



cogitativo



Advanced Machine Learning Solution to Reduce Chronic Disease Burden

Chronic disease is the leading cause of death and disability in the United States, where nearly half population suffers from chronic illness.^{1,2} When a chronic disease is not effectively managed, other chronic conditions often arise or worsen. Unfortunately, most people with chronic diseases do not receive adequate healthcare, which leads to preventable complications, hospitalizations, and costs.²

Several interacting factors contribute to this ineffectiveness in our healthcare system, where we are engaged in a reinforcing-feedback loop of deteriorating health status and escalating health-related costs.

Accelerating healthcare demand.



Chronic disease. The need for medical management and intervention is higher than ever and growing. Today, about 4 out of 10 adults have at least two chronic illnesses, and the prevalence of multiple chronic conditions is rising across all age groups.^{3,4} Furthermore, it is estimated that nearly half of the US population will be affected by chronic conditions by 2025.⁵



Delayed care. Exacerbating the deteriorating health challenge is the propensity of people to delay care until the disease is advanced. This rate increased during the COVID-19 pandemic, when people avoided healthcare settings for various reasons related to COVID-19, with the net effect of delayed or deferral of necessary care.

Plummeting healthcare supply.



Rather than the supply of healthcare workers increasing to meet demand, physicians, nurses, and other providers are retiring or leaving medicine. According to the American Hospital Association, a shortage of up to ^{3,2} million healthcare workers is expected by 2026.⁶

Skyrocketing healthcare costs.



Compared to other developed nations, the relative health of US citizens is declining despite our outspending other nations on healthcare.⁷ Importantly, chronic disease now accounts for more than 85% of the more than \$4 trillion we spend annually on healthcare.^{8,9}

Mitigating Disease Progression is Essential to Enhance the Effectiveness of our Healthcare

Lowering the cost of chronic care while promoting earlier intervention

More efficient and effective care delivery is critical for reducing the growing incidence and burden of chronic disease and targeted therapeutic intervention is integral to instantiating this efficiency.¹⁰ Preventive care staves off critical illness and costly and often ineffective late-stage management interventions.

It was estimated 20 years ago that better adoption of preventive care would reduce annual spending by up to \$111 billion, but preventive care remains ineffectually leveraged.^{11,12} Under constraining resources and an increasingly unhealthy population, identifying data-driven opportunities to deliver more efficient and effective healthcare is vital to our nation's physical and financial health.

Sophisticated data analysis is necessary to unlock these types of opportunities. In particular, machine learning models can serve as a predictive triage system to identify individuals with the most urgent needs and recommend optimal methods and modes of care delivery for each patient.



Cogitativo's response— Personalized multimorbidity disease progression predictions

A platform that leverages clinical literature, biomarkers, diverse training sets, and advanced machine-learning models

Cogitativo has deployed a predictive disease progression platform that detects vulnerable individuals with imminent and emerging risks. In real-time, Cogitativo's Disease Prediction Index (DPI) models produce probabilities that individual patients will endure disease progression or acute events by analyzing key inputs such as data on demographics, clinical conditions, medical procedures, medications, laboratory results, personalized biometrics, and social determinants of health factors.

While several single disease progression models exist, Cogitativo has advanced predictive health science to render patient-level disease progression probabilities for multiple morbidities simultaneously.

These insights allow:

Forecasting of health-related events to optimize resource allocation.

These predictive outputs enable systems of care to identify the most clinically vulnerable and deliver personalized, optimal care, thereby improving resourcing effectiveness. Furthermore, support staff and providers can practice at the top of their license, which enables the alignment of acuity of required care to specialist resources. Looking into the future, health organizations can now accurately build care capacity with these necessary insights to meet high-probability future care needs.

Proactive improvements in care quality and customization.

While elucidating the ideal timing and order of care delivery, Cogitativo's platform also generates novel predictive insights into individual risk factors and the type of care that will be most advantageous for each patient. Specifically, the platform captures the subtleties of patient responses to treatments and guides providers to make the most effective therapy recommendations based on each patient's unique biological, social, and clinical characteristics. This data also provide unique insights into patient-level quality of care, which can be attributed to affiliated and non-affiliated providers. Other use cases include the ability to tailor outreach activities with the highest probability of engagement.

In addition to providing a snapshot of a patient's health, using the DPI to monitor patients' health over time provides further insight into the quality of interventions, care providers, and health systems, which can inform future care decisions. The DPI can also detect and mitigate health disparities at a societal level through its sensitivity to social determinants of health (SDoH) data.

The future release of DPI will incorporate the ability to ingest voice, video, actigraphy data, and waveforms from remote patient monitoring devices in inpatient, step-down, or at-home care locations. These additional biomarkers will give a more complete and comprehensive view of a person's health status.

Cogitativo's DPI is Solving Pressing Chronic Health Challenges in Acute Situations

Cogitativo's DPI was developed using a heterogeneous dataset from over 200 million individuals. The data include a longitudinal view of patients and their biomarkers as well as both clinical and nonclinical data. Clinical data include patient details and data related to claims, pharmacies, providers, and Electronic Medical Records (EMR). Nonclinical data include the EPA's Environmental Justice Index and the CDC/ATSDR Social Vulnerability Index. Cogitativo's platform incorporates clinical expertise, peer-reviewed clinical research, and nationally accepted medical guidelines to ensure that output variables are comprehensive and reflect the latest medical knowledge.

Cogitativo's condition library currently includes atherosclerotic cardiovascular disease (ASCVD), diabetic complications, chronic kidney disease, and chronic obstructive pulmonary disease (COPD). Each patient's likelihood of experiencing outcomes related to these conditions can be scored in any combination to tailor care to the individual.

The DPI risk measurements include the following health outcomes:

CONDITION	ASCVD	Type II Diabetes Complications	Renal Function	COPD
RELATED OUTCOMES	• Myocardial infarction (MI) • Congestive heart failure (CHD) • Stroke or transient ischemic attack (TIA) • Aneurysm major artery • Cardiac arrest	• Amputation • Chronic/non-healing wound or ulcer • Mild retinopathy • Moderate retinopathy • Severe retinopathy	• CKD2 • CKD3 • CKD4 • ESRD	• Pulmonary condition in the emergency room of inpatient hospital setting • Pulmonary exacerbation stage B: one or more emergency department visits without hospitalizations related to COPD in the last 12 months • Pulmonary exacerbation stage C: one hospitalization within the last 12 months related to COPD • Pulmonary exacerbation stage D: two or more hospitalizations within the last 12 months related to COPD



Cogitativo's DPI has been used to facilitate and improve care in the face of healthcare emergencies.

Improving care and vaccination rates during the COVID-19 pandemic.

- A prominent west coast payor utilized Cogitativo's DPI to identify their most at-risk members during the pandemic and match them with beneficial personalized medical care and support.
- The Department of Health and Human Services (HHS) partnered with Cogitativo to identify patients for whom COVID-19 posed the greatest risk, map their optimal vaccine pathways, and determine the locations for pop-up COVID-19 vaccine centers accordingly.

Mitigating effects of deferred care amongst Veterans.

- Based on their observations of the detrimental impacts of deferring care in the context of cardiovascular disease, chronic kidney disease, and diabetes, the Veterans Health Administration (VHA) has used DPI to identify Veterans at high risk for disease progression and to develop healthcare strategies to boost Veteran wellbeing.

Cogitativo's Capabilities Provides Novel Insights Over Time

Understanding our healthcare system is one of our most complex adaptive challenges. Despite the exponential growth of medical knowledge and the development of new biomarkers, our understanding of which features and influences drive individual health continues to challenge our scientific and clinical communities unarguably.

Complicating our understanding of health influences are the temporal, dynamic factors that may impact health outcomes in unpredictable ways. These factors

include the aging of patients, changing climate conditions, exposure to hazardous environments, or outbreaks of new infectious diseases.

Fortunately, Cogitativo's advanced machine learning capabilities address this vexing conundrum. The platform can process hundreds of millions of noisy health and biomarker signals, which, when integrated with peer-reviewed clinical literature, can produce previously undiscovered personalized clinical insights. Moreover, these insights will equip providers with new intelligence and tracking capabilities that were previously unavailable.

Journey of Making the Unseen Seen to Enhance Clinical Response

1	2	3	4	5
Identify At-Risk Patients	View Precise Predictions	Understand Modifiable Risk and Societal Barriers	Recommend Patient Specific Interventions	Continually Monitor Effectiveness
Alert! Mary's DPI Risk Trajectory is increasing. She is high risk for disease progression	Patient is at high risk for progression for Chronic kidney disease and Stroke	Understand which of Mary's risk factors are modifiable and what social determinant of health factors are effecting their health	The platform's optimization layer recommends tailored interventions for Mary to improve her health status	The platform continually evaluates the health of Mary while learning and measuring the effectiveness of interventions throughout the entire patient population.

Enabling a virtual 24x7 monitoring of Mary's health condition



Takeaway

Protecting citizens' health and a nation's financial stability requires we urgently enhance healthcare efficiency, finding ways to produce better outcomes at lower costs. However, doing so depends on our ability to determine when and how to best treat each patient in a society saturated with medical needs that outstrip care supply and place undue stress on providers.

At the individual patient level, Cogitativo's DPI predicts risk of disease progression and acute events to prioritize the most potentially beneficial care decisions. At the population level, the DPI simultaneously identifies driving factors for disease progression and health-related costs to guide more efficient care. The index, which focuses on four common chronic illnesses, has already

been used to identify high-potential opportunities and deliver effective solutions for vaccine deployment and Veteran wellbeing.

The ubiquity of illness and lack of systematic data collection and processing methods result in patient data that is unwieldy and difficult to navigate.

Cogitativo's advanced machine learning solution transforms this noisy and incomplete patient data into actionable care delivery information that guides the timing and type of care to optimize health outcomes across the population.

References

1. Boersma P, Black LI, Ward BW. Prevalence of Multiple Chronic Conditions Among US Adults, 2018. *Prev Chronic Dis*. 2020;17. doi:10.5888/PCD17.200130
2. Saude J, Baker ML, Axman LM, Swider SM. Applying the Chronic Care Model to Improve Patient Activation at a Nurse-Managed Student-Run Free Clinic for Medically Underserved People. *SAGE Open Nurs*. 2020;6. doi:10.1177/2377960820902612
3. About Chronic Diseases | CDC. Accessed May 30, 2023. <https://www.cdc.gov/chronicdisease/about/index.htm>
4. Sambamoorthi U, Tan X, Deb A. Multiple Chronic Conditions and Healthcare Costs among Adults. *Expert Rev Pharmacoecon Outcomes Res*. 2015;15(5):823. doi:10.1586/14737167.2015.1091730
5. The growing crisis of chronic disease in the United States. fightchronicdisease.org.
6. Fact Sheet: Strengthening the Health Care Workforce | AHA. Accessed May 30, 2023. <https://www.aha.org/fact-sheets/2021-05-26-fact-sheet-strengthening-health-care-workforce>
7. Papanicolas I, Woskie LR, Jha AK. Health Care Spending in the United States and Other High-Income Countries. *JAMA*. 2018;319(10):1024-1039. doi:10.1001/JAMA.2018.1150
8. Holman HR. The Relation of the Chronic Disease Epidemic to the Health Care Crisis. *ACR Open Rheumatol*. 2020;2(3):167. doi:10.1002/ACR2.11114
9. Trends in health care spending | Healthcare costs in the US | AMA. Accessed May 30, 2023. <https://www.ama-assn.org/about/research/trends-health-care-spending>
10. Levine S, Malone E, Lekachvili A, Briss P. Health Care Industry Insights: Why the Use of Preventive Services Is Still Low. *Prev Chronic Dis*. 2019;16(3). doi:10.5888/PCD16.180625
11. McGlynn EA, Asch SM, Adams J, et al. The Quality of Health Care Delivered to Adults in the United States. <https://www.nejm.org/doi/full/10.1056/nejmsa022615>
12. The Role Of Clinical Waste In Excess US Health Spending | Health Affairs. Accessed May 30, 2023. <https://www.healthaffairs.org/content/briefs/role-clinical-waste-excess-us-health-spending>

