



## **Enabling smart health care with a modern analytics architecture**

Tackling the global challenge of  
non-communicable diseases



# Content

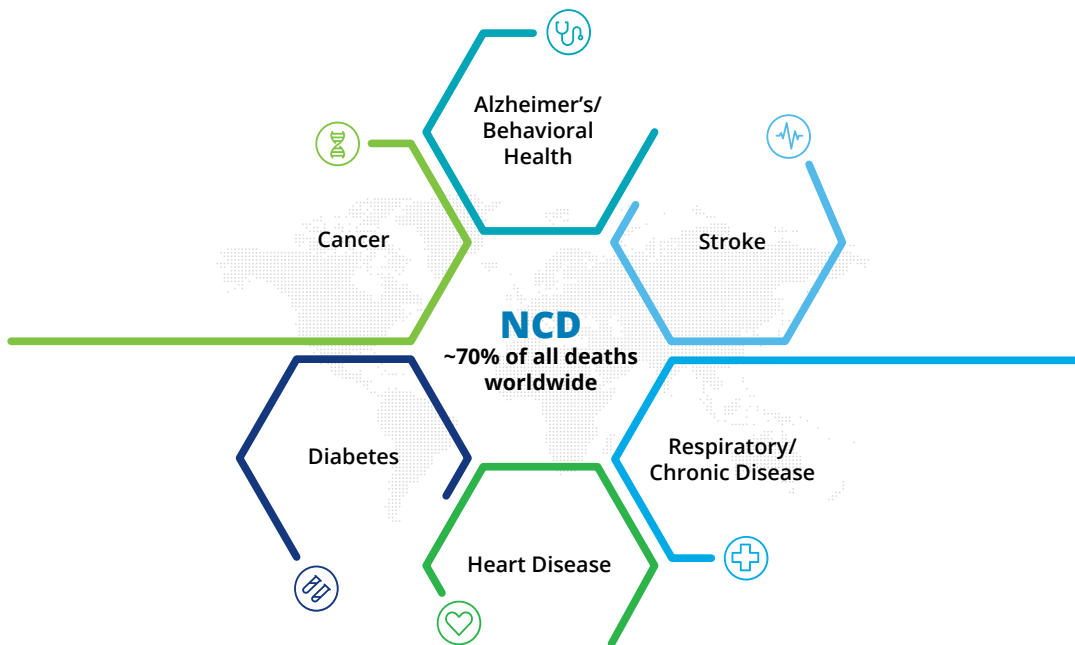
Executive summary	4
Non-communicable diseases: A globally shared health and cost issue	6
Modern analytics architecture: The linchpin of smart health care communities	7
The promise of smart health care communities for NCDs	10
The time to move	12
Contacts	14
Endnotes	15

# Executive summary

Health care organizations share a common global problem: managing the growing costs of care while supporting the health and the well-being of an increasing and aging population that is significantly impacted by lifestyle-related non-communicable diseases (NCDs). Examples of NCDs include heart disease, stroke, cancer, diabetes, respiratory disease, mental health conditions

such as Alzheimer's disease, and other chronic conditions (Figure 1). NCDs are not constrained by political borders or countries, or limited to specific races or cultures; collectively they are responsible for almost 70 percent of all deaths worldwide<sup>1</sup>, accounting for an estimated 15 million deaths in 2017 between the ages of 30 and 70.<sup>2</sup>

Figure 1: Examples of non-communicable diseases



SOURCE: Non-communicable Diseases 2017 Progress Monitor Report, World Health Organization, 2017

As a result, health care leaders around the world are recognizing that traditional efforts to treat NCDs have had limited success and are seeking new approaches to this growing problem. Two common themes are emerging in various countries' efforts to manage NCDs at the individual and population level. First, effective management of NCDs requires the health ecosystem to work

together, engaging key partners from the public and private sector (e.g., public health agencies, research organizations, privately owned health systems, non-profit health systems, technology vendors, etc.) to address social determinants of health care (e.g., tobacco use, unhealthy diets, substance abuse, etc.) and other major factors impacting high-risk consumers. Through increased

collaboration and transparency, health care organizations are better positioned to monitor their population's health status, align health care services with individual patient needs, and improve outcomes.

Second, advancements in medicine, analytics, and information technology are enabling fundamental shifts in the way health care services are organized and delivered. With the growth in personalized medicine, underpinned by individual genomic and microbiome analysis, medicine is moving to targeted interventions. This shift is made possible by powerful analytics and decision support tools that continuously monitor health to identify risks sooner, advise consumers to influence behavior, and support their efforts to maintain health and well-being, thus giving everyone a better chance for success.

As analytics and other information technologies become more prevalent, health care communities are overcoming traditional barriers such as lack of data, interoperability, fragmentation of efforts, and resistance to change.<sup>3</sup> In some countries,

consumers empowered by access to more data and mobile devices are becoming more demanding in their expectations and needs. At the same time, patients in rural areas are gaining access to specialized expertise and treatment regardless of geographic distance.

Forward-thinking health care organizations are quickly recognizing the value of smart connected devices, artificial intelligence (AI), advanced analytics, and accurate master data delivered through cloud-based platforms. Together, these capabilities enable smart health care community networks that can radically transform the delivery of population and individual care at the local, regional, and global levels.

This article describes NCDs' impact on global health; reviews consumers' evolving health care needs in an increasingly complex, connected world; discusses the components of a modern analytics architecture to support smart health care communities; and proposes a path forward to engage stakeholders in a collaborative effort to treat NCDs and related complications.

# Non-communicable diseases: A globally shared health and cost issue

Meet Fiona, 72, and Charles, 75, a married couple of 40 years. Fiona and Charles are on a fixed income and live in the house they built shortly after their wedding. Charles has two NCDs—heart disease and Type 2 diabetes—and experiences periodic bouts of depression that last from a few days to several weeks. Like many individuals with complex health issues, managing diet and lifestyle continues to be a burden for both of them. Fiona, although overweight, is in generally good health. She is Charles' primary caregiver, as their children are grown and reside several hundred miles away. For 10 years, the couple has depended on a combination of government and private health insurance. As out-of-pocket costs continue to escalate, they worry about maintaining their health care coverage should Charles' condition deteriorate. At the same time, their local government health ministry and supplemental insurance company continue to struggle with how to provide more efficient health services to a growing population while containing costs.

This situation is prevalent throughout the world and is indicative of the increasingly pervasive impact of NCDs on individuals and society. The World Economic Forum estimates that between 2010 and 2030 cardiovascular disease, chronic respiratory disease, cancer, diabetes, and mental health diseases represent a cumulative output loss of US\$46.7 trillion, roughly 75 percent of the global GDP.<sup>4</sup>

Recent statistics indicate that NCD issues are not limited to older generations, as depression and other mental health conditions are becoming more prevalent in younger adults. Once associated with developed markets, chronic diseases exacerbated by changing lifestyles are becoming a larger health and cost issue.<sup>5</sup> Consider:

- Rapid urbanization, sedentary lifestyles, changing diets, and rising obesity levels are fueling an increase in chronic diseases—most prominently, cancer, heart disease, and diabetes—even in developing markets.<sup>6</sup>
- Chronic care conditions such as cardiovascular disease result in over 17 million deaths per year, a number that is expected to grow to more than 23.6 million by 2030.<sup>7</sup>
- Diabetes results in approximately 3.7 million deaths per year and impacts 8.5 percent of the global adult population.<sup>8</sup> China and India have the largest number of diabetes sufferers in the world, at around 114 million and 69 million, respectively. Globally, the number is expected to rise from the current 415 million to 642 million by 2040.<sup>9</sup>
- Compared to non-depressed individuals, studies indicate that people with depression can exhibit almost three times the risk of an acute myocardial infarction.<sup>10</sup> Other studies indicate that the relationship between cardiovascular disease and depression may be bi-directional, increasing the complexity of treatment pathways.

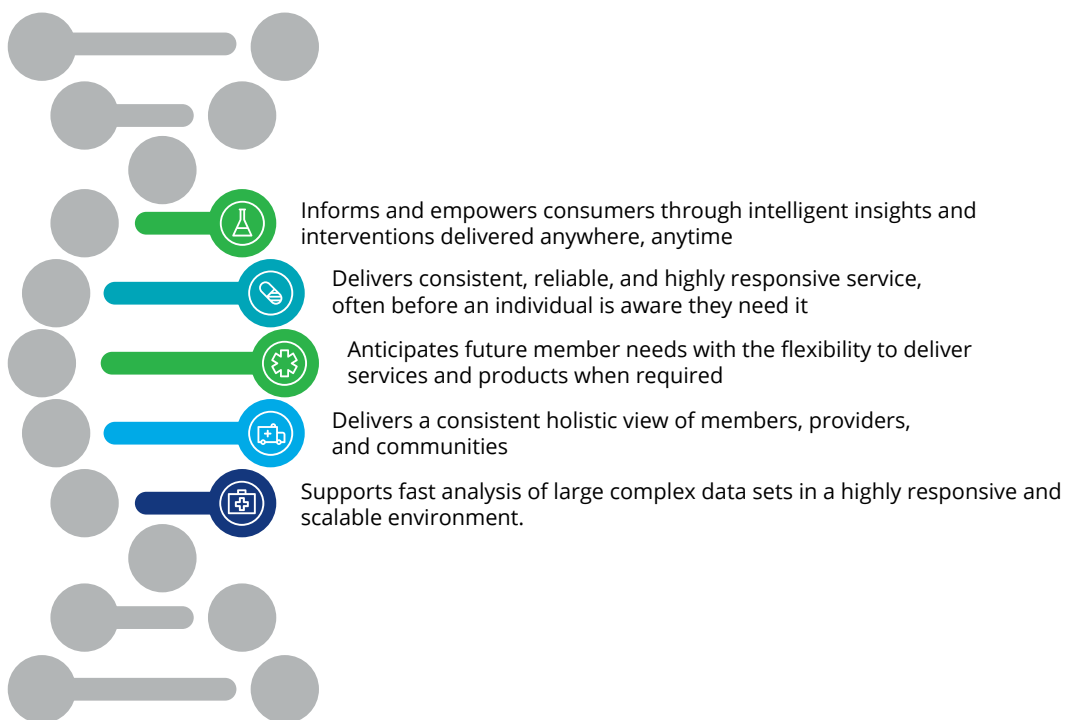
In many public health systems, timely access to care is a significant issue. Access may be limited by too few providers, over-reliance on physicians versus alternate care providers, geographic distances, and other factors. Fragmented data, lack of interoperable systems, and outdated business models have limited countries' ability to understand and act on underlying patterns and trends in their population's NCD treatment needs. Fortunately, we are now seeing exciting initiatives taking place that are enabled by a modern analytics architecture. These initiatives are offering dramatic evidence of how analytics can impact the health and well-being of communities and individuals throughout the world.

# Modern analytics architecture: The linchpin of smart health care communities

Managing NCDs traditionally has been characterized by complex relationships among providers, payers, suppliers, and consumers where relationships formed between parties based on transactions and competing incentives. Information systems and reporting evolved on an as-needed basis by automating manual processes and producing retrospective reports that provided limited insights into underlying patterns of behavior and trends. As a result, members of the health care community were often left to operate

within the boundaries of their own organizations and technical capabilities.

While specific diseases, delivery systems, and payment models vary by geographic region, the overarching challenge of improving health care access, value, and effectiveness is universal. Addressing these issues requires a modern analytics architecture that promotes a more sustained, collaborative payer-provider-consumer relationship, one that:



By leveraging modern analytics and information management capabilities and working together as part of a broader plan, health care organizations can transform their current networks into smart health care communities. The Vietnam Ministry of Health is sponsoring one smart health care community initiative where each hospital is expected to meet certain criteria, including using artificial intelligence and predictive analytics,

integrating with social media, implementing electronic health records, and contributing to a shared database for Ho Chi Minh City's health sector for operational and research purposes. As a result, the system has helped shorten time for administrative procedures, streamline care delivery, limit the number of medical errors, and enable management agencies to issue more effective forecasts in the case of epidemics.<sup>11</sup>

Smart health care communities rely on a blend of analytics and technologies to generate better insights into their population segments, identify the most effective evidence-based treatments, monitor outcomes in real-time, and anticipate future health care needs. To do this, they need a modern analytics architecture that includes the following components:

- **Smart connected devices:** Often referred to as the Internet of Things (IoT), this technology performs distributed processing in component devices where the data is collected rather than pushing it up to a centralized location. As with many technologies, connected devices are getting easier to deploy and use. With a couple of clicks, patients can notify care staff about their health status, order medications, or request urgent help. This allows NCD patients to live independently while retaining access to their medical team when they need it. Through connected IoT devices, wearables (e.g., continuous glucose monitors, accelerometers, electrocardiogram monitors, and nano-based drug-dispensing systems) can interact with each other in real-time and enable a more informed and proactive response to changes in an individual's personal health situation.
- **Artificial intelligence:** AI refers to a broad field of science encompassing computer science, psychology, linguistics, and other areas that are concerned with getting computers to do tasks that normally require human intelligence.<sup>12</sup> AI augments human performance by constantly searching through data to detect and extract patterns (e.g., interactions, relationships, etc.), analyze available options, and recommend new strategies (i.e., the next best move). As health care organizations strive to improve service, many are beginning to use AI-powered well-being

coaching, social network bots, and interactive games to create a better customer experience and/or streamline back office operations.

- **Advanced analytics:** Advanced analytics uses data science methods and technologies such as graph databases, machine learning, and deep learning to generate new information, highlight patterns, and predict outcomes. The resulting insights can improve existing processes, highlight potential new business opportunities, and enable new business models. Examples of advanced analytical solutions include using machine learning to perform more accurate risk stratification; “always on” monitoring of physical, social, and behavioral activity; and automated health screening.
- **Master data management (MDM):** MDM is a discipline that provides control over master data (e.g., member ID, provider ID, location, and other specific data constructs) to enable a consistent view use across systems. Reliable master data is an essential ingredient to organizing and linking data that is required for personalized medicine, coordinated supply chain, and other clinical and operational needs.
- **Cloud computing:** Cloud architecture allows companies and individuals to use a network connection to access shared hardware, applications, and other computing resources via a service provider rather than an on-premises infrastructure. Cloud technology offers numerous advantages, including flexible capacity on demand, pay-as-you-go capabilities, and faster access to newer applications. As smart health care communities implement virtual care programs, analyze complex genomic data, or perform real-time analytics, cloud computing is ideally suited for quickly processing large data without huge up-front technology investments.



Fiona and Charles' local health ministry serves as the community's primary organizer, integrator, and collaborator. With access to large data sets including demographics, claims, social determinants of health, and an expanding base of other data sources (e.g., genomics, proteomics, etc.) the ministry is well-positioned to apply machine learning algorithms (e.g., associative rules, clustering, prediction, recommendations, etc.) to provide insights (which are also made available to the community's health care providers) to identify the optimal mix of resources and services that need to be mobilized at a regional, local, and/or consumer level. Through the active management of its master data related to members, providers, and other domains, the ministry simultaneously improves the accuracy of its analytic insights and the effectiveness of its operational processes. And by leveraging cloud-based infrastructure, the ministry gains access to highly scalable storage and computing resources in an efficient manner while minimizing the capital investment. Finally, as population demographics, medical needs, and health care technologies change, artificial intelligence may be used to self-optimize the flow of these resources and services.

Government agencies, health care providers, payers, and advocacy groups seeking to advance NCD management should consider joining forces in establishing virtual smart health care communities based on modern analytics architectures. A great example is SmarthHealth India, a health care delivery system developed by George Institute of Global Health researchers in India, Australia, and the United Kingdom.<sup>13</sup> SmarthHealth India uses a combination of smartphones developed by the Oxford Institute of Biomedical Engineering of The University of Oxford and advanced analytics to allow primary care providers in urban areas to team with local health care assistances called ASHAs treat patients in rural areas. Through this joint effort, local healthcare is delivered while concurrently producing data that can be used to develop more cost-effective treatments and reduce avoidable deaths from NCDs.

## Smart community analytics support population health management and wellness

Population health—from prevention to diagnosis and treatment of NCDs—takes a broad look at the management of outcomes for a health system's patients, including efforts to use its resources effectively while efficiently improving the health and well-being of specific population segments.<sup>14</sup> Population health requires diverse data sets and advanced analytics to identify at-risk patients and target services that can aid in reconfiguring services, reducing expense, and improving the quality of care.

Successful programs often deploy innovative delivery models that analyze data and trends in a population's health, quality, and costs, and bearing financial risk. In 2018, the Israeli government announced a \$275 million program designed to improve the way it manages health information to define health policy, operate its health care system, and promote research while protecting individual privacy.<sup>15</sup> Israel's vision is to utilize a modern analytics architecture and coordinate cross-organizational processes to support personalized health, population management, care delivery, and innovation. The program will combine the use of EHR data; health information exchanges; big data analysis of genomic, physiologic, and clinical data; telemedicine centers; and advanced analytics to improve health care delivery to patients with NCDs and other ailments.<sup>16</sup>

Combining the power of a modern analytics architecture with mobile devices, wearables, and other nontraditional sources of data collection could enrich wellness programs by identifying new care pathways and high-risk individuals.<sup>17</sup> By aggregating and analyzing such large and diverse data sets, countries such as Israel are able to gain important insights regarding the current and future needs of its citizens. To accomplish this objective, standards—in areas such as interoperability, medical terminology, and data management—are essential. Finally, a compelling user interface is needed to enhance the customer experience through AI-enabled bots, recommendation engines, and "Smart Agent" digital displays.

# The promise of smart health care communities for NCDs

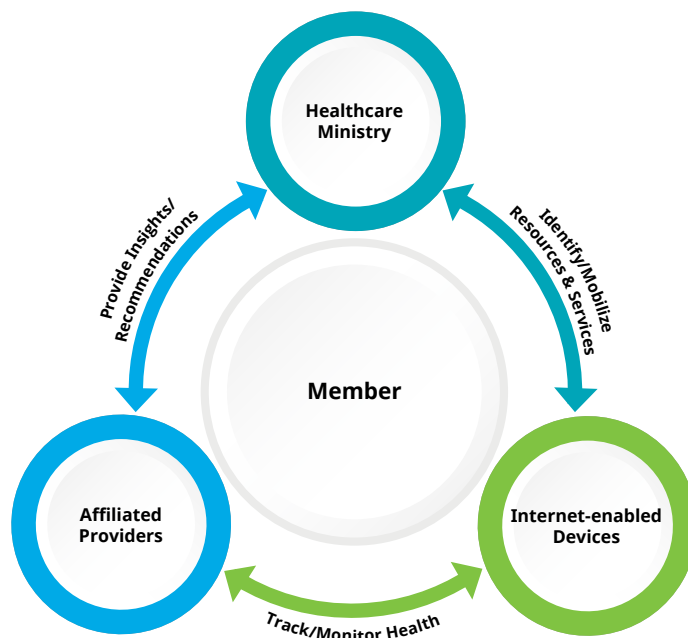
Health care has long operated as a collection of loosely connected networks directed by human stakeholders who often have conflicting incentives, influence, or information to optimize these networks. The insights and intelligent interactions resulting from a modern analytics architecture can transform these community networks into more efficient virtual communities that augment human capabilities and enhance the effectiveness of all stakeholders.

## Smart health care community living

Collaboration powered by technology and analytics is an important attribute of smart health care communities, with each party contributing to the

success of the others (Figure 2). By participating in a new health and wellness program offered by their local health ministry, Fiona and Charles gain access to personalized services (e.g., wellness coaches, financial counselors, communities of interest, self-assessments, etc.) that are designed to detect, anticipate, and respond to their changing health care needs. In some instances, these services may be the result of population health programs and include vaccinations, eye exams, and other preventive health measures. In other instances, services can reflect personalized recommendations based on social determinants, smart device data feedback, and self-reported data.

Figure 2: Smart health care community collaborators



To begin their program participation, Fiona and Charles receive Internet-enabled devices: 1) an activity tracker that includes a heart monitor, accelerometer, and fitness reminders; 2) a smartphone; 3) a portfolio of smartphone-enabled apps (e.g., sleep pattern, exercise routine, activity and calorie tracker, virtual provider, online health communities); 4) an in-home digital assistant with AI capabilities; and 5) other patient-specific enabled devices (e.g., continuous glucose monitoring device). These devices interface with the ministry's cloud environment to assist Fiona and Charles in monitoring their health and wellness indicators; provide reminders about medications, diet, and lifestyle changes; and predict the outcomes of their actions and decisions.

Affiliated providers are a critical member of the smart health care community. They participate in

the health and wellness program by using AI- and advanced analytics-powered applications to supply them with trending and exception-based insights to understand the status of their patients. The applications also offer proactive recommendations to providers on other interventions and services, such as timely access to a psychologist who can, for example, help Charles during stressful situations that may trigger depression.

Together these analytics capabilities promote a greater synergy that enables all parties to provide more proactive services to NCD patients, the provider community, and the region at large. As a result, everyone is more informed and better prepared to face the challenges of NCDs and enjoy the dividends of smart health care communities.

# The time to move

The increasingly complex needs of the world's health care communities are quickly overtaking the capabilities of traditional health delivery systems and approaches. Today we have the technology available to empower individuals, communities, and countries are struggling with the pervasive problem of NCDs. Applying technology advancements and analytical insights in a smart health care community setting could be a game-changer and a life-saver.

For this approach to succeed, individual health care organizations and the industry need to transcend transactional approaches and collaborate within an informed network of analytically-enabled relationships and mutually beneficial interactions. The steps illustrated in Figure 3 and described below can help define a common vision and build momentum for success.

Figure 3: The path forward



**1. Envision the future.** Engage key stakeholders and thought leaders with diverse backgrounds including health care, data science, engineering, consumers, providers, investors, technology, government, and community planners to create a compelling picture of what the future smart health care community will look like. Take advantage of innovation labs and other accelerators to demonstrate how analytics will impact the future business architecture, customer experience, and operations.

**2. Accelerate strategy development.** Use agile methods and other structured thinking techniques to expedite the development of high-level success criteria, implementation strategies, key milestones, funding models, and constituent roles. Identify critical areas where solution components may still be in early-stage development and consider the trajectory of technology innovation on implementation objectives.

**3. Prioritize high-value targets.** Identify components of the future vision that offer the greatest potential impact for the least amount of resources. Balance initiatives that will have long-term transformative impact with those that offer near-term gains and demonstrate potential future value to key stakeholders.

**4. Implement for impact.** Launch concurrent, quick-win initiatives targeting areas such as improving consumer experience or provider engagement around a specific NCD problem (e.g., health monitoring, lifestyle recommendations, care coordination). Measure results and leverage lessons learned to expand into other problem areas.

**5. Scale to transform.** Establish a dedicated organization that is empowered and capable of engaging and collaborating with other stakeholders to achieve the future vision. Partner where necessary to access competencies, technologies, and other resources to excel at the local, regional, and national level.

Non-communicable diseases are a shared issue that requires a shared solution. Enabling smart health care communities to collectively apply advanced technologies and analytics can yield gains that last for years to come.

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