
Unlocking the power of Machine Learning in health



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Improving Healthcare Outcomes and Containing Costs with Machine Learning and Virtual Care



Health systems all over the world face complex challenges in attempting to deliver high quality, cost-effective care. Factors contributing to this include continual cost increases at rates much higher than inflation and GDP growth rate, a higher prevalence of chronic diseases and their complications, higher use of expensive medical technology, a rise in the proportion of patients over 65, and continuing fragmentation of care delivery.

Health organizations need sustainable solutions, especially in the United States, with its large population and complex payment models. Value-based care (that is, “paying for value, not volume”) is gaining currency.

One important aspect to improving the value proposition is that healthcare should be delivered in the setting (whether primary, secondary or community) that best suits a patient’s needs and delivers care at a sustainable price. Increasingly we recognize that care delivered in the community can meet both goals by providing the care the patient needs in the most cost-effective way.

As health systems strive to “do better with less” there is a real opportunity for machine learning approaches to guide the priorities and actions of providers across a population in a highly effective manner.

The importance of comprehensive data to improve care delivery

This whitepaper explores these concepts and includes a case study to illustrate the important differences in quality of care and application of machine learning to a population of patients.

Virtual care is an approach to care delivery that is provided to patients remotely using technology. It integrates remote monitoring with comprehensive care coordination and patient engagement tools. Central decision support and other key capabilities round out a comprehensive package that extends the care provider's reach into the home, while involving patients more closely in their care planning and delivery. Virtual care is key to a sustainable health system that delivers the right care to the right patient at the right place.

The importance of timely, high-quality, accurate data to manage healthcare cannot be overstated. Awareness has evolved, and experts widely agree that health status is affected

by the environment people live in, as well as their socio-economic status, lifestyle and cultural background. These are examples of the social and environmental determinants of health that have a major impact on patient outcomes.

To have a full picture of a patient's health status, clinicians need to be aware of the patient's social determinants of health. Add data from genomics and the other “* omics” plus clinical, behavioral and lifestyle data and now the care provider has access to a huge virtual library of relevant patient information. Healthcare data may grow to 25,000 petabytes in 2020 (Pyne, Rao, & Rao, 2018). Coping with this volume and variety of data is a huge challenge for clinicians. To be useful for patient care, we must present data in ways that add value.

Machine learning and virtual care can transform the way healthcare providers gain insight from clinical and other data repositories to make informed decisions.



“Healthcare spending will outpace GDP growth for the next 15 years.”



Global annual healthcare spending is projected to increase at a rate of **5.4%** in 2018- 2022, a huge rise from **2.9%** in 2013-2017.

Per person healthcare spend in 2022 is expected to continue to vary widely from

\$11,674

in the **US** to

\$454

in **Pakistan**



Higher per person spending does not always equate to higher quality healthcare.

74.4 years

projected life expectancy in 2022, increased from 73.5 years in 2018. This brings the number of people aged over 65 to more than 668 million, or 11.6% of the global population.



Non-communicable diseases, most prominently cancer, heart disease, and diabetes, accounted for **71%** of the 56.9 million deaths worldwide in 2016; that share increased to **80%** in developed markets.



71%

of deaths worldwide in 2016 were due to non-communicable diseases such as cancer, heart disease and diabetes. This number increased to 80% in developed markets.

Case Study – A high-risk patient with gestational diabetes

To explore how machine learning and virtual care can help deliver high-value healthcare, let's look at a common important clinical scenario: a patient with gestational diabetes. If diabetes is not managed carefully throughout pregnancy, the mother and baby face serious health risks.

Our example patient is a 30-year-old woman named Linda who is in her second pregnancy and has gestational diabetes. Linda has a low income and no easy way to get to clinic appointments from her home in a poor neighborhood.

This whitepaper will examine two scenarios for Linda. In the first scenario, the high-risk nature of her pregnancy is not recognized until late, she is admitted to a hospital and has a complicated birth. In the second scenario, her high-risk pregnancy is recognized early and acted on (“the right care, at the right time in the right place”).

Unrecognized high-risk pregnancy

In the first version of the scenario, Linda doesn't realize that diabetes and pregnancy “don't mix” and that her health, and that of her unborn child, are at risk. She doesn't seek medical advice until her pregnancy is well into the second trimester.

Because Linda is busy and finds it hard to travel to see a healthcare provider, she does not seek medical care until


she has an episode of hyperglycemia. She is then admitted to the hospital with pre-eclampsia and unstable diabetes. From 28 weeks of pregnancy, Linda is frequently admitted to the hospital for bed rest, fetal monitoring and close supervision by a wide range of specialists.

Despite the monitoring and bed rest, Linda's pre-eclampsia does not resolve, and her unborn baby is significantly larger than normal for each date it is measured. Linda has a difficult labor because of the baby's size, and the baby requires neonatal intensive care for many weeks. Highbirthweight babies are at risk of obesity and its complications when they become adults.

A better way of using population-level data and community monitoring of care

LINDA'S CARE JOURNEY




Frequently in hospital
for third trimester



PCP identifies that Linda has
a high-risk pregnancy using
machine learning



Enrolled in a care plan,
managed with a virtual
care team

- PCP
- Care team
- Diabetes specialist
- Midwife



In hospital only for birth

Given the importance of gestational diabetes and its potential to adversely impact pregnancy outcomes, we need to ask some questions to provide Linda and her baby with better care. For instance, what is the earliest we can possibly recognize high-risk pregnancies? When should the patient be referred to specialist care? Are there interventions we can provide, at a low cost, to help our patients while they are in the community?

Machine learning and predictive modeling can enable earlier recognition of issues like high-risk pregnancies by better leveraging data already known about a patient and

a population. Machine learning puts hightech data analysis in the hands of clinicians, generating meaningful insights and a comprehensive view of patients.

The best way to reduce the risks to a diabetic patient and her unborn child is to recognize the situation early, then monitor and ensure the diabetes is well controlled before, during and after pregnancy. Virtual care enables monitoring and treatment while the patient is at a distance (remote) from their healthcare facilities.

An optimistic scenario with machine learning and population health analytics



In the second, more optimistic scenario, Linda's primary care provider uses the Health Information Exchange (HIE) data platform to run frequent population-level risk scores based on machine learning algorithms to generate a list of new high-risk pregnancies. In this way, the high-risk situation can be found within a whole population and addressed early.

Software tools enable a PCP to identify their patients with high-risk pregnancies early and with unmatched accuracy. Machine learning tools can aggregate tens or even hundreds of weak signals in the data that, taken together, point to a high-risk situation. The PCP can then arrange appropriate care to ensure their patients' diabetes and pregnancies are well managed much earlier than previously possible.

Based on early recognition of a potential high-risk pregnancy, the PCP asks Linda to come in for an early visit and creates a care plan for her pregnancy. The PCP arranges for virtual care-enabled monitoring of the pregnancy to ensure Linda and her diabetes stay clinically well controlled.

With virtual care, Linda can access healthcare services from a variety of internet-connected devices. Later in Linda's pregnancy, when she needs higher levels of care such as by diabetologists and obstetricians in the hospital setting, her care team are fully briefed, and the delivery is incident free.

When Linda returns home from giving birth at the hospital, she once again uses virtual care for various aspects of her diabetes management. Her diabetic care team stay in close contact and her diabetes is well controlled.

Making sure the right patients receive the right care with the right provider at the right time and place is key to improving population health.





RIGHT PATIENT

Right patient means stratifying a patient population and identifying patients with risk factors for disease or issues such as chronic disease complications, frailness or adverse events.



RIGHT CARE

Right care means matching patients with appropriate intervention(s). This can mean recommending preventative treatment or referral to a specialist to mitigate risk or prevent complications.



RIGHT PLACE

Right place means ensuring patients receive care in the location of their preference that has the necessary resources to deliver that care. Depending on the situation, this can be at home, in a clinic or in a hospital. Virtual care can help remove access and location barriers by expending providers' reach into the home.

Right Place: Hospitals saved for appropriate specialty care

Making sure the right patients receive the right care with the right provider at the right time and place is key to improving population health. To achieve this, health services must be planned more strategically and with greater care than has been typically the case until now. The high-level goals for any health system usually come down to delivering the right care to the right patient at the right place. It is important to remember that integration of care is essential no matter where or how the individual care encounters are organized.

As healthcare systems shift towards paying for quality care and patient outcomes, hospitals can focus on the areas where they have clear advantages, such as trauma, hightech surgery and complex cancer care. The higher cost of hospital care is justifiable in a value-based world where it delivers positive outcomes that cannot be achieved in other care settings.

Exacerbations and complications of chronic disease cause a significant number of acute hospital admissions. These are often preventable with high-quality community-based care. Promoting wellness, including more focus on preventative care, and shifting care to the community, must become a reality. For care to shift to the community, a key requirement will be that care is coordinated between primary care and community care-based service providers.

Community-based care puts the needs of a patient and their families first and is the cornerstone of effective integrated care. This is true whether the clinical condition is gestational diabetes or any other complex condition.

Understanding community care

The key components of integrated care include:

- Services provided at or near patients' homes
- Services delivered without duplication or gaps
- Integrated primary, community and secondary care services
- A multi-disciplinary team that works well together
- Patient is an active part of the care team

Technology that supports integrated care must include data integration. Shared electronic health records (EHR) such as HIEs are ideal examples of technology that is purpose-built to address data integration in the most comprehensive way possible.

Virtual care – A new approach to care in the community



Virtual care includes remote patient monitoring via video, phone, email and messaging. Deploying machine learning on the captured data enhances the clinician's ability to reach patients in their homes and communities.

Virtual care supports integrated patient care by removing accessibility and location barriers. The multi-disciplinary team can access all the patient's data in one place, allowing them to develop a comprehensive care plan. This can help patients to better manage their condition. By integrating diverse data types on one platform, virtual care eliminates duplication and gaps in care.

In Linda's case, the PCP can tailor a personalized diabetic and pregnancy monitoring plan for Linda that leverages virtual care. Specialists on Linda's care team can monitor specific medical conditions and comorbidities and can start early interventions immediately when they are needed

Linda uses the technology platform to record her daily health activities from home. These may include recording

vital signs such as blood pressure, and noting symptoms of increasing pregnancy risk.

While interacting with the virtual care platform, Linda also learns about healthier behaviors, and when to contact her care team, giving her a sense of security about her condition.

Better at-home monitoring and communication tools enable fewer hospital admissions. In addition, the community is the optimal location for interventions aimed at socio-economic needs, behavior change and disease education.

In the study, Evaluation of a Telehomecare Initiative Used in Women with Gestational Diabetes, results showed a significant decrease in medical visits without compromising pregnancy outcomes, quality of care, or patient satisfaction.

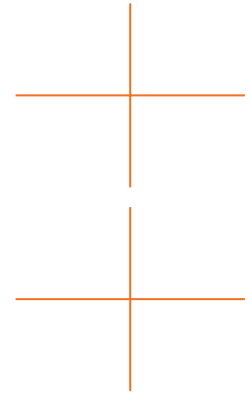
Better medication adherence with virtual care

Using virtual care, Linda can update her medication profile, allowing her PCP to generate medication adherence reports. Virtual care can alert Linda to take medications and prompt her to record her symptoms and any side effects.

Linda's care team can use the data she uploads via virtual care to monitor drug interactions and dosages. They can review logs of her blood sugar, blood pressure, and weight as her pregnancy progresses and adjust her medications as needed.

Strengthening the patient's circle of care with virtual care

Friends and family are a key part of the care team for a person with any complex or chronic condition, and virtual care can help them be more effective by linking them to the patient's circle of care. This helps friends and family securely access and contribute to the patient's care plan. Similarly, the circle of care includes all the relevant providers and organizations who take part in the patient's care.



The future of healthcare

Our high-risk pregnancy scenario illustrates that a strategic balance of hospital and community-based care is the right way to achieve the best possible outcomes for both mother and baby.

Machine learning is an exciting new capability in population health management. There are several immediately apparent use cases that will serve to greatly improve our ability to identify and better manage patients for many important conditions like high-risk pregnancy. Understanding the risk profile of a population is essential to managing the health of that population.

Virtual care also shows great promise as a clinician extender, enabling clinicians to interact with patients in the community with high confidence, and patients to be more involved in their healthcare. Virtual Care has potential to improve the quality and cost of care delivery to a population. With real time monitoring

of the patient's key indicators, easy communication between the patient and the care team and patient-tailored alerts, virtual care can significantly improve how care is delivered to a population.

As we move to a population-level, value-based healthcare system, it will become increasingly important to adopt more alternative, preventative and non-traditional interventions such as those that are supported by machine learning, based in the community, and supported by virtual care.

We already see applications of machine learning in healthcare that are advancing medicine into a new realm. In the future, it will be commonplace to see embedded machine learning expertise that is embedded in health systems to help analyze different types of population data and shift the delivery of care to target the right patient, provide the right care at the right place and time.



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