Clinics were observed. This yielded a process that is easy and provides usable information in the clinical workflow. For enrolled clinicians from these practices, the system captures patients meeting specific criteria who are also scheduled for an encounter. Data for these patients is pre-processed. When the patient arrives at the encounter, new vitals will be committed to the application which in turn will run an inference model. The results are presented to the provider through a web-based call from EPIC to the application, all of which is quick and seamless for the provider.

The platform has been developed, and data from patients was used to build and validate predictive models. There are 793 variables categorized as vital signs, medications, comorbidities, laboratory results, left ventricular ejection fraction, body mass index (BMI), and outpatient clinical encounters. This categorical data was temporally organized to create a dynamic dataset. The dataset included information for over 350,000 patients and over 10 million outpatient encounters between 2015 and 2022. The resulting area under the curve was 0.756. Analyzing over 240,000 patients suggested that ~20% could be controlled. Using published data on economic costs and life years, the impact would $98.6M in saved costs and over 13,000 life years gained. The current minimally viable product employs a modern data and machine learning operations architecture built in Azure and Databricks. Data from 2020 to 2023 was populated in the solution and adjustment were made to increase [SENSITIVITY] resulting in an AUC 0.070. A randomized controlled trial is targeted for 2025.