Synthetic Data

Case Study: Sharing Complex Health System Data

Appendix A

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Synthetic Data

Case Study: Sharing Complex Health System Data

Background

Accessing individual level-health data is a process that can be convoluted and time consuming and can act as a significant barrier to the health innovation community. Data accessibility is a difficult endeavor and many organizations that have shown interest in health data have not been able to harness the potential power of this data.

New methods, such as synthetic data generation, have the potential to unlock the historically siloed and difficult-to-access data sets, and provide a channel for readily available access in a secure and reliable manner. Synthetic data is not considered to be personal information because there is no one-to-one mapping between the synthetic records and real people.

In this R&D project, we wanted to answer the question of whether synthetic data can be analytically useful and at the same time protect patient privacy. We synthesized a complex longitudinal health system dataset and evaluated its utility in a typical series of epidemiological analyses.

Objectives

The benefits of demonstrating that synthetic data can replicate estimates derived from longitudinal real-world -individual level data are:
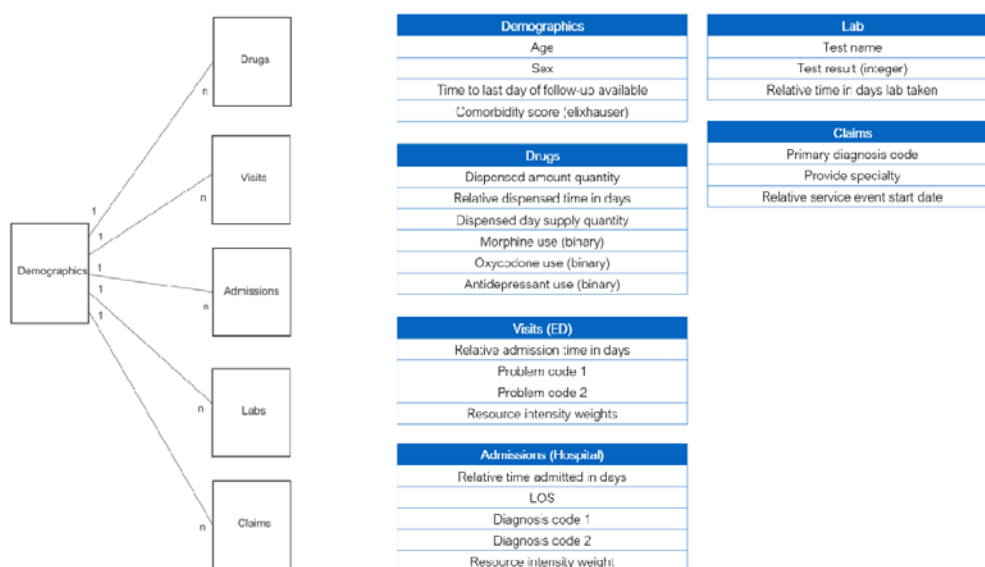
1) It would allow data to be made portable and, as a result, these datasets could be shared with researchers and industry partners outside of their respective jurisdictions without concerns related to the HIA or privacy - facilitating other research which is currently very difficult or not happening outside of the jurisdictions.

2) By allowing this data to be portable, researchers would be able to combine individual level data from multiple jurisdictions to conduct analyses at the individual level. This would be particularly appealing for exposures or endpoints that have low frequencies in any one population as the combination of the populations would increase statistical power and allow for the identification of rare but important exposures or events in populations. This also overcomes the current approach of running underpowered models within each jurisdiction and then combining the results through meta-analytical techniques.

3) From an economic development perspective, synthetic data enables investigation from the business and health innovation community to accelerate activities and levels the playing field for smaller companies or start-ups to enable product development, evaluate product market fit, and related commercialization activities.

4) Positive results also reduce the privacy and security risk and can attract organizations seeking access to health data to the province and country, leading to related economic development outcomes.

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The project was performed as a collaboration among multiple organizations, including IHE, Health City, Replica Analytics, University of Alberta, and Alberta Innovates. Along the way, consultations with the provincial privacy commissioner were key to ensuring that the approach taken was transparent and benefited from regulatory feedback.

The Project and Data

The specific project to kick-off this effort focused on a single complex health dataset that combined administrative and clinical information. The dataset that needed to be synthesized consisted of 300,000 patient records covering multiple events per patient. Some patients had a handful of events and others had tens of thousands of events over a seven-year period. The domains covered in the data included drugs, laboratory results, emergency department visits, hospital admissions, and doctors' visits.

Data synthesis proceeds in two general steps. The first is to train a generative model on the original data. This training captures the patterns in the original dataset. Then the generative model is used to synthesize a new dataset that is based on the patterns that were captured during training. The generated data comes directly from the model and is not derived from the original data.

Demographics
Age
Sex
Time to last day of follow-up available
Comorbidity score (elixhauser)

Drugs
Dispensed amount quantity
Relative dispensed time in days
Dispensed day supply quantity
Morphine use (binary)
Oxycodone use (binary)
Antidepressant use (binary)

Visits (ED)
Relative admission time in days
Problem code 1
Problem code 2
Resource intensity weights

Admissions (Hospital)
Relative time admitted in days
LOS
Diagnosis code 1
Diagnosis code 2
Resource intensity weight

Lab
Test name
Test result (integer)
Relative time in days lab taken

Claims
Primary diagnosis code
Provide specialty
Relative service event start date

The objective was to create a generative model from this dataset such that the synthesized data would replicate analytic patterns. Specifically, the synthetic data was assessed based on how well models of mortality and other events (such as hospitalization) agreed with models built using the real data.

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Solution & Outcomes

A deep learning model was developed to generate synthetic data. The model captured the baseline characteristics of the patients as well as their sequence of events and event attributes. Novel approaches were needed to address the heterogeneity in the data, and to leverage the history of events to generate valid subsequent events for each patient.

To validate the approach, some general comparisons of the original and synthetic data were performed. The comparisons showed that both datasets were quite similar. In addition, Cox regression models to predict various outcomes were also developed. The real and synthetic model were very similar with high confidence interval overlap (see the summary in the sidebar).

To address privacy concerns, a privacy risk assessment was performed to evaluate the likelihood that records in the synthetic dataset can be matched with real individuals. The results of that assessment demonstrated that the meaningful identity disclosure privacy risks were below commonly used risk thresholds by approximately an order of magnitude (see the summary in the sidebar).

Overall, we were able to demonstrate that a deep learning generative model can capture the key characteristics of a complex longitudinal health dataset and generate realistic synthetic variants. The synthetic variants had an acceptably low identity disclosure risk.

This approach allows data users to access the synthetic data with minimal constraints, but still provide privacy protection. As the technology is scaled, this will provide a means to rapidly make data available to a broad community of users and drive innovation within the province.

How Safe is Synthetic Data?

As part of this project, we evaluated the privacy risks of the generated synthetic data. The focus was estimating the probability to which a synthetic record can be correctly linked to a real person *and* learning something new about that person from the synthetic data. We determined that this probability was 0.0019 (less than half a percent), which is very low and lower than generally accepted thresholds for privacy risks. In general, it is always good to be prudent and evaluate the privacy risks in synthetic data, and we have a well-documented methodology for doing so.

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Future Opportunities

We see synthetic data as a precursor 'funnel' to *bona fide* health system data. Many health data requests are not developed or robust enough for direct access to health data. Yet, it is difficult for potential users to have sufficient data literacy without access to actual data (chicken/egg problem). We believe synthetic data addresses this problem by enabling users to better understand and refine their project or study parameters enabling them to have a well-developed data request prior to using actual health data.

Deploying synthetic data sets in areas of public health concerns will enable provincial health systems to freely partner with academic institutions, institutes or philanthropic organizations, or industry to broaden their talent pool of data scientists as well as data sets (such as social indicators of health).

A similar access challenge exists with artificial intelligence and machine learning projects. These projects often do not have a targeted question with defined parameters established but rather, are exploratory in nature and look for compelling artifacts or correlations in the data that one would not typically predict. However, securing ethics approval for such studies can be challenging. From an academic perspective this restricts the ability of exploratory data science research and limits our ability to train the next generation of health data scientists. Synthetic data sets would offer a safe way to make health data broadly available to many researchers and students for training and data literacy.

The concept of virtual clinical trials has been around for some time but here too, personal health data privacy is also a concern. The ability to leverage synthetic data techniques to better design clinical trials by testing hypothesis on synthesized data sets has the potential to enable rapid study design before ever touching a patient. The ability to integrate patient-facing input such as apps or other forms of data capture while maintaining privacy is a significant opportunity to transform how clinical trials are conducted.

How Good is the Quality of Synthetic Data?

The synthetic data was evaluated using multiple approaches. The first is to use generic metrics that compare the structure of the synthetic data to the real data. For example, we compare whether the number and type of events in the synthetic data are similar to those in the real data. The second approach is to perform a substantive epidemiological analysis on both datasets and see if we would draw the same conclusions. In the current project we built models to predict mortality and hospitalization.

Our results indicated that the synthetic data was similar to the real data structurally, and the substantive conclusions that would be drawn from the statistical models would be the same, even for complex multivariate models. This gives us some assurance that the synthetic data can be a useful proxy for real data in a number of specific use cases.

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Health City is a Canadian not-for-profit Corporation that works with clinicians, innovators, philanthropic organizations, and companies to develop new pathways of care that can drive better health outcomes and economic development in the health sector. Our focus is on transforming innovations from our health sector into solutions that have commercial application and global relevance, adopting them for impact locally and scaling them for export to global markets.

For more information, visit www.edmontonhealthcity.ca.

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2020 Health City Press Releases

Appendix B

Health City

Source: Health City

May 26, 2020 06:00 ET

Local Company uses AI to Bring Screening to the Point of Care

Edmonton Innovator Develops World-Class Technology to Drive Better Outcomes

EDMONTON, Alberta, May 26, 2020 (GLOBE NEWSWIRE) -- Health City is pleased to announce a collaboration between MEDO.ai, WestView Primary Care Network and Alberta Innovates to initiate a key pilot study of MEDO.ai's artificial intelligence-augmented 3D ultrasound platform.

Edmonton-based MEDO.ai, following their "Engineering of the Future" award from Falling Walls Venture 2019 in Berlin, and has been accepted into the Alberta Innovates' Accelerating Innovation into Care (AICE) – Market Access Program. AICE is a key entrepreneurial ecosystem support program that provides digital health tech companies in Alberta with the opportunity to implement their innovative solutions in a real-world setting anywhere in North America.

"We could not be more excited about our partnership with the WestView Primary Care Network and Health City," stated David Quail, MEDO.ai's Vice President, Technology. "This partnership not only represents an opportunity to prevent hip osteoarthritis for thousands of Albertans every year but is also a critical step towards delivering MEDO.ai's artificial intelligence-based products into care. We now have the opportunity to deliver a service to remote and rural communities, which would normally only be available at large hospital centres."

By introducing this innovative new technology at the point of care, the solution has the potential to be deployed in remote communities that do not have ready access to major centres and hospitals. Early intervention drives better patient outcomes and reduces overall costs to the system.

"This is a fabulous example of the kind of collaboration that can occur between primary care and the other parts of the health care system to bring better care to more of our population. It is a real opportunity to promote better health care solutions through innovation," stated Dr. Allan Bailey, Director of Research and Evaluation, WestView Physician Collaborative and WestView Primary Care Network.

"Our local innovators are working to improve the lives of Albertans in direct partnership with health care providers," shared Dr. Antonio Bruni, Health City's Director, Business Development. "They are developing tools and creating a platform to test these solutions in real-case settings. We recognize that funding programs, like AICE are also instrumental in moving these initiatives forward."

Health City seeks to engage strong local leaders with a global vision. This project demonstrates the true spirit of collaboration and the potential to transform health for better outcomes and economic development. Technology in the community is the direction that health is going, and Alberta is taking a bold step to make this happen. Our region is a hub of world-class technology, talent, and innovation.

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This collaboration brings innovative new technology to the point of care. Alberta-developed health care solutions provide local impact with global relevance — providing better access for patients and better tools for clinicians. Health City takes tremendous pride in showcasing the world-class technology and talent of the region.

About MEDO.ai
MEDO is an artificial intelligence technology startup company headquartered in Edmonton, Canada. MEDO builds cutting edge artificial intelligence that pairs with ultrasound devices to facilitate novice users' ability to detect common and critical conditions, even in remote and rural areas. MEDO believes that such technology will transform ultrasound for the 21st century. For more information, visit https://medo.ai/.

About Health City
Health City is an economic development organization that catalyzes, accelerates, and connects the health innovation community in Edmonton and surrounding regions. Health City promotes collaboration to create a vibrant health industry with improved health and social outcomes for our citizens. Our focus is on transforming innovations from our health sector into solutions that have commercial application and global relevance, adopting them for impact in Edmonton, and scaling them for export to global markets. For more information, visit www.edmontonhealthcity.ca.

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Health City
Edmonton, Canada

Source : Health City

07 juil. 2020 08h00 HE

Central Alberta Patients Participate in Home Health Monitoring Trial

Rural Patients Gain Access to an Innovative Model of Care

EDMONTON, Alberta, July 07, 2020 (GLOBE NEWSWIRE) -- Patients in central Alberta are participating in a home health monitoring technology trial. Wolf Creek, Drayton Valley, and Kalyna Country Primary Care Networks (PCNs) will be the first Central Zone PCNs to trial the technology for people with chronic health conditions, with potential to add more Central Zone PCNs in subsequent phases. The initiative is a collaborative effort between, Alberta Central Zone Primary Care Networks (PCNs), TELUS Health, Boehringer Ingelheim (Canada) Ltd., Alberta Innovates, Health City, and Alberta Health Services.

The initiative aims to implement and rapidly scale proven digital technologies to alleviate stress on the health system, while serving as a national model for ongoing stability of care. The project will test the efficacy of virtual monitoring solutions to care for a large number of patients at one time while in their own homes, and the ability to provide care in rural locations.

Dr. Jordan La Rue, a family physician in Sylvan Lake who is also Central Zone PCN Committee Co-chair noted, "as innovation hubs for team-based family medical services, PCNs are an ideal place to try out technology that may enhance access to high quality healthcare."

Andrea Thain Liptak, Committee Co-chair and Executive Director of Public Health, Primary Care, Chronic Disease Management, Children's Rehab Services, Allied Health, and Community Admin Support with AHS Central Zone, added, "we are excited to explore this new model of care through the Central Zone PCN. Our partnership between all Central Zone PCNs and Alberta Health Services puts us in a unique position to spread and evaluate innovative practices such as Home Health Monitoring."

"This collaboration is an opportunity to tangibly improve the lives of Albertans by using innovative approaches and technology to provide increased access to care in rural communities and addressing the challenges patients with chronic conditions face," stated Reg Joseph, Health City's CEO. "The Health City model supports early intervention in patient needs to drive better health outcomes and lower overall cost to the system, resulting in positive health impacts and economic impacts for our region. This project is the actualization of that model."

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"Boehringer Ingelheim's collaboration with Health City & Central Zone PCNs highlights our dedication to delivering innovative solutions that serve current and future healthcare needs," said Andrea Sambati, President and CEO, Boehringer Ingelheim (Canada) Ltd. "The Central Zone PCN Home Health Monitoring Project will not only improve outcomes for those most at risk in primary care, but also provide significant benefits to the healthcare system, such as reducing hospitalizations and overall healthcare costs."

The TELUS Home Health Monitoring (HHM) solution allows patients to upload, view and trend their daily biometric results, such as temperature and blood pressure, and interact with their clinicians from home. The patient's physicians and clinical team use the dashboard to view and monitor large groups of patients and interact with them to provide any necessary support and resources.

"As a fellow Albertan, I'm proud that our province is the first to deploy Home Health Monitoring for chronic disease management and COVID-19 response in the primary care setting; enabling clinicians to remotely observe their patients with these conditions not only keep them safe from further exposure but also helps to alleviate some of the pressures on the healthcare system," said Shane Sabatino, vice president, public sector, TELUS Health.

"This collaborative aligns strongly with our innovation priorities at Alberta Innovates- namely, empowering and enhancing patient-centered care and realizing efficiencies in care pathways, by leveraging digital health solutions. We are in the fortunate position to partner with all the players involved to accelerate a timely and valuable digital innovation into care," said Tim Murphy, Vice President of Health, Alberta Innovates.

This project brings healthcare technology leaders together with local networks, providing new tools to patients and clinicians to drive positive health outcomes for the community. Health City is proud to be a part of the collaboration to bring health transformation to the Alberta Central Zone Primary Care Networks.

About Health City

Health City is a Canadian Not-for-profit Corporation that works with clinicians, innovators, philanthropic organizations, and companies to develop new pathways of care that can drive better health outcomes and economic development in the health sector. Our focus is on transforming innovations from our health sector into solutions that have commercial application and global relevance, adopting them for impact locally and scaling them for export to global markets.

For more information, visit www.edmontonhealthcity.ca.

About Boehringer Ingelheim (Canada) Ltd.

Making new and better medicines for humans and animals is at the heart of what we do. Our mission is to create breakthrough therapies that change lives. Since its founding in 1885, Boehringer Ingelheim is independent and family-owned. We have the freedom to pursue our long-term vision, looking ahead to identify the health challenges of the future and targeting those areas of need where we can do the most good.

As a world-leading, research-driven pharmaceutical company, more than 51,000 employees create value through innovation daily for our three business areas: Human Pharma, Animal Health, and Biopharmaceutical Contract Manufacturing. In 2019, Boehringer Ingelheim achieved net sales of 19 billion euros. Our significant investment of almost 3.5 billion euros in R&D drives innovation, enabling the next generation of medicines that save lives and improve quality of life.

We realize more scientific opportunities by embracing the power of partnership and diversity of experts across the life-science community. By working together, we accelerate the delivery of the

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next medical breakthrough that will transform the lives of patients now, and in generations to come.

The Canadian headquarters of Boehringer Ingelheim was established in 1972 in Montreal, Quebec and is now located in Burlington, Ontario. Boehringer Ingelheim employs approximately 600 people across Canada.

More information about Boehringer Ingelheim can be found at http://www.boehringer-ingelheim.ca or in our annual report: http://annualreport.boehringer-ingelheim.com.

About TELUS Health and Payment Solutions

TELUS Health is a leader in digital health technology solutions such as home health monitoring, electronic medical and health records, virtual care, benefits and pharmacy management as well as personal emergency response services. TELUS Health is leveraging the power of technology to improve access to care and revolutionize the flow of health information to create better outcomes for Canadians while facilitating collaboration, efficiency and productivity for physicians, pharmacists, health authorities, allied healthcare professionals, insurers, employers and citizens. TELUS Payment Solutions complements our health solutions by delivering secure, industry-compliant payment and lending solutions that connect lenders, payors, insurers, extended health care providers and financial institutions to their customers across Canada.

For more information please visit: www.telushealth.com and www.telus.com/payment-solutions.

About Primary Care Networks

Primary Care Networks are a made-in-Alberta approach to improve and better coordinate patient access to primary care. Primary health care is the first point of contact most people have with the health system. In each PCN, a group of family doctors works with Alberta Health Services and other health providers such as pharmacists, nurses, mental health therapists, and dietitians to provide excellent health care. Each PCN designs programs and services to best meet local needs, which may vary from area to area. In the Central Zone, there are 12 PCNs that work together through the Central Zone PCN Committee to identify and coordinate opportunities for healthcare improvement throughout the Zone.

About Alberta Innovates

Alberta Innovates (AI) is a provincial agency working to address today's challenges, create new opportunities and forge a healthy, sustainable, and prosperous future for Albertans today and for generations to come. AI is well positioned to advance digital health technologies to accelerate improvements in the quality and long-term sustainability of our health system and the health of Albertans.

For more information, visit https://albertainnovates.ca.

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Source : *Health City*

22 sept. 2020 08h30 HE

Virtual Care Pharmacy Services Offered in Alberta Long-Term Care Facilities

Patients and Care Teams Across Alberta Increase Connectivity with Virtual Care Platform

EDMONTON, Alberta, Sept. 22, 2020 (GLOBE NEWSWIRE) -- Residents in long-term care facilities in Alberta can now access care from their pharmacist remotely thanks to a new pilot project that uses virtual care to improve connectivity between patients and healthcare providers. The CareRx Alberta Virtual Care Project is a collaboration between CareRx Corporation ("CareRx") (TSX: CRRX), a Canadian specialty pharmacy care provider, pharmaceutical company Boehringer Ingelheim (Canada) Ltd, and Health City.

CareRx pharmacists in Alberta are using CloudMD's virtual health platform, Livecare, to provide care to residents and assess the impact that virtual care can have on chronic disease management, particularly focused on residents with diabetes given its prevalence in the long-term care setting. The project aims to optimize treatment by utilizing a screening tool to assess cardiovascular risk reduction and customize care for each resident.

"Pharmacists play an important role as part of the long-term care team and that role is expanding to include chronic disease management and proactive medication optimization," said Ryan Stempfle, Vice President and General Manager (Western Canada) of CareRx. "Virtual care platforms are expected to increase connectivity with residents and create more opportunities to provide timely, preventative care to those residents that need it the most."

CareRx selected Livecare for the project due to its user-friendly platform and customizable experience. Using the platform, residents will have the ability to remotely access services such as pharmaceutical consultations. Livecare's technology will allow a full integration into CareRx's current pharmacy services, with the opportunity for further integration as residents' needs evolve. The remote services will provide residents with access to care in a safe environment and reduce the risk of exposure to illness, especially in light of COVID-19.

"Providing an integrated virtual care option for long-term care residents will increase access to care for a vulnerable population, reducing their risk of exposure and creating a connected care community for patients managing chronic conditions," said Reg Joseph, Health City's CEO. "Increased access to care results in early intervention, better health outcomes for residents, and lower overall cost to the health system."

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"Boehringer Ingelheim's collaboration with CareRx and Health City highlights our dedication to delivering innovative solutions that serve current and future healthcare needs," said Andrea Sambati, President and CEO, Boehringer Ingelheim (Canada) Ltd. "The CareRx Alberta Virtual Care Project will not only improve outcomes for an at-risk patient population, but also provide benefits to the healthcare system, such as reducing hospitalizations and overall healthcare costs."

This project provides patients and care teams with new tools to increase connectivity and drive positive health outcomes for the community. Project evaluations will inform future expansions.

About Health City

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For more information, visit www.edmontonhealthcity.ca.

About CareRx Corporation

CareRx is Canada's leading provider of specialty pharmacy services to seniors. We serve approximately 50,000 residents in over 900 seniors and other communities, including long-term care homes, retirement homes, assisted living facilities, and group homes. We are a national organization with a large network of pharmacy fulfillment centres strategically located across the country. This allows us to deliver medications in a timely and cost-effective manner and quickly respond to routine changes in medication management. We use best-in-class technology that automates the preparation and verification of multi-dose compliance packaging of medication, providing the highest levels of safety and adherence for individuals with complex medication regimes. We take an active role in working with our home operator partners to promote resident health, staff education, and medication system quality and efficiency.

For more information, visit www.carerx.ca.

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More information about Boehringer Ingelheim can be found at http://www.boehringer-ingelheim.ca or in our annual report: http://annualreport.boehringer-ingelheim.com.

About CloudMD
For more information on CloudMD and the Livecare telehealth solution visit https://investors.cloudmd.ca.

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Source : *Health City*

21 oct. 2020 10h00 HE

Alberta Project Validates First Synthetic Health Dataset in Province

Project Increases Data Accessibility While Maintaining Patient Privacy

EDMONTON, Alberta, Oct. 21, 2020 (GLOBE NEWSWIRE) -- The health innovation community has one more approach towards increasing the timely and safe utilization of health data thanks to a research project co-sponsored by Health City and the Institute of Health Economics (IHE) in partnership with Alberta Innovates, Replica Analytics, and University of Alberta. Unique in Canada, this project was initiated to provide insight into the value and validity of synthetic (simulated) data in health services research. The promising results have been submitted for publication.

Health City and its partners identified synthetic data generation as one approach to leverage the region's capacity and partnerships in data, artificial intelligence, and machine learning to fuel health system innovation. Synthetic data accurately simulates patient-derived datasets and, although generated from real world data, is not linked to the individuals from whom the data were derived. Because synthetic data contains no real patient health information, the datasets have the potential to be shared freely among investigators or those in industry without raising patient privacy concerns or contravening the Alberta *Health Information Act*. The project engaged the Office of the Information and Privacy Commissioner of Alberta to ensure synthetic data can be used in a way that respects the privacy of citizens.

"It was important we demonstrate not only that we protect the data privacy of Alberta," said Mark Diner, Director at Alberta Innovates, "but that the OIPC understands how the process works as well. Albertans must have confidence in game-changing, data-driven innovation."

"Alberta has the largest regional health authority in Canada, and the opportunity to use data to drive improved health outcomes is immense. Complex healthcare datasets can support research, policy development, and quality improvement projects across the province, but we need advanced tools like synthetic data to make use of these data sets safely. Due to its complexity, the notion that synthetic data would be able to sufficiently capture and simulate real world data in Alberta was unlikely," said Dr. Dean Eurich, Professor at University of Alberta. "Remarkably, I was somewhat shocked to observe the research results could be replicated with a fairly high level of precision within synthetic data. These synthetic datasets will be extremely beneficial for researchers to share data across jurisdictions. They will also allow academics and students easier access to health data and support more efficient training of the next generation of health data scientists."

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Demonstrating the viability of synthetic datasets creates further opportunities for innovators to work alongside the health system while preserving patient privacy. Creating further opportunities for health innovation to occur in Alberta is a component to driving economic development for the province.

"Better data analysis techniques lead to better healthcare. Synthetic data provides a safe way for talented data scientists from community, academia, and industry to work alongside the health system to drive improved health and validate novel solutions developed in Alberta for Albertans," said Reg Joseph, CEO, Health City.

"Alberta has a rich repository of health data that can provide important insights to support improvements in health care and improved use of health care resources," stated Dr. Chris McCabe, CEO of IHE. "Synthetic data is a promising way to address the challenges of using personal health data directly. We look forward to testing this out and providing lessons on how we can use it for improved health and economic benefit for Alberta."

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For more information, visit www.edmontonhealthcity.ca.

About Institute of Health Economics

Institute of Health Economics (IHE) is a not-for-profit health research organization providing expertise to provincial and national stakeholders from the public and private sectors in evidence production, synthesis and application; economic analysis; and policy engagement. It was founded in 1995 on the belief that the best solutions to healthcare problems are the result of a collaborative approach, with all stakeholders at the table sharing insights and information in support of improved health outcomes and a thriving economy.

For more information, visit www.ihe.ca

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2020 Central Zone MLA Conversations

Appendix C

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MLA Name	Central Zone Region
Garth Roswell	Vermillion-Lloydminster-Wainwright
Jason Stephan	Red Deer South
Deron Bilous	Edmonton-Beverly-Clareview
Honourable Rick Wilson	Maskwacis-Wetaskawin (Minister of Indigenous Relations)
Honourable Nathan Cooper	Olds-Didsbury-Three Hills (Speaker of the Legislative Assembly of Alberta)
Honourable Adriana LaGrange	Red Deer North (Education Minister)
Ronald Orr	Lacombe-Panoka
Jackie Lovely	Camrose

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Health City Publication

Appendix D

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CANADIAN COLLEGE OF
HEALTH LEADERS
COLLÈGE CANADIEN DES
LEADERS EN SANTÉ

Health City: Transforming health and driving economic development

Reg Joseph, MBA[1] ●; Antonio Bruni, PhD[1]; and Chris Carvalho, PMP[1]

Abstract

Health City was established in the fall of 2018 as a Canadian not-for-profit corporation that works with numerous stakeholders to develop new pathways of care that can drive better health outcomes and economic development in the health sector. Data, artificial intelligence, and extended reality are technology platforms in healthcare that are highlighted in the context of Health City Initiatives presented here. Health City's future area of focus in addressing challenges in procurement for health innovations is also discussed as a new approach that connects the health industry to healthcare. Health City has been an active stakeholder in health innovation in Edmonton and will continue to focus on developing a global niche and owning that space through meaningful partnerships and impactful projects. This will drive improved health outcomes and economic development for the Edmonton region and Canada that can be scaled globally.

Introduction

In the summer of 2017, the mayor of Edmonton, Don Iveson, with leadership from a steering committee,[1] launched Health City.[2] The intent stemmed from a confluence of factors that included the need to diversify our regional resource-based economy, increasing cost pressures on our health system while relative healthcare performance in Canada continued to decline,[3] and the Edmonton Region's potential to participate in the global disruption of the health sector.[4] These factors also apply broadly to the rest of Canada where provincial healthcare costs are approaching 50% of annual budgets in several Canadian jurisdictions.[5]

What is also clear is the opportunity for the municipality to play a role in health. Health is impacted by all levels of government. Typically, municipal governments do not play a substantive role in health planning or investment decisions. However, municipal investments often have direct impact on social indicators of health. If municipalities better understand these indicators and make investments that are coordinated, they unlock the ability to influence the entire health value chain. This enables the health system to act strategically and proactively in concert with the municipality to make an impact on both health costs and outcomes. Although a complex task, other global jurisdictions have accomplished this[6] and Edmonton must try as well.

The formation of Health City

Health City was officially established in the fall of 2018. Health City is a Canadian not-for-profit corporation that works with clinicians, innovators, philanthropic organizations, and companies to develop new pathways of care that can drive better outcomes and economic development in the health sector. Health City is Edmonton-championed with a national scope.

Health City develops and executes transformational projects that leverage innovation and talent to increase patient access and to foster effectiveness within care teams. In doing so, Health City creates an innovative "living lab" environment that promotes the development of regional innovation. In turn, regional innovation retains and attracts companies to scale regionally and export globally. By bridging non-traditional partnerships and deconstructing silos, Health City can achieve its mandate to diversify our economy, drive cultural change and policy adoption, and provide validation opportunities for regional health-based companies.

Health City initiatives: Responding to trends and needs in healthcare

The digitization of healthcare has been a complex discussion over the last decade, but it has now arrived. To win in digital health—in the same way Netflix won in media streaming—organizations need to rethink their business models to meet goals related to cost, quality, patient engagement, and customer experience. To proactively embrace digital health, it is important to take note of other industries where digital convergence is a way of life. The pressure is on the health sector to catch up and keep up. As other industries have learned, disruption through digital innovations is full of threats and opportunities.[7]

There are many innovators from industry who are looking at the big picture and developing novel solutions to well-established healthcare challenges. Health City embraces these innovators and includes them as part of the team for health innovation. This collaborative effort enables Health City to

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impact health transformation and, of equal importance, to drive economic development. Thus far, the initiatives that Health City has been involved in are mainly related to digital health. As such, data, artificial intelligence, virtual care, and extended reality are trending areas of influence in healthcare that will be highlighted in the context of Health City Initiatives presented in the next sections.

The data opportunity

The use of data in healthcare has been bantered about for some time. The opportunity is not about "monetizing" the data; the real opportunity around data is to effectively track and use the right data to drive better health outcomes. Like in other industries, there is no reason why health companies should not play a defined role to join forces with health systems to address key public health or operational challenges in a transparent manner.

Industry consultation and participation is often done in sectors such as energy, agriculture, and the auto industry. It is key to find a way to do the same in the health sector. Adopting policies for proper use of healthcare data enable nations to both nurture a domestic healthcare industry and to reshape interactions with multinational companies that provide healthcare goods and services. The underlying motivation is clear: publicly funded healthcare is invariably a valued social program but can also contribute to economic development.[8] In relation to data use, Health City has important initiatives underway.

One of the ways to address privacy with healthcare data is through the concept known as synthetic data. Synthetic health data sets are generated from real data sets that contain actual patient information. Statistical methods are used to maintain the quantitative properties of the original data set, yet importantly do not correspond to identifiable individuals from the original data set (the data set contains fictitious patient data). Thus, synthetic data maintains patient confidentiality. Since synthetic data contains no protected health information, the data sets can be shared freely among health investigators or those in industry, without raising patient privacy concerns or contravening the Alberta Health Information Act.

Health City is exploring the value of synthetic data in a collaboration with the Institute of Health Economics, Alberta Innovates, the University of Alberta, and an Ottawa-based start-up—Replica Analytics—as an innovation that can address existing reservations around de-identifying data, and the ability "re-identify" individuals' personal data.[9] This project is focused on achieving four key objectives, which are critical to the future scale and spread of a larger synthetic data initiative. These objectives are establishing a process for generating synthetic data that are representative of an existing Alberta Health database; identifying, documenting, and addressing the privacy and security concerns of key groups in Alberta (eg, Canadian Intellectual Property Office, data custodians, ethics boards) for future use and distribution of

the generated synthetic data set; analyzing and validating the synthetic data set to ensure their future utility; and presenting the results and outcomes to key government stakeholders that may assist in the development of required policy changes in data access, as well as acceptance of analyses conducted with synthetic data.

The initial stages of this work are expected to be completed by the fall of 2020. The anticipated outcomes could lay the foundation for future scale. Additionally, community and industry researchers may have increased opportunities for data accessibility and consequently, increased collaboration with the health system in a safe way that allows for the exploration of innovative solutions in various areas of healthcare.

Artificial intelligence to drive health outcomes

Remote and rural communities can be burdened with a lack of infrastructure and resources to ensure the delivery of adequate healthcare as compared to major centers. Equitable access to healthcare services is still a considerable barrier that must be addressed to meet the needs of these communities. Such barriers can lead to undiagnosed conditions that can result in long-term complications, straining an over-burdened acute care system. With rapid advancements in technology, closing the gap to equitable access is becoming a real possibility with solutions being developed within the Edmonton region. As an example, MEDO.ai, an Edmonton-based start-up, has developed technology which is being used in rural communities to aide in disease diagnosis and timely intervention. Through a partnership with Health City, WestView Primary Care Network (PCN), and Alberta Innovates, MEDO.ai has been able to deploy ultrasonography in remote and rural communities to diagnose hip dysplasia in newborns.[10] Harnessing the power of artificial intelligence, the technology aims to better diagnose hip dysplasia in patients, with the anticipation of leading to timely intervention for improved health outcomes at the point of care in community care settings.

Another Health City initiative began with a collaborative partnership with Boehringer Ingelheim (Canada) Ltd (BI). The goal is to leverage artificial intelligence to examine patient data, with a focus on the social determinants of health, to better address health issues (including seniors' health and chronic diseases). The project uses natural language processing on unstructured physician notes in patients' electronic medical records where information on the patients' social indicators of health often resides. Using such data, BI can develop risk prediction models that will support clinicians in augmenting and customizing care pathways for their patients.[11] The Health City partnership with BI is expected to drive innovation in the Edmonton region while yielding improved patient outcomes. The partnership, while in its infancy, has already created multiple collaborations with local innovators in the private sector, including Okaki Health Intelligence and AltaML, as well as partnerships with

the University of Alberta and SAGE Seniors' Association. At the heart of using artificial intelligence is the development of tools that can facilitate frontline providers to identify patients' needs, optimize care pathways, and focus on prevention.

Virtual care

Digital-based technologies not only address efficiency and improved tracking and measurement, but also enable basic tenets that Canadians hold dear, such as access to high-quality healthcare. While Alberta has slowly adopted virtual care, the COVID-19 pandemic has accelerated these changes thus creating opportunities to leverage gains and we are encouraged will likely to continue post-pandemic. Health City is currently involved in two key multiparty projects that demonstrate emerging models in virtual care delivery. The first is the Alberta Central Zone PCN Home Health Monitoring project (HHM). This initiative—a collaborative effort between Health City, Alberta Central Zone PCNs, Telus Health, BI, Alberta Innovates and Alberta Health Services—aims to deploy a community-based HHM solution for individuals with chronic conditions.

Patients across three PCNs in central Alberta will soon be participating in an HHM technology trial. The aim is to implement and rapidly scale proven remote monitoring digital technologies. This will alleviate stress on the health system while serving as a national model for ongoing stability of care. By reducing the risk of infection, enhancing patient recovery at home, and promoting self-management, it may be possible to shorten the time necessary for (post-pandemic) economic resurgence in Canada.

The second project pertains to virtual care delivery in Long-Term Care (LTC) facilities. Health City has partnered with Centric Health and BI to implement an initiative that will provide access to remote treatment to senior residents in LTC facilities in rural communities. In view of the scope of practice of Alberta Pharmacists, the Centric Health team will work closely with the selected LTC sites to establish a process whereby the pharmacist will send a daily schedule to the on-site staff member with a list of patients to be seen virtually. This project will be able to provide essential services to seniors while offering a proof of concept for how virtual services can be scaled across Centric Health and other organizations.

The overarching goal of virtual care Health City initiatives is to develop both operational and outcomes data around community-based models of care that can inform policy-makers as they consider virtual care solutions as part of the healthcare delivery toolset.

Extended reality

The extended reality market is also a key area of focus for Health City. In particular, *Enhanced Learning Incorporating eXtended Reality* (ELIXR) has the ability to bring Edmonton-based post-secondary institutions together under one umbrella, building critical mass for such an important health subsector. Educators and practice experts will have the ability to create virtual and augmented reality simulations, training, and learning experiences. Using agile strategies, content can be distributed collaboratively through ELIXR's network of publishers to ensure that high-quality, extended reality learning experiences are made widely available to benefit students' and practicing professionals' continuing education and development.

Health City's mandate is to help pave the way for the transformation of our health economy through connecting ELIXR to companies and organizations in Health City's network. This will enable a marketplace for both Business-to-Business and Business-to-Consumer transactions that will serve as an economic driver for extended reality in the health sector.

Health City's future areas of focus

One of the challenges to innovation is procurement. In most Canadian jurisdictions, when innovators initiate the process of demonstrating an application's utility on a broad scale, procurement presents a hurdle. This is true whether innovation is developed internal or external to the health system. Health City—through its collaborations with various stakeholders in government, private sector, and health systems—expects to facilitate the adoption of healthcare innovations by addressing barriers in procurement. These barriers include inadequate early warning, lack of engagement between procurers and suppliers, overly prescriptive and burdensome procurement processes, risk aversion, and procurement capability shortfalls.[12] Procurement teams often focus almost exclusively on the lowest up-front prices for products and services not fully considering the potential greater return on investment in a total cost of ownership model.

Health City's strategic initiatives and collaborations have the potential to facilitate embedding innovation in procurement policies and procedures while maintaining transparency, integrity, economy, openness, fairness, competition, and accountability as core fundamental principles of public procurement. A new approach that connects the health industry to healthcare, going beyond the traditional purchaser-vendor relationship that currently exists, is much needed. There is also an imminent need to address increasing healthcare costs while improving health outcomes that are stagnant at best.

Canadian innovation is not wishful thinking: It is already happening

Canadian innovation is already happening and Health City has been an active stakeholder. A tangible and exciting example is Edmonton's representation in the Canada-Chicago Mentoring

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Program (C2MP). C2MP was formed as a partnership between the Canadian Trade Commissioner Service and the Chicago Innovation Mentors at MATTER.health. C2MP delivers tailor-made mentorship focused on life sciences and healthcare innovators working in pharmaceuticals, health IT, and medical devices to Canadian companies. The competitive application process saw the admission of three Edmonton-based companies (RUNWITHIT Synthetics, UMAY Care, and Health Gauge) in the 2019 six-month program, emphasizing the strength of the Edmonton region's med-tech companies.[13]

As an opportunity to celebrate these companies, but also create opportunities of collision with C2MP and other local innovators, Health City hosted a unique forum to showcase the Program as part of its 2019 Breakfast Series. The panel-centric breakfast featured a participating C2MP mentor, regional innovators excelling within the C2MP, and the Canada Trade Commissioner Service. The anticipation is that more regional-based companies will apply to future C2MP cohorts, gaining access to expertise from mentors in the Chicago area while excelling and growing their companies locally. For those interested in following Health City's initiatives and exciting news, the web site https://edmontonhealthcity.ca/ and the Twitter account @Yeghealthcity are the places where the most current information can be found.

Conclusion

Canada's estimated spending is $264 billion in 2019, representing 11.4% of its gross domestic product. While many jurisdictions boast about their clinical and academic excellence globally, or innovations they have developed that are having global impact, most view the Canadian health systems through a single lens—a "cost centre" that needs to be managed. The progress and success achieved by Health City come in part from the organization's ability to host a table to explore projects that are informed by many stakeholders. Health City has an opportunity to drive innovation in the health system while simultaneously building a sector that can play a role in Alberta's economy. This combination will be even more vital in Alberta's post-pandemic recovery.

Overall, the emerging health economy is being disrupted by trends in healthcare, including digital health, virtual care, artificial intelligence, and extended reality. If the Edmonton region is to compete in these high-growth markets, Health City needs to continue to focus on developing a global niche and owning that space through meaningful partnerships and impactful projects. This will drive improved health outcomes and economic development for both the Edmonton region and Canada which can be scaled globally.

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