

PRECISION HEALTH STRATEGY



*‘Striving for improved health for Albertans through
research, innovation and education’*

Faculty of Medicine & Dentistry

Full Report

January 2020

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PREFACE TO THE FACULTY OF MEDICINE & DENTISTRY'S PRECISION HEALTH INITIATIVE

BACKGROUND AND RATIONALE

“Precision Health” is a transformation, a new approach to health; it focusses on greater precision in the prediction, treatment and prevention of disease, and the ecosystem necessary to fulfil this.

The generation of new health technologies, and the health and economic benefits of this disruptive era are becoming significant. Innovations in Precision Health are rapidly becoming new economic drivers in the health sector and are changing the delivery of health care globally. Many countries, including the UK, USA, France, Germany, Australia, India, and China are investing heavily to ensure that they realize the benefits from creation and adoption of precision health approaches into healthcare.

Alberta's research and health system environment presents an unprecedented opportunity for the Faculty of Medicine & Dentistry (FoMD) to lead and deliver on a Precision Health strategy. The University of Alberta and the Faculty have invested heavily in discovery, translational, and clinical and implementation sciences to create a strong framework of 'Precision Health' research programs, platforms and technologies. In collaboration with the University of Alberta's Machine Intelligence Institute (Amii), the Faculty is also uniquely poised to apply advanced approaches in artificial intelligence and machine learning to create new products and processes that improve care and care delivery. Further, Alberta's single healthcare system and the new pan-provincial electronic health record (*ConnectCare*) establishes a unique system to discover, trial and adopt (where appropriate) new 'Precision Health' products, processes, programs and policies.

THE PRECISION HEALTH FRAMEWORK

The vision for the Faculty's Precision Health initiative is to coordinate our strengths and assets and develop a framework that supports discovery, validation, and clinical adoption of Precision Health products and processes while focusing on areas relevant to the needs and interests of the health-system, industry and our research community.

As shown in the figure below, the 'health innovation lifecycle' for Precision Health consists of the following inter-related components: (1) research and discovery, (2) development and validation, (3) evidence generation (e.g. clinical trials) and commercialization (where applicable), and (4) integration/adoption and knowledge transfer into practice.

The University, the Faculty, and our partners (e.g., Alberta Health Services) are home to significant assets and established research programs that span this framework – and through collaboration and co-development we are poised to lead the world in:

- Reclassifying disease via integration and analysis of 'omics' data with clinical data
- De-risking newly discovered Precision Health technologies to increase their commercial value
- Developing evidence and processes to support implementation of new Precision Health products and approaches
- Training the future workforce to deliver on 'Precision Health' healthcare and research

'Health Innovation Lifecycle' for Precision Health



SCOPE AND PROCESS FOR THIS INITIATIVE

The decision by the FoMD to develop research and education programs in Precision Health goes back to the spring of 2016 when the Faculty established the *'Alberta Consortium to Implement Precision Medicine'*. Given the broad mandate of the Consortium, its work was soon adopted by the Alberta Academic Health Network (AAHN), and following much stakeholder engagement the AAHN produced the *'Precision Health for Alberta – A Prospectus'* document (January, 2017), that was presented to government.

Throughout 2016, the Faculty continued to develop momentum and strategy in Precision Health for both the University and the Faculty. Notably, the Faculty led the strategic establishment of the **University of Alberta Signature Area in Precision Health** that was announced by the University in the fall of 2018. As a soft launch for this new University priority, the Faculty hosted a *'Gairdner Symposium in Precision Health'* (November 2018). On the provincial front, the AAHN and its stakeholders produced the *'Alberta Precision Health Strategy'* (April, 2018) and the *'Alberta Precision Health Implementation Plan'* (December, 2018). The AAHN continues to lead the implementation of aspects of the provincial PH strategy, with participation by the Faculty.

During 2019, the Faculty focused on developing a detailed Precision Health strategy that would incorporate our specific strengths and interests. The *Faculty of Medicine & Dentistry Precision Health Steering Committee* (membership noted below) oversaw development of the strategy.

The Steering Committee functioned in part by establishing a series of agile Task Force Groups to inform the strategy. Task force groups addressed the following areas: Surveying FoMD for PH Interests and Strengths; Artificial Intelligence/Machine Learning (A/ML) Applied to Health; AI/ML Capacity Building; Education & Engagement for PH; Funding & Grants for PH; Developing Themes & Teams for PH; and Delivering PH Workshops to Further Define Research Themes and Projects.

Consultation with all Department Chairs and Institute Directors also informed the strategy. Further, individual meetings with stakeholders, including representatives from Alberta Health Services, Alberta Innovates, various government agencies, and the private sector informed specific sections of the strategy.

Thus, this report represents a collection of information from many inputs, including surveys, consultations and focused workshops. The Executive Summary captures the main elements of the strategy and detail is available in key Task Force Reports provided as Appendices.

In closing, and speaking on behalf of the Steering Committee, we hope that the Faculty finds this report valuable in advancing this important area for the health and well-being of the public and patients whom we serve.



Deborah James, PhD
Lead, University of Alberta and Faculty of Medicine & Dentistry Precision Health Initiative

FACULTY OF MEDICINE & DENTISTRY PRECISION HEALTH STEERING COMMITTEE MEMBERS

- Dennis Kunimoto, MD, Interim Dean, Faculty of Medicine & Dentistry; Chair, Precision Health Steering Committee
- Deborah James, PhD, Executive Director, Innovation, Faculty of Medicine & Dentistry; Co-Chair, Precision Health Steering Committee
- Ulrike Brockstedt, PhD, Associate Director, Precision Health Initiative, Faculty of Medicine & Dentistry
- Amit Bhavsar, PhD, Assistant Professor, Department of Medical Microbiology and Immunology, Faculty of Medicine & Dentistry
- Robert Burrell, PhD, Professor and Chair, Department of Biomedical Sciences, Faculty of Medicine & Dentistry
- Derek Emery, MD, Professor and Chair, Department of Radiology, Faculty of Medicine & Dentistry
- Salena Kitteringham, BA, Director, Communications and Marketing, Faculty of Medicine & Dentistry
- Xin-Min Li, MD, Professor and Chair, Department of Psychiatry, Faculty of Medicine & Dentistry
- John Mackey, MD, Professor, Department of Oncology, Faculty of Medicine & Dentistry
- Michael Mengel, MD, Professor and Chair, Department of Laboratory Medicine & Pathology, Faculty of Medicine & Dentistry
- Neesh Pannu, MD, Professor, Department of Medicine, Faculty of Medicine & Dentistry
- Chris Power, MD, Vice-Dean Research, Faculty of Medicine & Dentistry
- Lawrence Richer, MD, Associate Dean, Clinical and Translational Research, Faculty of Medicine & Dentistry
- Daryl Silzer, BPAS, Assistant Dean, Advancement, Faculty of Medicine & Dentistry
- Oksana, Suchowersky, MD, Professor, Department of Medicine, Faculty of Medicine & Dentistry
- Mark Taylor, MSc, Senior Director Research, Faculty of Medicine & Dentistry
- James Young, PhD, Professor and Chair, Department of Physiology, Faculty of Medicine & Dentistry

EXECUTIVE SUMMARY

Alberta's research and health system environment presents an unprecedented opportunity for the Faculty of Medicine & Dentistry (FoMD) to lead and deliver on a Precision Health strategy to improve health for Albertans through research, innovation and education.

PH can be defined as “an approach to improving the health of individuals and populations by harnessing the power of data, biological and clinical sciences and new technologies, as well as the use of predictive analytics that also take into account personal, environmental and social determinants of health.”*

This holistic and interdisciplinary approach aims to provide targeted, predictive and individualized care through integration and interpretation of complex data sources - *that include those from clinical care, molecular analysis, real-life medical experiences, environmental exposures, lifestyle choices, mobile devices, and more* – to provide a higher resolution of health. This should allow to better identify individuals who would benefit from specific preventative or therapeutic interventions and spare those who will not from unnecessary, ineffective or harmful treatments.

In order to implement PH in Alberta we can take advantage of unique existing assets in the province as well as the infrastructure and exceptional expertise at UAlberta in this field. Alberta has a distinctive advantage with its province-wide health system and provider: Alberta Health Services (AHS). AHS is Canada's largest single provincial healthcare system with administrative health data collected on over 4 million people. AHS recently launched its advanced clinical information system—*Connect Care*—which will consolidate some 1,300 information systems and provide a single electronic health record. The system will allow health-care providers a central access point to patient information and best health-care practices. With *Connect Care* patients will also have access to their health information, enabling them to actively participate in their care. Empowering patients with information and with shared decision-making surrounding treatment approaches is a crucial component of the PH approach and holds enormous promise for improving treatment outcomes while reducing unwanted procedures and unnecessary therapies.

A key component of this new concept of healthcare delivery is ‘data’. Over recent years, access to health data from AHS, the Ministry of Health, community care and elsewhere has markedly improved. However, working in close collaboration with AHS and other partners, there are still areas where data access needs to be solved. As an example, improved access to diagnostic imaging data and images (MRI, CT, and ultrasound) could be an opportunity for Alberta; applying Artificial Intelligence methods to diagnostic imaging data combined with a patient's other clinical data could lead to new findings and products that could be easily scaled to a population level. Further, access to and analysis of data from other agencies and ministries (education, social services, judicial) will significantly inform our understanding of the social determinants of health.

The UAlberta and the Faculty have invested heavily in discovery, translational and clinical sciences to create a strong framework of research programs and sophisticated technologies necessary to deliver on PH (e.g., ‘omics’, imaging, drug target discovery, computational biology, clinical research and more). In collaboration with the UAlberta's Machine Intelligence Institute (Amii) the Faculty is also uniquely poised to apply advanced analytics – artificial intelligence (AI) and its subset machine learning (ML) – to improve care and care delivery. New digital tools have already been developed – and we need to also focus on how to translate new AI-driven product and processes into healthcare. This will require more AI experts that also have clinical and health system knowledge.

Further, Alberta provides a framework for system-wide health research, innovation and implementation through AHS's Strategic Clinical Networks (SCNs), the Alberta SPOR SUPPORT Unit (AbSPORU), Alberta Innovates, and the Northern Alberta Clinical Trials and Research Centre (NACTRC).

*Adapted from Genome Canada and CIHR “Genomics and Precision Health Forum, Oct 2016, Toronto

In this context the FoMD identified 3 PH research themes of existing strength and priority, each with 3 sub-themes, and also developed an education and engagement plan for PH:

- **AI Applied to Health:** disease management; risk prediction and outcomes research; social determinants of health
- **Precision Diagnostics:** imaging; biomarkers; genomics/omics/pharmacogenomics
- **Precision Therapeutics:** drug/vaccine discovery and development; innovative treatments; innovative clinical trials

In order to deliver on each of the PH themes and establish PH as an area of research and teaching excellence at UAlberta and within the Faculty of Medicine & Dentistry, the following recommendations were developed. They are based on reports of various PH Task Force groups, meetings with Department Chairs and Institute Directors, and consultations with UAlberta faculty members, AHS, the Ministry of Health, the Ministry of EDTT, Alberta Innovates, and other stakeholders.

1) Recommendations for 'AI Applied to Health'

- Establish an **Integrated Data Analytics Platform** that facilitates access to necessary data and analytic expertise; do so in close collaboration with AHS and also by leveraging other existing resources including the Alberta SPOR SUPPORT Unit (AbSPORU) Data Platform
 - Share, analyze and link traditional datasets, including data from the electronic health record, with data from new and emerging sources such as continuous patient monitoring and real-time laboratory results
- As part of the **Integrated Data Analytics Platform**, create an **AI in Health Unit** designed to support AI researchers and users from across FoMD, AHS, Amii, UAlberta campus and elsewhere (e.g., the private sector)
 - Provide expertise, advice and service in AI methods applied to health, algorithm validation, clinical IT and research IT infrastructures
 - Support scientists to access health data in collaboration with stakeholders (Ministry of Health, AHS); explore ways in which to stream-line data access
 - Foster connections between FoMD and other AI/ML experts
 - Monitor clinical impact of digital innovations using Canadian Academy of Health Sciences framework of metrics
 - House the Unit in association with NACTRC's Real World Evidence (RWE) Unit where connectivity to RWE studies/data, ethics, legal, and contract management exist
 - Collaborate with industry, patients, payers, and regulators to generate knowledge that guides clinical care, defines product use, and informs decision-makers
 - Serve an advocacy role: champion work with Alberta's Privacy Commissioner to build the Privacy Policy Architecture for Precision Health in Alberta
- Develop an AI/ML in health research program that leverages our unique strengths and interests
 - Establish research and innovation themes that develop and apply new AI/ML algorithms/tools to chronic disease management
 - Develop AI/ML tools to discover information from unstructured data (e.g., clinical notes/text), validate the information via the AI in Health Unit, the RWE Unit and pragmatic trial approaches; implement and scale findings
 - Create clinical decision support tools and visual interfaces showing AI-driven risk predictions for specific patients
 - Develop AI technology for rural areas to improve healthcare access and quality e.g. with AI-assisted interpretation of portable ultrasound, X-ray, MRI, CT, echocardiography

- Build capacity in data expertise in FoMD: e.g., analysts, bioinformaticians, statisticians, and AI experts with backgrounds in health sciences (refer to immediate action plan section, below)

2) Recommendations for 'Precision Diagnostics'

- Create a **Testing and Validation Hub for Diagnostics and Medical Devices** to support a host of research and innovation projects and provide specific supports and services to enable academic and private sector researchers to
 - Access translational research space and supporting infrastructure
 - Access data to support RWE generation and diagnostic development
 - Access clinically-annotated specimens including information on patient outcomes to validate biomarkers
 - Refine biomarkers and conduct preliminary clinical validation
 - Assess technical and clinical utility of new diagnostics and medical devices
 - Perform assay and prototype assessment and refinement under real world conditions
 - Perform assay and prototype operational validation under real world conditions
- Create PH Hubs/Units of Research Excellence, using a holistic approach to develop targeted prediction, prevention, early diagnosis and personalized therapy for: addiction & mental health care, rare genetic diseases, cardiovascular disorders and cancer
- Create a research unit for early interventions, focusing on energy metabolism and its regulation and risk of chronic disease & aging

3) Recommendations for Precision Therapeutics

- Develop a **Novel Drug Discovery and Personalized Therapeutics Program** that does not rely on time consuming and expensive chemistry efforts, and includes the development of
 - Midsize drugs (e.g. small cyclic peptides) through accelerated selection of functional molecules using a novel platform developed at the UAlberta based on genetically encoded libraries of small molecules for ligand discovery
 - Customized antisense oligonucleotides tailored to a specific patient
 - Phage therapies
 - Cell-based therapies: Car-T cell therapy (taking advantage of the existing Alberta Cell Therapy Manufacturing (ACTM) facility at UAlberta), senolytics (existing expertise at UAlberta), and islet cell stem cells (Edmonton Protocol II)
 - Structural vaccinology
 - N-of-1 trials as a design of testing personalized treatments

These areas of capacity and inquiry at the UAlberta could be developed into a unique therapeutic discovery program that also leverages our pre-clinical and clinical trial assets. The programs could be part of an innovative therapeutics hub that supports a diversity of research and innovation projects. With a focus on clinical adoption of PH insights, processes, products and practices the therapeutics hub will help bridge the gaps that stop many new discoveries and technologies from making it from bench to bedside. A strong emphasis will be on the development of commercial strategies for all new products. The therapeutics program would work in close collaboration with industry with the expectation that the Faculty would take products to Phase I stages, at which point industry would become involved.

Recommendations for FoMD PH Education & Engagement

- Develop a monthly PH Seminar and Rounds Series hosting internal and external speakers with a balance between basic & clinical research areas and interdisciplinarity where possible
- Develop an AI/ML seminar series in FoMD to include joint seminars/workshops with Amii
- Host PH Workshops with focus on omics, sequencing, bioinformatics, artificial intelligence, social and legal implications of omics and develop intensive multi-disciplinary 'PH Education' boot camps; potentially within the SPOR SUPPORT Unit framework
- Organize and participate in PH related conferences in Alberta; host 2nd Gairdner Symposium on Precision Health
- Review PH aspects in existing FoMD programs with the aim of integrating PH themes and lectures and embed AI/ML training into medical school curriculum
- Add topics on PH within existing continuous professional development courses and increase training opportunities to support the evolution of PH into clinical practice
- Develop multidisciplinary intra-university collaborative training opportunities (e.g. NSERC CREATE) and joint capstone projects among FoMD and e.g. Faculty of Science (Computing Science) and Amii researchers/students
- Collaborate with AHS and Alberta Health in engaging patients, families, and populations in opportunities to learn about PH
- Engage the provincial professional colleges (College of Physicians and Surgeons of Alberta, Alberta College of Family Physicians) in discussing the preparation of health care professionals to knowledgeably and competently apply PH approaches
- Create a collaborate environment that is favorable to PH and develop a plan for continuous engagement of FoMD researchers in the PH initiative
- Engage patients and the public and educate on data ownership, privacy and sharing

IMMEDIATE ACTION PLAN



- Strike a 'Task Force' responsible for developing a plan to establish an **AI in Health Unit** at FoMD, including solidifying partnerships, securing funding, establishing the Unit's operational mechanisms, hiring professional staff and recruiting academic leaders in AI applied to health
- Establish an Integrated **Data Analytics Platform** in close collaboration with AHS and through leveraging existing resources
- Establish a 'Precision Health Research Project Task Force' with the academic leads of Precision Diagnostics, Precision Therapeutics and AI Applied to Health to support establishment of the **Research and Innovation Hubs/Projects**

- Establish a FoMD ‘Precision Health **Education and Engagement** Steering Committee’ with representation from key stakeholders to develop metrics and deliverables for the uptake and implementation of PH educational strategies, training and engagement opportunities
- Develop a plan for continuous **engagement** of FoMD researchers on the PH research initiative
 - Offer opportunities for workshop participants to stay connected (FoMD webpage)
 - Offer regular seminar series and /or workshops to engage broader community
 - Develop and maintain concrete relationships with AHS SCN’s, patients, and PCN’s/community care centres to inform FOMD’s researchers and programs regarding patient and health system needs
- **Funding** and **Recruitment** strategy:
 - Use one of FOMD’s CRC positions (Tiers II) to recruit an AI applied to health expert and determine commitment of FoMD and its departments for salary funding during and beyond CRC award
 - Work with UAlberta and FoMD Advancement Offices to develop a strategy for philanthropic funding and other major funding opportunities to establish major research programs in diagnostics, therapeutics and AI/ML applied to health
 - Develop and implement a plan regarding the 2 AHS Translational Research Chairs
 - Work with OoR, FoMD, the VPRI Office (AVP Innovation), AHS, and funding agencies to secure major funding opportunities for the research & innovation hubs – e.g., apply to
 - BC Digital Supercluster initiative to help fund the Data Analytics Platform (ongoing)
 - Western Economic Diversification to help fund the research and innovation hubs

In order to achieve the above, the FoMD needs to develop mutually beneficial collaborations with researchers in the Faculty and across UAlberta, and with other relevant stakeholders. AHS needs to be included very early in research planning and the Faculty’s PH research strategy needs to be harmonized with the initiatives and mandates of the Research & Innovation Office of AHS.

This report establishes a PH strategy and an action plan for FoMD that can be used to implement PH into medical practice in Alberta to further improve health and achieve high quality, cost-effective care. It also offers significant opportunities for the creation of new technologies, processes and programs that may have commercial value.

Information regarding the FoMD PH Survey and the Gairdner Symposium on Precision Health held on campus in 2018 – plus the individual PH Task Force Reports, including their recommendations can be found in the following Appendices:

- Appendix 1: PH Workshops – Research Projects – Task Force Report
- Appendix 2: AI/ML Applied to Health – Task Force Report
- Appendix 3: AI Applied to Health – Capacity Building – Task Force Report
- Appendix 4: PH Education & Engagement – Task Force Report
- Appendix 5: FoMD Precision Health Survey
- Appendix 6: Gairdner Symposium Precision Health

Appendix 1: Precision Health Workshops – Research Projects Task Force Report



PRECISION HEALTH RESEARCH PROJECTS – TASK FORCE REPORT

TASK FORCE MANDATE

The Faculty of Medicine & Dentistry (FoMD) is developing a Precision Health (PH) strategy with oversight from the FoMD PH Steering Committee. The Committee established the ‘Precision Health Research Projects Task Force’ to engage faculty members in workshops and develop new research project ideas on the topic of precision health and for future funding opportunities. Please refer to Appendix A for details on Task Force membership, meetings and workshops, and to Appendix B for a detailed description of proposed research projects.

BACKGROUND & CONTEXT

The Faculty’s PH strategy leverages our strengths and assets, and aligns with broader UAlberta and provincial efforts in PH. Given that, PH is a faculty priority and the FoMD is a crucial component of the university's signature area in PH, we invited members of the FoMD to participate in a “Precision Health Survey” in March 2019. The purpose of the survey was to identify areas of established strength in PH, pinpoint gaps in infrastructure and talent to determine where further investment may be needed, and identify research themes and connect teams.

Based on the survey results (149 responses \pm 20%) and meetings with Faculty members, 3 core PH themes, each with 3 sub-themes were identified:

- 1) Precision Diagnostics
 - a. Imaging
 - b. Biomarkers
 - c. Genomics / Omics / Pharmacogenomics
- 2) Precision Therapeutics
 - a. Drug/Vaccine Discovery & Development
 - b. Innovative Treatments
 - c. Innovative Clinical Trials
- 3) Artificial Intelligence (AI) Applied in Health
 - a. Disease Management
 - b. Risk Prediction & Outcomes Research
 - c. Social Determinants

In this context, three PH theme-based workshops were hosted in October 2019 aimed at delineating research and training projects that can be presented to donors or targeted for grants to garner funding. Participants were also asked to suggest a team member (not necessarily from FoMD) that performs research relevant to their area of interest to be part of the theme-based workshops. In order to facilitate the dialogue across disciplines, participants were encouraged to engage in roundtable discussions.

GOALS

The purpose of the workshops was to brainstorm ideas for new PH projects with the goal to develop a PH strategy for the Faculty that will lead to improved health for Albertans through research, innovation and education. These projects will drive upcoming major fundraising campaigns. Another objective was to provide workshop participants with new networking opportunities within and outside FoMD.

OVERVIEW OF RESEARCH PROJECT IDEAS DEVELOPED IN WORKSHOPS

Precision Diagnostics Projects	Idea
1) Precision Health Hubs/Units of Excellence	<ul style="list-style-type: none"> Using a holistic approach to addiction & mental health care, rare genetic diseases, cardiovascular disorders and cancer to develop targeted prediction, prevention, early diagnosis and personalized therapy
2) 'Bill Gates' Centre/ Institute for Precision Health	<ul style="list-style-type: none"> Real world data access and platform for early screening & intervention of new diagnostics Efficient real world validation environment for diagnostics (access to data, samples, technologies, clinical standards) AI/ML research and innovation space with infrastructure, expertise and resources
3) Energy at Risk	<ul style="list-style-type: none"> Research unit for early interventions on outcomes, focusing on energy metabolism and its regulation & risk of chronic disease & aging
Precision Therapeutics Projects	Idea
4) Development of Novel Personalized Therapeutics	<ul style="list-style-type: none"> Using unique and innovative technologies available at UAlberta to reduce the time for preclinical drug discovery and development
5) a. Grow Your Own Cells for Your Own Disease	<ul style="list-style-type: none"> Cell-based interventions to treat your own disease (Car-T cell therapy, senolytics, islet cell stem cells)
b. 'Democratic' Optimized Treatments	<ul style="list-style-type: none"> N-of-1 trials as a design of testing personalized treatments
c. Small Project Ideas	<ul style="list-style-type: none"> New treatment options for epilepsy New antibodies for treating celiac disease Nutrition/obesity/metabolism studies
6) Tx Innovation	<ul style="list-style-type: none"> Platform to create the 'Innovation Wheel for therapeutics' – Large scale research with a focus on pre-clinical commercial activity
AI Applied in Health Projects	Idea
7) Precision Health Data Platform	<ul style="list-style-type: none"> Improved healthcare delivery by leveraging all available data and sharing data on a continuous basis
8) Chronic Disease Management Centre	<ul style="list-style-type: none"> Centre for personalized chronic disease management using holistic data approach
9) Primary Care - Frailty	<ul style="list-style-type: none"> From data to wellness: creating an 'aging well' hub

Please refer to Appendix B for a detailed description of proposed research projects.

SUMMARY AND RECOMMENDATIONS

Summary

An overarching theme among all workshops was the need for a platform that could facilitate access to data and analytic expertise necessary to deliver on each of the PH themes (diagnostics, therapeutics, AI) and the individual projects within. The implementation of an integrated data access and analytics platform will offer the opportunity to link traditional datasets, including data from the electronic health record, with data from new and emerging sources such as continuous patient monitoring and real-time laboratory results. The generation of novel, data-driven hypotheses and tools based on interpretable models will still require stringent validation and experimental testing which would form a critical arm of the platform. This is true for new diagnostic, therapeutic, medical device and AI (digital) tools/products and processes that are foundational to the Faculty's PH initiative.

This gap and need for an integrated data analytics platform was also noted in the Faculty's AI in Health Task Force Report where it was also suggested that the platform be housed in NACTRC and host personnel with AI/ML expertise. Members of this AI/ML working session noted that access to robust data is at the core of PH and our efforts to deliver individualized disease prevention and management. A series of research themes and individual research projects (those described in the AI section of this report) would have access to the platform that would support innovation and translation of PH digital approaches.

Members of the 'Diagnostics Workshop' felt strongly that the PH initiative would benefit with the creation of a testing and validation hub for new biomarkers and diagnostics (including medical devices). In addition to the data platform noted above, creation of a diagnostics 'innovation sandbox' (R&D unit) that is embedded within the clinical diagnostics setting is needed. The unit would provide specific supports and services to enable academic and private sector researchers to:

- Access translational research space and supporting infrastructure
- Access data to support Real World Evidence generation
- Access specimens with clinical data and information on patient outcomes information to validate biomarkers
- Refine biomarkers and conduct preliminary clinical validation
- Assess technical and clinical utility
- Assay and prototype clinical assessment under real world conditions
- Assay and prototype operational validation under real world conditions

A testing and validation hub for diagnostics and medical devices would support a host of research and innovation projects including those described in the workshop session.

Members of the therapeutics workshop determined that the Faculty's opportunity was to develop a robust drug discovery and development program around several unique technologies and infrastructures (e.g., Alberta Cell Therapy Manufacturing (ACTM) Facility) that exist on our campus. These approaches could include use of: a platform for genetically-encoded libraries for target-ligand discovery; the development of customized antisense oligonucleotides tailored to a specific patient; the development of phage therapies; the development of cell-based therapies; the development of structural vaccinology; and the development of senolytics in oncology. These are all areas of capacity and inquiry at the UAlberta and could be developed into a unique therapeutic discovery program that also leveraged our unique pre-clinical and clinical trial assets. It was discussed that we would place strong emphasis on developing commercial strategies for all new products and would work with the private sector (industry) to do so. The therapeutics hub would support a diversity of research and innovation projects including those described in this workshop session.

Recommendations

1. Establish an Integrated Data Analytics Platform, a Diagnostics Testing and Validation Hub, and a Therapeutic Discovery and Innovation Hub to serve as PH research and innovation centres for the Faculty and University
2. Work with OoR, FoMD, the VPRI Office (AVP Innovation), AHS, and funding agencies to secure major funding opportunities for the hubs – e.g.,
 - a. Apply to the BC Digital Supercluster initiative (RFP #4 in 2020) to help fund the Integrated Data Analytics Platform
 - b. Apply to WED to help fund the Diagnostics Testing and Validation Hub
 - c. Apply to WED to help fund the Therapeutic Discovery and Innovation Hub
3. Establish the Integrated Data Analytics Platform in close collaboration with AHS and through leveraging existing resources including the Alberta SPOR SUPPORT Unit (AbSPORU) Data Platform and other enterprise data platforms within AHS
4. Refine and co-establish the Faculty’s PH research strategy in collaboration with the Innovation Office of AHS and their initiatives and mandates.
5. Establish a ‘Precision Health Research Project Task Force’ with academic leads of Precision Diagnostics (M. Mengel), Precision Therapeutics (J. Mackey), and AI Applied to Health (L. Richer) to:
 - a. Support establishment of the research and innovation hubs as noted above
 - b. Evaluate and prioritize research projects that will form aspects of grant applications, philanthropy proposals, etc.
 - c. Refine projects with the help of workshop participants; determine lead(s) for projects
 - d. Develop a funding strategy for major funding opportunities (as noted above) to establish major research programs in diagnostics, therapeutics and AI/ML applied to health
6. Develop a plan for continuous engagement of FoMD researchers on the PH research initiative
 - a. Offer opportunities for workshop participants to stay connected (FoMD webpage)
 - b. The Engagement and Education Task Force group to offer regular seminar series and /or workshops to engage broader community
7. Work with UAlberta and FoMD Advancement Offices to develop a philanthropic funding strategy for creation of the research and innovation hubs and for delivery of a variety of PH research projects as detailed in Appendix B

APPENDIX: WORKSHOPS – RESEARCH PROJECTS

APPENDIX A: TASK FORCE MEMBERS, MEETINGS & WORKSHOPS

Members

Michael Mengel, Deborah James (moderators for PH Diagnostics Workshop); John Mackey, Matthias Gotte (moderators for PH Therapeutics Workshop); Lawrence Richer, Neesh Pannu (moderators for AI Applied in Health Workshop), and Ulrike Brockstedt

PH Workshop Planning Task Force Meetings

Jun 25, 2019
Sep 20, 2019
Nov 08, 2019

Workshops

Oct 11, 2019: **FoMD PRECISION HEALTH WORKSHOP—Precision Diagnostics**

Attendees:

Alan Wilman, Alison Eaton, Andrei Drabovich, Benjamin Adam, Bo Cao, Carmen Charlton, Christian Beaulieu, David Eisenstat, Deborah James, Frank Wuest, Gary Lopaschuk, Gina Rayat, Ian M MacDonald, Jacob Jaremko, James Hammond, Katherine Aitchison, Kumaradevan Punithakumar, Michael Mengel, Michael Serpe, Oksana Suchowersky, Raja Singh, Richard Camicioli, Robert Stobbe, Roger Zemp, Ross Tsuyuki, Russ Greiner, Soufiane El Hallani, Stacey Hume, Trevor Steve, Ulrike Brockstedt, Vivian Mushahwar, Walter Maksymowych

Oct 18, 2019: **FoMD PRECISION HEALTH WORKSHOP—Precision Therapeutics**

Attendees:

Andrea Haqq, Armin Gamper, Ayman El-Kadi, David Jenish, Deborah James, Fleur Huang, Hamdy El-Hakim, Harley Kurata, Holger Wille, John Mackey, Justin Ezekowitz, Luc Berthiaume, Matthias Gotte, Ratmir Derda, Salima Punja, Sunita Vohra, Toshifumi Yokota, Ulrike Brockstedt, Vincent Rogers

Oct 25, 2019: **FoMD PRECISION HEALTH WORKSHOP—AI Applied in Health**

Attendees:

Brenda Hemmelgarn, Cindy Westerhout, Daryl Silzer, Deborah James, Denise Campbell-Scherer, Eleni Stroulia, Finlay McAlister, Geetha Menon, Giovanni Ferrara, Giseon Heo, Hollis Lai, Jean Triscott, Joanna MacLean, Jonathan Duff, Lawrence Richer, Marjan Abbasi, Michael Stickland, Michelle Noga, Neesh Pannu, Padma Kaul, Randy Goebel, Rhonda Rosychuk, Roger Zemp, Russ Greiner, Sheny Khera, Ulrike Brockstedt

All workshops were held at the University of Alberta Faculty Club, Papaschase Room, 11435 Saskatchewan Drive, Edmonton, AB.

APPENDIX B: DETAILED DESCRIPTION OF PROPOSED PROJECTS FOR FOMD'S PH INITIATIVE

1) Precision Health Hubs / Units of Excellence

The Idea

Creating 'Precision Health Hubs/ Units of Excellence' with a holistic approach to health combining latest advances in prediction, prevention, early diagnosis, and personalized therapy with the goal to improve healthcare and lower its costs.

The Challenge

The healthcare system is currently not well prepared to deliver precision health at the individual level.

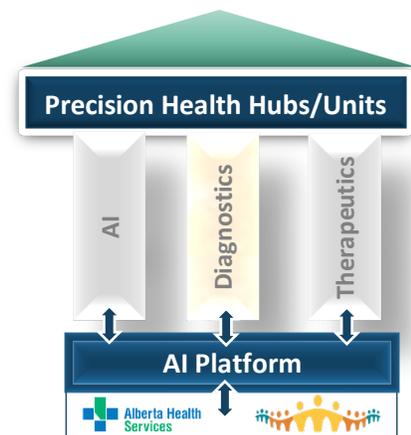
The Opportunity

Creating resources to apply precision health technologies (diagnostics) and streamlining the pathway from laboratory research to effective health system adoption and personalized treatment by:

- Assembling and supporting researchers and clinicians in an interdisciplinary program aimed at applying advanced genomic testing, disease screening and AI/ML data analysis technologies taking individual characteristics, from family and medical history to lifestyle and environmental factors into account
- Creating a comprehensive personal profile of patients to predict risk of disease, more accurately diagnose medical conditions, and tailor a treatment or prevention plan that is most effective
- Establishing a network of counseling services and other resources to help patients understand diagnostic information and make the most informed medical decisions
- Understanding how individual lifestyles, behavior, environment and genetics interact and how they affect an individual's health to systematically integrate these factors into the prevention, diagnosis and treatment of disease

Focus Areas / Expertise / Existing Strengths

1. ADDICTION & MENTAL HEALTH
 - Prediction (Genetics, Epigenetics, Environment, Indigenous/Immigrants)
 - Prevention & accurate diagnosis (biomarkers; pharmacogenomics; microbiome)
2. RARE GENETIC DISEASES
 - Metabolic genetics
 - Whole genome sequencing (WGS) – AI, bioinformatics, rapid diagnosis in eg. neonatal intensive care unit (NICU)
 - Research (Genome Canada), diagnosis (digital facial recognition, AI), psychosocial aspects
 - Prevention of macular degeneration; neuromuscular disorders (Duchenne muscular dystrophy (DMD), spinal muscular atrophy (SMA)); neurodegenerative diseases (Huntington, Hereditary Spastic Paraplegia (HSP)), Fragile X
3. CARDIOVASCULAR DISORDERS
 - Transplant rejection (prediction/ prevention); ischemic disease (metabolomics); cardiogenetics (clinics/ research/ exomes); stroke (AI, biomarkers)
4. CANCER (adult & pediatric)
 - Leverage the Alberta Tomorrow Project
 - Personalized treatments; biomarker



2a) Centre for Precision Health

The Idea

Create a 'Bill Gates Centre for Precision Health' to build relationships that span multiple sectors or domains related to precision health, and establish cross functional teams generating opportunities for AI Applied in Health projects for early screening and intervention.

The Challenge

Current knowledge and data are siloed, there are limited resources, services and infrastructure available to ensure data is accessible for research.

The Opportunity

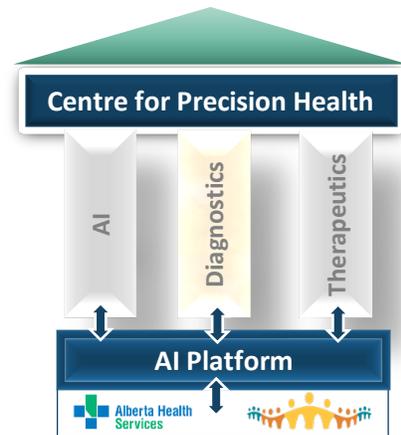
Invest in a Centre for Precision Health, a unit with AI/ML research and innovation space, infrastructure, expertise and resources to:

- Connect and build expertise across disciplines and institutions
- Align in push-pull relationship with the health care system
- Identify projects / tasks / research programs
- Work with partners to identify and advance promising discoveries
- Provide a framework for data aggregation, data storage or a data centre
 - Diagnostics
 - Personal data (eg. wearables)
- Develop AI/ML methods expertise and research services support
- Help desk: 1-800-precise
 - Matchmaker service for researchers interested in AI applied in health
- Develop training opportunities in AI/ML, statistics
- Connect individual labs & Connect Care
- Build capacity in data experts through collaboration and training
- Adopt AI in healthcare
- Develop Point of Care and telemedicine devices
- Provide researchers access to samples (with patient consent)

Focus Areas / Expertise / Existing Strengths

The Centre could offer particular expertise in:

- Intervention techniques (diagnostic imaging, eg. using new innovations in ultrasound technology (at UAlberta) to diagnose hip dysplasia)
- Prediction (for diseases with no current treatment available (e.g. Alzheimer), predicting progression or mild cognitive impairment (MCI)
- Multiple sclerosis (MS)
- Inflammatory bowel disease (IBD)



2b) Institute for Precision Health

The Idea

Creating a 'Bill Gates Centre/Institute for Precision Health' to provide an efficient validation environment for new biomarkers and diagnostic tests.

The Gap/ Challenge

Accessing appropriate testing and validation platforms that meet highly regulated clinical diagnostic test quality control standards, and translational research expertise.

The Opportunity

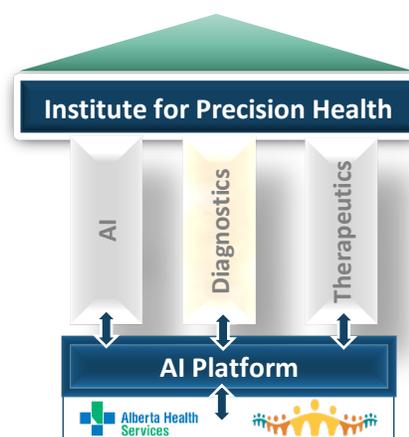
Investing in an institute that will provide infrastructure, specific supports and services to enable academic and private sector researchers to:

- Access data to support Real World Evidence generation
- Access research space and supporting infrastructure for diagnostic/assay development
- Access specimens with clinical data and information on patient outcomes information to validate biomarkers
- Refine biomarkers and conduct preliminary clinical validation
- Assess technical and clinical utility
- Perform assay and prototype clinical assessment under real world conditions
- Perform assay and prototype operational validation under real world conditions
- Connect users to other partner organizations
- Translate and commercialize leading-edge diagnostic tests, platforms, and processes
- Translate academic discoveries into Alberta's health care system
- House diagnostic technology platforms supporting both clinical service and research and development demands
- Serve as a portal for industry collaborations and partnerships, bringing private sector expertise to bear to help validate and commercialize high-value diagnostics
- Provide key equipment necessary to support biomarker validation and diagnostic development by the provision of data, samples, and space
- Provide specialized infrastructure and health system linkages that supports feasibility studies, development, validation, and evidence generation
- Work with partners to identify and advance promising discoveries, transforming them into validated investments

Focus Areas / Expertise / Existing Strengths

For disease-focused donors, the institute could provide particular expertise in:

- Auto-immune diseases (rheumatoid arthritis (RA), inflammatory bowel disease (IBD), multiple sclerosis (MS), transplant rejection)
- Cancer (eg. prostate, and liquid biopsies)
- Cardiovascular diseases
- Asthma
- Mental Health



3) Energy at Risk

The Idea

'Energy at Risk' is a research project focusing on energy metabolism and its role in chronic disease to develop data pipelines from measures to outcomes for early prediction.

The Challenge

Many diseases, especially those related to aging such as type 2 diabetes, many cancers, Alzheimer's disease, and Parkinson's disease, obesity and heart disease are associated with abnormalities in energy metabolism.

The Opportunity

Using specific biomarker for the detection and early predictions on outcomes of chronic diseases and aging, with a focus on:

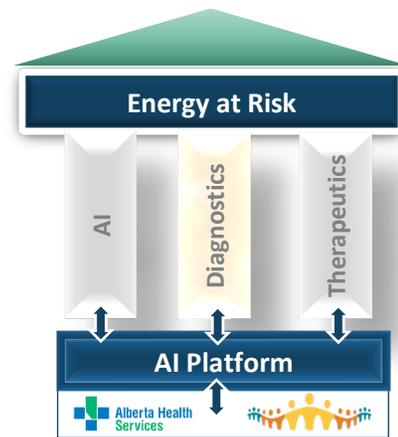
- Energy metabolism and its regulation, including
 - Alterations in cardiac energy metabolism, cardiac dysfunction and risk of chronic disease
 - Contribution of different energy substrates to ATP production in different pathophysiological conditions
 - Lipid metabolism and disease vulnerability
 - Pharmacological interventions targeting specific metabolic pathways
 - Changes in energy metabolism during aging
 - Developing new biomarkers for studies of heart disease, diabetes, aging, cancer, and neurodegenerative disorders

Measures

- Metabolic imaging (PET MRI, EEG)
- Genomics (metabolomics, proteomics, lipidomics)
- Wearables
- Biomechanics

Focus Areas / Expertise / Existing Strengths

- Cancer, heart disease, diabetes, neurodegenerative disorders, aging



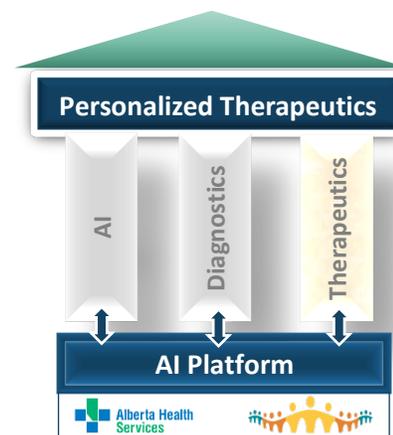
4) Personalized Therapeutics

The Idea

Development of novel 'Personalized Therapeutics' using innovative technologies that do not rely on time consuming and expensive chemistry efforts.

The Challenge

Drug discovery, including target identification and validation, assay developments and lead generation can take up to several years and costs can be enormous.



The Opportunity

Accelerating the drug discovery and development process by focusing on novel technologies that include:

- Midsize drugs (e.g. small cyclic peptides) through accelerated selection of functional molecules using a novel platform developed at the UAlberta based on genetically encoded libraries of small molecules (in the order of millions to billions) for ligand discovery
- Antisense oligonucleotides tailored to a particular patient based on specific pathogenic mutation–patient-customized oligos
- Phage therapies
- Cell based- therapies
- Structural Vaccinology
- Senolytics in oncology

Focus Areas / Expertise / Existing Strengths

- Structural biology
- Intelligent designs of vaccines and treatments

5a) Grow Your Own Cells for Your Own Disease

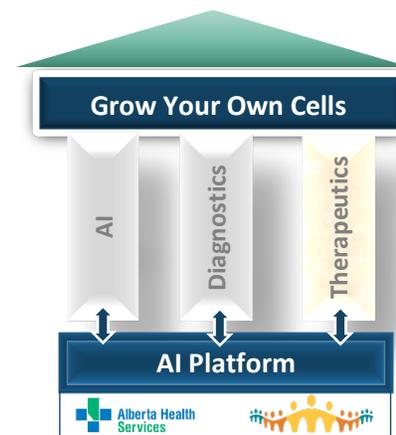
The Idea

'Grow Your Own Cells for Your own Disease' to treat your own disease to provide new therapeutic options to patients who currently have limited or no options for treatment.

The Opportunity

Harnessing the patient's own immune system to fight disease by offering cell-based interventions to treat their own disease, eg.

- Car-T cell therapy – Cancer
 - Patient's own T cells are extracted, modified, and returned to the patient
 - CAR-T cells are able to recognize and destroy cancer cells
 - Use the ACTM (Alberta Cell Therapy Manufacturing) facility for manufacturing cell-based therapy products and GMP cell therapy production for clinical trials
- Cell therapy in transplantation
 - Edmonton Protocol II
 - Improved islet cell transplantation procedure (autologous stem cells)
 - Potential to develop AI algorithms for predictors of success
- Cell therapy in immune modulation
- Senolytics
 - Proposed as second-line adjuvant tumor therapy



5b) Democratic Optimized Treatment

The Idea

Using *N-of-1 Trials* – the ultimate form of patient centered treatment – to generate population-level data

The Opportunity

Using N-of-1 trials to collect, aggregate and analyze data from multiple N-of-1 trials to generate population-level data on therapy response

- Organize province-wide recruitment
- Apply to chronic conditions (areas of application: palliation cancer, mental health, sleep disorders), and other conditions
- AI automation for aggregated learning and prediction
- Interface with Multi-Omics (genomics/ pharmacogenomics) platforms
- Integrate data in Connect Care

5c) Smaller Projects

Epilepsy

- Prediction of epileptic attacks & immediate treatment

Celiac Disease

- UAlberta study shows promise in a new treatment in the form of a pill for celiac disease, one which uses an antibody derived from egg yolks to neutralize gluten's impact on the digestive system (*Dig Dis Sci. 2017 May;62(5):1277-1285*)

Nutrition/obesity/metabolism studies (collaborate with ALES)

- Obesity/weight loss interventions (prediction of response, bariatric surgery, medications)
- Whole Body Calorimetry, rehabilitation (cardiac + cancer), AI + omics

Focus Areas / Expertise / Existing Strengths (for all projects)

- Connect Care/ Captive population (4.2 M, one payer system)
- A.P.I. (Applied Pharmaceutical Innovation)
- Pre-Phase One Cancer Program
- Edmonton Protocol
- ACTM (Alberta Cell Therapy Manufacturing)
- CAR – T cells
- Metabolomics
- Virology/ Prions
- Metabolism/Obesity/Nutrition
- Senolytics
- Imaging / Radiopharmaceuticals
- AI/ML (AMII)

6) Tx Innovation

The Idea

Creating the *Innovation Wheel* by supporting discovery, validation, and clinical adoption of PH insights, processes, products and practices

The Challenge

Helping to bridge the gaps that stop many new discoveries / technologies from making it from bench to bedside

The Opportunity

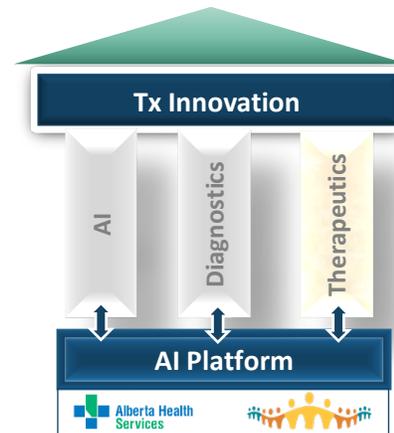
Creating a large-scale outcomes research platform by:

- Connecting large data sets (EMR), AI, etc.
- Build in clinical trials to answer/ inform research questions
- Using innovative clinical trials for intervention
 - Public engagement/education
 - Sign up for trials/research
- Incorporating the patient voice from cradle to grave
- Focusing on repurposing drugs for earlier outputs
- Refining Tx pathways to improve outcomes
- Creating a Concierge Portal of Entry to foster new innovations
- Recruiting groups of experts who can inform IP and commercial strategies
- Focus on therapeutic development up to ~Phase I
- Work with industry to co-develop products
- Taking advantage of Connect Care and involving clinicians for robust data entry
 - Using our pipelines (data) and building ideas based on our backyard (indigenous health, Mennonites, mental health)
- Creating a Dragon Den
 - Researchers/Innovators pitch ideas to donors
- Leveraging public and private corporate partnerships to commercialize innovative technologies
- Involving all necessary skill sets
- Providing researchers access to samples (with patient consent)

Focus Areas / Expertise / Existing Strengths

Leverage existing resources:

- Northern Alberta Clinical Trials and Research Centre (NACTRC)
- Canadian VIGOUR Centre (CVC), Canadian arm of the international VIGOUR (Virtual Coordinating Centre for Global Collaborative Cardiovascular Research) Group



7) Precision Health Data Platform

The Idea

Ensuring improved healthcare delivery by cutting across features leveraging all available data and sharing data on a continual basis.

The Challenge

Reshaping the way we think about human health, diagnosis and treatment of disease.

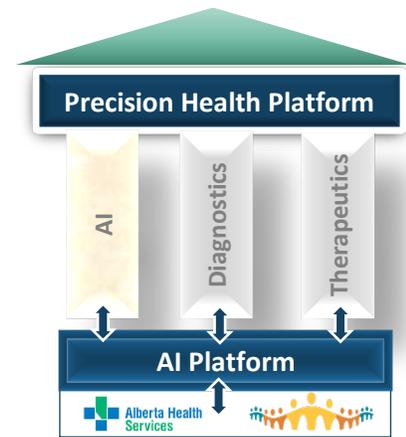
The Opportunity

Data are the draw - leveraging AB data to improve health care by promoting/fostering

- Culture shift of physicians, patients, care givers & community to improve delivery of healthcare & patient outcome
- Partnerships to share data and skillsets
- People & technologies to bring data together for use & reinforcement learning
- Advanced data measurements
- Applications for measurements, ways of measuring and collecting data
- Wearable technologies
- Usage of data on a continuous basis
- AI scientists as prediction data navigators

Applying AI in Education

- Use natural language processing to better assess exams, admissions/ invest in better physicians



8) Chronic Disease Management Centre

The Idea

Management of disease for the best treatment of patients - prevention of disease and disease progression

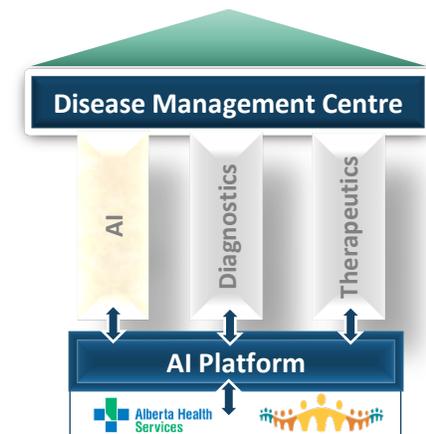
The Challenge

Access to data, limited availability of data for patient/care giver decision making; especially in pediatrics data are limited, rather observational

The Opportunity

Individualizing disease management by:

- Developing tools to personalize chronic disease management using holistic data approach (genomics, clinical, healthcare, experiences, social determinants of health)
- Reinforcement Learning to create 'refined' Tx plans
- Optimal, sequential, decision making
- Individualized clinical pathways – based on learning systems, continuous input of outcomes data, personal data, environmental data – social determinants of health
- Incorporating existing predictive diagnostic tools, eg. imaging (tumors) & clinical



- Incorporating existing chatbots - individualized
- Using AI shared decision making with broad sets of data to:
 - Empower the patient to choose preferences
 - Provide tools for individual shared decision-making (e.g., that includes patient preferences) based on patient’s data relative to BIG DATA platforms of “like situations”, eg. 100K patients, finding “twin” patients in a data cloud (aligning characteristics, phenotypes)
 - Prove the value/ provide evidences
 - Incorporate new technologies, phenotypes & health services that patients access
 - Provide literacy & education tools to understand consequences – side effect profile

Infrastructure requirements

- Application Programming Interface (API)
- Methodological experts/ professional scientists
- AI platform – Service platform/ core facility
- Access to data in real-time
- Synthetic data sets
- Simulated data sets
- Link to health system

9) Primary Care - Frailty

The Idea

Creating an ‘Aging Well Hub - From Data to Wellness’ / ecosystem of data, people and partner for proactive care and technology-based solutions, policies and practices for healthy aging

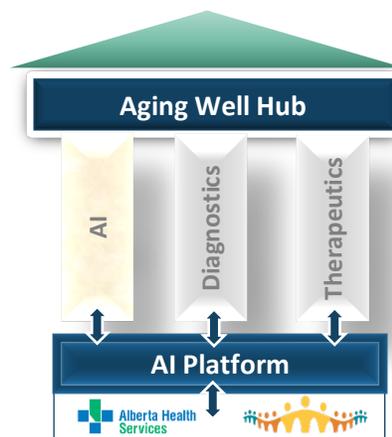
The Challenge

Barriers to using existing data / access to data, eg. primary EMR data, administrative healthcare data, technology assisted data measurements

The Opportunity

Investing in an aging well hub to deliver more comprehensive care through data-driven insights for individualized care, faster adoption of technologies, and new ways of proactively providing services. The hub will:

- Facilitate access to data
- Create a common language around data
- Transform Dr.’s notes into easy extractable, functional information
- Provide a safe haven for data
- Triage data: non-valuable vs valuable data
- Improve interpretation of data and create clinically relevant information from raw data
- Collect data in an organized way, use proper coding to ensure data are in the system
- Use semantically linked data
- Use natural language processing (NLP), eg. for healthcare chatbots
- Create a health data learning system integrated into the provincial health care system
- Identify dynamic data that predict wellness trajectory



- Focus on early intervention to identify people at risk of frailty and change the trajectory of functional and cognitive decline
- Reorient clinical practice away from the disease-orientated approach towards a more effective individualized approach, taking physical and mental attributes, socio-economic and physical environments into account

Focus Areas / Expertise / Existing Strengths

The hub could benefit from existing facilities and data, e.g.:

- Seniors' Community Hub, a patient-oriented model of care to promote healthy aging and independence for seniors
- Technology assisted data measurements (eg. home health monitoring), eg the SMART Condo, which uses wireless sensors for remote monitoring
- Comprehensive data (accessible) from a ten-year pregnancy and birth cohort

Appendix 2: Artificial Intelligence/Machine Learning Applied to Health Task Force Report



ARTIFICIAL INTELLIGENCE/MACHINE LEARNING (AI/ML) APPLIED TO HEALTH TASK FORCE

TASK FORCE MANDATE

The Faculty of Medicine & Dentistry (FoMD) is developing a Precision Health (PH) strategy for the faculty with oversight from the FoMD PH Steering Committee. The Committee established the 'AI/ML Applied to Health Task Force' to develop recommendations for what the FoMD could lead in the area of AI/ML applied to health and how to achieve such. Please refer to the Appendix for details on Task Force membership, meetings and consultations.

BACKGROUND & CONTEXT

Health systems around the world are developing strategies that leverage the power of data and sophisticated analytics to individualize care, improve outcomes and contain costs. The province of Alberta has developed a Precision Health initiative and the University of Alberta has identified Precision Health as a signature area and thus an area of research and training priority, with these and additional goals in mind. Alberta's single-payor health system, data assets and diverse population – combined with its strengths in AI/ML, and basic and clinical sciences at its academic centres – offers a distinct competitive advantage in discovering and developing data-driven innovations to advance health and create economic wealth for Albertans.

In healthcare and biomedical sciences, AI/ML has applications in diagnostic processes (genomic/omic analysis, biomarker discovery, and image analysis), treatment protocol development (clinical decision support tools, predictive analytics), drug discovery and development, and remote patient monitoring. Additionally, hospitals are looking to AI solutions to support business operations that produce efficiencies and cost savings, improve patient satisfaction, and satisfy staffing needs.

In the context of the mandate noted above, the AI/ML in Health Task Force focused on understanding the strengths and gaps within our AI/ML and research ecosystem, and developed an AI/ML strategy that seeks to serve the AI/ML needs of our basic and clinical researchers, academic entrepreneurs, and commercial partners. We also propose creation of an operational framework for 'digital innovation' that (1) supports and nurtures emerging projects that incorporate AI/ML approaches, and (2) incorporates the explicit needs of patients and the health system in the case of clinical innovation.

STRENGTHS, OPPORTUNITIES & CHALLENGES

The province of Alberta, the University of Alberta and the FoMD have a tremendous opportunity to lead the nation in applying AI/ML technology to biomedical discovery and to the development and implementation of new tools to improve health.

Alberta Health Services (AHS) is Canada's largest single provincial healthcare system with administrative health data collected on over 4 million people. Data can be sourced from many population-level databases including those for specialized clinical information systems, ambulatory care, discharge data, pharmacy claims, and others. Alberta's emerging advanced clinical information system—*ConnectCare*—will also consolidate some 1,300 information systems and provide a single medical record that can be accessed at any point in the health system, including by patients themselves. Another opportunity to leverage data is to collaborate with Alberta's largest health research study - *Alberta's Tomorrow Project* - a long-term cohort study following the health of 55,000 Albertans.

The FoMD also has an exceptional opportunity to take advantage of an existing University of Alberta AI/ML ecosystem via the Alberta Machine Intelligence Institute (Amii). FoMD has already developed several collaborations with Amii researchers and successfully applied AI/ML technologies in several areas including mental health and imaging.

Finally - Alberta provides support and a framework for system-wide health research, innovation and implementation through AHS's Strategic Clinical Networks (SCNs), the Alberta SPOR SUPPORT Unit (AbSPORU), Alberta Innovates, and the Northern Alberta Clinical Trials and Research Centre (NACTRC).

The Task Force also identified several obstacles and challenges that need to be addressed to successfully move its Precision Health strategy forward. Within the healthcare system, issues of data access need to be solved. As an example, improved access to diagnostic imaging data and images (MRI, CT, and ultrasound) could be an opportunity for Alberta; applying AI methods to diagnostic imaging data combined with a patient's other clinical data could lead to new findings and products that could be easily scaled to a population level. Further, access to and analysis of data from other agencies and ministries (education, social services, judicial) will significantly inform our understanding of the social determinants of health.

Although a significant number of investments in high performance computing have been made in Alberta, the question remains how to connect them into healthcare. Also, there is a lack of experts for the development of AI applications in health, and a need for experts with both clinical knowledge and data science background.

WHERE ARE WE?

The Task Force recognizes the importance and the opportunity to develop 'AI/ML applied to health' as an area of strategic focus for the Faculty. As Dr. David Naylor stated during his recent visit and lecture at the University of Alberta, "*medicine is becoming a data science*". Planned yet uncoordinated investments in 'infrastructure, operations and people' exist which could be leveraged to support AI/ML activities. This includes a John R. Evans Leaders Fund (JELF) application from the Department of Psychiatry for computational infrastructure (grant is currently under review) and an emerging application to WD for computational and operations support (currently in discussions with WD). The Alberta Health Services Research Chair in Health Informatics is being leveraged to develop capacity in AI/ML as it relates to Connect Care and the Faculty has the opportunity to recruit at least 2 'AI/ML in health experts' in collaboration with Amii. Further, the Faculty recently submitted an NSERC CREATE LOI that outlines delivery of a graduate training program in 'AI/ML applied to health'. These and other initiatives are beginning to establish the needed capacity and services in this area.

PROPOSED GOALS AND ACTIVITIES

1. Create AI capacity in health and adopt AI in healthcare
 - a. Develop AI/ML methods expertise, QA/QC processes, and research services support for discovery, translational, clinical, population health scientists
 - b. Support Pillar 1 research (e.g. drug and biomarker discovery; genomic data analysis) with AI/ML expertise
 - c. Develop the ability to prototype, trial and validate clinical AI/ML tools (academic and commercial) within FoMD's/AHS' clinical research environment
 - d. Build 'people capacity' in the field of AI/ML applied to health and biomedical sciences
 - e. Implement AI/ML tools (predictive analytics, point-of-care imaging diagnostics, clinical decision support tools, etc.) that fill clinical gaps and support provision of optimal and individualized care in tertiary and primary/rural settings

2. Establish functional networks, partners, and processes to maximize success rates and alignment with health system needs
 - a. Collaborate within the University of Alberta and with external stakeholders (AHS, AH, Alberta Innovates, University of Calgary, others) to inform and accomplish the above
 - b. Optimize/align existing FOMD infrastructure and AI/ML expertise
 - c. Demonstrate FoMD's value and impact to patients, the community and to the health system by addressing patient, community and health system needs with high quality, relevant AI/ML research and innovation
3. Create opportunities for new and/or continued investment in AI/ML applied to health
 - a. Advancement, Chair Funds (e.g. Amii CIFAR AI Chairs)
 - b. Industry (partner for grant opportunities, Western Diversification Program)
 - c. Leverage existing resources (e.g., NACTRC)

RECOMMENDATIONS

1. **Create a 'Translational Health Artificial Intelligence' Unit for AI/ML research and innovation in FoMD** (please see figure below)
 - a. Invest in a 'Translational Health Artificial Intelligence' Unit to:
 - i. Offer robust QA, QC, methods advice and service, algorithm validation, and more, for both commercial and academic (discovery, translational, clinical, population health scientists) research and innovation activity
 - ii. Nurture and de-risk early-stage projects/ideas in the emerging field of AI/ML applied to health and to biomedical discovery, and advance those projects to the next level
 - iii. Trial AI/ML algorithms and data products via an Application Programming Interface (API) system, developed in collaboration with AHS
 - iv. House both clinical IT and research IT infrastructures
 - v. Develop and invest in early and fast prototyping and trialing of digital products
 - vi. Monitor clinical impact of digital innovations using Canadian Academy of Health Sciences framework of metrics



Figure: Translational Health Artificial Intelligence UNIT; **ADI:** Alberta Data Institute, **Amii:** Alberta Machine Intelligence Institute, **API:** Application Programming Interface, **NACTRC:** Northern Alberta Clinical Trials and Research Centre, **PCN:** Primary Care Network, **SCN:** Strategic Clinical Network, **SPOR:** Strategy for Patient-Oriented Research

- b. Develop and maintain concrete relationships with AHS SCN's, patients, and PCN's/Community Care centres to inform FOMD's research programs regarding patient and health system needs
- c. Develop the Unit's translational team to support scientists to access data, manage projects, foster connections between FoMD and other AI/ML experts, understand and process regulatory issues, and more:
 - i. Employ an AI/ML 'Professional Scientist' with clinical training
 - ii. Employ a 'Program & Research Coordinator' to manage project ethics, contracts, etc.
 - iii. Recruit an 'AI/ML in Health' leader to be Director of the Unit
 - iv. Assign high-impact Chair (e.g. Capital Health Chair in Informatics) to AI/ML efforts
- d. House the Unit within FoMD adjacent with the RWE (Real World Evidence) Unit where connectivity to RWE studies/data, ethics, legal, and contract management exist
- e. Collaborate with industry, patients, payers, and regulators to generate knowledge that guides clinical care, defines product use, and informs decision-makers
- f. Work with stakeholders (AH, AHS) to explore ways in which to stream-line data access (e.g., AH analysts/programmers could support researchers; academia could access AH's data haven via AH's license)
- g. Serve an advocacy role: champion work with Alberta's Privacy Commissioner to build the Privacy Policy Architecture for Precision Health in Alberta
- h. Develop both the clinical adoption and commercialization pathways for digital tools

2. Develop a research program that leverages a perspective on the future of AI/ML in health, plus our unique strengths and interests

- a. Apply AI/ML methods to Pillar 1 science for biomarker and drug discovery; genomics; and bioinformatics
- b. Establish research and innovation themes that develop and apply new AI/ML algorithms/tools to chronic disease management
- c. Develop AI/ML tools to discover information from unstructured data (e.g., clinical notes/text), validate the information via the Translational Unit and RWE Unit and pragmatic trial approaches, implement and scale findings
- d. Create clinical decision support tools and visual interfaces showing AI-driven risk predictions for specific patients
- e. Develop AI technology for rural areas to improve healthcare access and quality e.g. with AI-assisted interpretation of portable ultrasound, X-ray, MRI, CT, echocardiography

3. Build Capacity in data experts through collaboration and training

- a. Build data expert capacity: e.g., analysts, bioinformaticians, statisticians with background in health sciences (see recommendation #1 regarding hiring into the Translational Unit)
- b. Pursue joint recruitments with Amii of 2 senior academic AI/ML positions
- c. Develop joint capstone projects among FoMD and Amii researchers/students
- d. Pair and cross-train Amii and graduate students (FoMD, health sciences and others)
- e. Develop an AI/ML seminar series in FoMD to include joint seminars/workshops with Amii
- f. Embed AI/ML training into medical school curriculum
- g. Engage public/media to convey strong positive messages about AI/ML in health
- h. Generate educational material for patients

4. Develop mutually beneficial collaborations with researchers and other relevant stakeholders

- a. Include AHS and other partners very early in research planning
- b. Take advantage of SPOR, Alberta Data Institute and the CISU (Clinical Inquiry Service Unit)
- c. Develop research collaborations across the University of Alberta and partnerships with University of Calgary and University Lethbridge
- d. Work with UA/FoMD Advancement Offices to develop a strategy for philanthropic funding

SUMMARY

In closing, the PH AI/ML Task Force proposes that the Faculty strike a 'Task Force' responsible for establishing the THAI Unit. This will include solidifying partnerships, securing funding, establishing the THAI Unit's operational mechanisms, hiring professional staff for the Unit, and recruiting senior academic leaders in AI/ML applied to health.

APPENDIX: AI/ML APPLIED TO HEALTH TASK FORCE

MEMBERS

Lawrence Richer (Chair), Deborah James (Co-Chair), Ulrike Brockstedt, Brian Buck, Bo Cao, Justin Ezekowitz, Diane Forbes, Jacob Jaremko, Neesh Pannu, Matt Tennant, and Dean Zaragoza

TASK FORCE MEETINGS

March 6, 2019

March 19, 2019

May 31, 2019

June 14, 2019

EXTERNAL CONSULTATIONS

March 19, 2019

Russ Greiner, Alberta Machine Intelligence Institute

May 08, 2019

Randy Goebel, Alberta Machine Intelligence Institute

May 21, 2019

Tim Murphy, Vice President, Health, Alberta Innovates

May 22, 2019

Larry Svenson, Executive Director for Analytics and Performance, Alberta Health

June 06, 2019

Cory Janssen, AltaML Inc.

June 20, 2019

Randy Duguay, Healthguage Inc., Adiant Inc.

AHS

Appendix 3: Artificial Intelligence Applied to Health – Capacity Building Task Force Report



ARTIFICIAL INTELLIGENCE APPLIED TO HEALTH - CAPACITY BUILDING – RECOMMENDATIONS TO FACULTY OF MEDICINE & DENTISTRY & PARTNERS

BACKGROUND & CONTEXT

Research and application of Artificial Intelligence (AI) to health are areas of strategic focus for the University of Alberta's Precision Health Signature Area initiative, for the Artificial Machine Intelligence Institute (Amii), and for the Faculty of Medicine & Dentistry (FoMD).

The University of Alberta has a ***time-limited opportunity to lead the world in the field of AI applied to health*** through collaboration and synergy among its leaders in artificial intelligence in Amii, and in clinical medicine in FoMD. This expertise, combined with Alberta's largest single provincial healthcare system where health data is collected on over 4 million people - provides a substantial competitive advantage.

Our competitive advantage however, is time-limited: Academic institutions across Canada and elsewhere are investing heavily in 'AI applied to health' given its potential to transform the way healthcare is delivered. **Appendix A** outlines existing Canada Research Chairs and investments specific to AI in health. These inventories are not complete - and the investment activity across Canada is quickly ramping up.

Further, the Canadian Institute for Advanced Research (CIFAR) recently launched a national Task Force (chaired by Dr David Naylor) to develop recommendations for a national health strategy in AI. Similarly, an AI and Digital Technologies Task Force has been established by the Royal College of Physicians and Surgeons of Canada with the aim to prepare the medical profession for the profound changes coming through AI and emerging digital technologies. It is expected that Federal granting opportunities will follow from this work. Thus it is time for Alberta/UAlberta to position itself for this new era of research and medicine and to take advantage of emerging opportunities.

Several months ago the Faculty developed an ***'AI Applied to Health Task Force Report'*** (see page 26) that outlines recommendations regarding what the Faculty, Amii and partners could uniquely lead in the area of AI/ML applied to health and how to achieve such. The need to build research capacity in AI is also addressed in the report.

Critical to FoMD's and Amii's vision and mission in AI is the need to develop research capacity in this field. This report outlines a plan to recruit and retain AI applied to health experts at our University.

ADVISORY GROUP

Deborah James (Chair), Randy Goebel (Co-Chair), Derek Emery, Andy Greenshaw, Xin-Min Li, Lawrence Richer, Mark Taylor, and Osmar Zaiane.

Meetings: August 7th, 2019; August 13th, 2019; and August 23rd, 2019

OPPORTUNITIES & CHALLENGES

OPPORTUNITIES

One of Alberta's advantages in terms of applying AI to health is its public health system. Alberta Health Services (AHS) is Canada's largest single provincial healthcare system with administrative health data collected on over 4 million people. Data can be sourced from many population-level databases including those for specialized clinical information systems, ambulatory care, discharge data, pharmacy claims, and others. Alberta's emerging advanced clinical information system—*ConnectCare*—will also consolidate some 1,300 information systems and provide a single medical record making AI research on this information much more accessible and meaningful.

Further, the Faculty of Medicine & Dentistry *has* started to develop capacity in the field of AI applied to health. A cohort of researchers are experts in the field¹ and many others (in the order of 40 - 50 are users of AI. In Amii, three (3) out of seventeen (17) AI researchers are engaged in research projects applied to health problems².

Finally, many funding opportunities are also emerging in the area of AI in health. The following are several such examples:

- A \$250M philanthropic donation for a 'National Child Health Response to Precision Medicine'
- The 'Roche Multiple Sclerosis' opportunity that is emerging in Alberta (~\$2M)
- The 'Canada-UK Artificial Intelligence Initiative' - and a research collaboration is being developed among UAlberta and University College London
 - **Canadian funding agencies:** up to C\$173,333 per year for Canadian teams for up to three years, for a total of C\$520,000 per project.
 - **UKRI:** up to £625,000 per project for UK teams at 100% full economic cost.
- Terry Fox and Imagia Initiative: Federal Government awards \$49M to Terry Fox Research Institute and Imagia led Consortium to Accelerate Medical Breakthroughs (2019 – funds will be distributed)

CHALLENGES

A significant challenge to building capacity in AI applied to Health at UAlberta is securing salary funding and positions for new recruitments. In present times of fiscal restraint and anticipated cut-backs in Alberta and within UAlberta, identifying unfilled tenure-track positions and salaries for the purpose of recruiting AI experts is challenging. Generally speaking, our Faculty departments are not in a position to plan outside of their current/near future salary and operational commitments. While some unfilled positions/salaries exist (now or in the near-term) across our basic departments, the funding is instead being used to support staff merit increments and COLA going forward. Thus no new recruitments are taking place.

Importantly, several of the external funding opportunities that do exist for full salary support, salary 'top-up', and/or equipment, explicitly require that a tenure-track position/salary is available. Given these combined circumstances, ***NEW funding is required to support the recruitment of AI experts in health.***

¹ For example: Dr Bo Cao, CRC Chair Tier II; Dr Patrick Pilarski, CRC Chair II; Dr Jacob Jeremko, AHS Chair in Radiology; Dr Lawrence Richer, AHS Chair in Health Informatics Research; and others.

² Dr Randy Goebel; Dr Osmar Zaiane; and Dr Russ Greiner.

SOLUTION

The Faculty and Amii are approaching the current opportunities in ‘AI applied to health’ plus our challenges as follows: We are building an environment where we can recruit the best in this field. This involves developing an AI in Health Core Facility to support our researchers and our recruits with AI infrastructure (computational capacity), methods expertise, data collection and cleaning, ethics and project management and more (this is outlined in more detail in the AI Applied to Health Task Force Report – and is referred to as the THAI Unit in that document).

We are also establishing an AI in health research group. This will help to (1) build community across UAlberta’s AI in health researchers and trainees; (2) establish and share best practices in the field; and (3) increase UAlberta profile nationally and internationally on the field of AI applied to health.

Establishing such an environment while also targeting and securing several significant recruitments in the field will solidify our ability to attract funding and resources to UAlberta. Thus creating an AI in health Core Facility, coordinating our existing research people and assets, pursuing recruitments, and garnering resources from various funding opportunities are all interdependent – and we propose a parallel approach to these activities.

Finally - with the salary challenges in mind as noted above, there still remains a host of possible salary funding opportunities available to support the recruitment of AI in health experts. As noted above, a limiting feature however, is the ability to secure an ‘on-going’ position independent of, and to support, the various ‘Chair’ opportunities. Various salary-support funding opportunities are noted below and serve as a basis for some of the recommendations provided in the next section of this document.

Table 1: Possible SALARY Funding Opportunities to Develop ‘AI in Health’ Research Capacity

	Salary Opportunities	Secure Salary Opportunities	Areas of Focus
1	<ul style="list-style-type: none"> • FoMD’s CRC allocation • CRC I (\$170K net salary) • CRC II (\$70K net salary) 	<ul style="list-style-type: none"> • Tenure-track salary/position in Psychiatry (Glen Baker’s former position) • UA Nursing Faculty – 17 (?) tenure-track salary/positions available • UA Rehab Medicine Faculty – 10 (?) tenure-track salary/positions available • Request tenure-track salary/position from UA central 	<ul style="list-style-type: none"> ▪ Mental Health • Cancer (for endowed Chairs) • Image analysis • Medical Records, Natural Language Processing • Basic science focus (omics, etc) • Child Health • Multiple Sclerosis • Other areas
2	<ul style="list-style-type: none"> • UofA - CERC (if announced) 		
3	<ul style="list-style-type: none"> • UofA – CRC • Dedicated for strategic priorities 		
4	<ul style="list-style-type: none"> • FoMD 6 Endowed Chairs in Cancer (coming up) 		
5	<ul style="list-style-type: none"> • FoMD Heart & Stroke Foundation Chair (coming up) 		
6	<ul style="list-style-type: none"> • FoMD - Capital Health Chairs 		
7	<ul style="list-style-type: none"> • Amii’s allocation of funds for the CCAI Chairs Program • Salary top-up to support individual Chairs and associated eligible costs (equipment, post-docs, students) • Seeking to support recruitment of 9 new faculty in conjunction with UofA; individuals require a secure salary/position (for top-up or beyond award) • Funds available: ~\$150K/annum x 9 		

	<ul style="list-style-type: none"> Definitions: Recruitment = non-Canadians; Retention = from Canadian institutions Retention : Recrutement (50:50) Female : Male (target is 50:50) 		
8	<ul style="list-style-type: none"> FoMD Dept Psychiatry – 20 new positions, must be a psychiatrist; 5 of these will be for clinical scientists 70% research, 30 % clinical 		
9	<ul style="list-style-type: none"> FoMD Dept Psychiatry – 1 or 2 Research Chairs (coming up) 		

RECOMMENDATIONS

CAPACITY NEEDS

- Create needed capacity and momentum in ‘AI applied to health’ such that UAlberta can accomplish the goals set out in the ‘AI Applied to Health Task Force Report’ (attached) and be a national leader in AI applied to health.
 - Hire a cohort of academic experts that are specifically trained in AI and address its clinical applications:
 - 3 Academic Positions** (MD, MD/PhD, PhD level), focusing in areas of strength and opportunity, for example:
 - AI and Imaging
 - AI and Mental Health
 - AI applied to basic science problems (omics, drug discovery)
 - Novel methods: Natural Language Processing applied to clinical notes/records
 - AI and MS
 - AI and Oncology
 - AI and children’s health
 - Others
 - At least one of the academic recruits should be a senior level (full professor level) academic, whereas the 2 other recruits could be more junior.
 - All academic positions should be ***cross appointments among Amii and FoMD*** (details to be determined).
 - Continue to work with Amii to secure a CCAI Chair (retention) for Dr Jacob Jeremko, AI specialist in ultrasound imaging.
- In parallel with recruitment, build an ‘AI in Health Core Facility’ designed to support AI researchers and users from across FoMD, Amii, UAlberta campus and elsewhere (SME’s, AHS) as described in the recent ‘Artificial Intelligence/Machine Learning Applied to Health Task Force Report’. Hire:
 - 1 Professional Scientist (FSO)
 - This person will be an expert in the field/methods of AI applied to health and will support research activity in this area.

b. 1 Project Manager

- i. This person will report to the Professional Scientist FSO and will support ethics, contracts, data access, etc., for research projects.

FUNDING APPROACHES – undertake several avenues for funding

3. Secure a Strategic CRC position and a 'base/on-going' salary from UA Central to recruit a Tier I Chair in AI applied to health. Locate this individual in a clinical department, cross appointed with Amii. This aligns with the UAlberta Precision Health Signature Area initiative, plus UAlberta's various other AI initiatives.

Match this Chair with a CCAI Chair in order to recruit someone senior; funds to be used for research and equipment.

Provide trainee stipends (from Provost's \$1M 'allocation' for trainees in AI) as part of the recruitment package (see below).

4. Use 2 of FOMD's upcoming CRC positions (Tiers I – 1; and Tier II - 1) to recruit AI applied to health experts (see **Appendix B** for an overview of FOMD CRC's and dates). Determine commitments within relevant Departments for salary funding during and beyond CRC award.
5. Access the Provost's proposed \$1M 'allocation' for training opportunities in AI, and provide student funding/stipends as part of the recruitment package for all new recruits.
6. Recruit an AI expert in mental health in Department of Psychiatry using Dr Glen Baker's former tenure-track position/salary. Consider providing equipment and trainee funds via a CCAI Chair allocation.
7. Develop a strategy with the Department of Oncology to use a combination of FoMD's endowed chairs in cancer for recruitment. Develop an approach for providing salary beyond (and possibly during depending upon the value of the awards) the duration of the Chairs.
8. Combine the two 'AHS Chairs in Translational Research' to create a salary with which to recruit an AI in health expert individual. Determine an appropriate home Department and develop an approach for funding salary beyond (and possibly during) the length of the Chairs. Examine all Departmental strategic plans to identify potential positions/salaries (future retirements) to support this endeavor. Consider providing equipment and trainee funds via a CCAI Chair allocation.
9. FoMD and Northern Alberta Clinical Trials and Research Centre (NACTRC) to jointly fund the Professional Scientist FSO and Project Manager positions for first 2 years. Funding for such may come from Dr Richer's AHS Chair in Health Informatics Research and from the \$500K that dean Fedorak reserved for Precision Health initiatives.

Develop and implement a revenue generating model for the Core Facility based on industry, other contracts and a fee-for-service model (cost-recovery for academics) that will support these positions beyond the 2 years.

NEXT STEPS (not necessarily in this order)

- 1) Continue this Task Force group with a mandate to execute on this AI in health capacity building strategy.
- 2) Dean Kunimoto, a lead from Amii, the Department Chair for Computing Science, and the HSC Board Chair representing the UAlberta Precision Health Signature Area - to meet with the Provost to review this strategic plan, secure a Tier I Strategic CRC plus salary, and trainee awards for all recruits as outlined. Determine FoMD clinical department for this CRC (joint appointment with Amii).
- 3) Work with Amii and Department of Computing Science to determine details regarding cross appointments and candidates for CCIA Chairs.
- 4) Meet with Dr Eisenstat to pursue an AI strategy with Department of Oncology, as noted above.
- 5) Develop and implement a plan regarding combining the 2 AHS Translational Research Chairs (e.g., areas of focus, potential candidates, home department, salary beyond the chair awards, etc.). Recruit into this position.
- 6) Generate a list of potential candidates for all proposed positions. Pursue their interest/commitment in coming to UAlberta. Develop job descriptions and post (prior to securing all funding details).
- 7) Post and hire the FSO and Project Manager positions and establish the AI in Health Core Facility (the THAI Unit).

APPENDIX: ARTIFICIAL INTELLIGENCE APPLIED TO HEALTH - CAPACITY BUILDING

APPENDIX A: CURRENT FILLED & OPEN CANADA RESEARCH CHAIRS – AI/ML IN HEALTH

Level	Chair Holder	Institute	Chair Title	Research Involves
Tier 1	Bengio, Yoshua	Montreal	Statistical Learning Algorithms	Developing improved learning algorithms for neural networks and machine learning.
Tier 1	Chan, Christine	Regina	Energy and Environmental Informatics	Developing and applying artificial intelligence and knowledge-based system technologies for analysis and decision support in energy and environmental systems.
Tier 1	Frey, Brendan	Toronto	Information Processing & Machine Learning	Developing new algorithms that allow computers to decipher the massive amounts of data being produced by medical professionals, which will allow us to better understand and treat disease.
Tier 1	Matwin, Stan	Dalhousie	Visual Text Analytics	Applying data-mining techniques to analyze written texts and deliver appropriate information to users.
Tier 1	Neal, Radford	Toronto	Statistics and Machine Learning	Understanding the principles and methods by which the structure and properties of complex systems can be inferred from observation and experiment.
Tier 1	Tsotsos, John	York	Computational Vision	Computational modelling of visual processes and visuo-cognitive behaviors so that the model has predictive power for human vision and applied relevance for practical robots.
Tier 1	Open	Saskatchewan	Imaging & Artificial Intelligence	Artificial intelligence (AI), machine learning, and deep learning research to facilitate adoption of AI-based technologies and in various sources of imaging across multiple disciplines.
Tier 1 or 2	Open	Ryerson	Artificial Intelligence and Machine Learning	Broad
Tier 2	Grosse, Roger	Toronto	Probabilistic Inference and Deep Learning	Using advanced computer science methods in machine learning—including probabilistic inference, Bayesian statistics and information geometry—to improve artificial neural networks.
Tier 2	Guo, Yuhong	Carleton	Machine Learning	Developing computer technology to reduce the dependence of data analysis systems on expensive human annotation.
Tier 2	Mostafavi, Sara	UBC	Computational Biology	Using machine learning and statistical genomics to understand complex disease.

Tier 2	Schmidt, Mark	UBC	Large-scale Machine Learning	Fitting complicated statistical models to very large data sets.
Tier 2	Schoellig, Angela	Toronto	Robotics and Control	Combining key technologies from engineering and computer science
Tier 2	Duvenaud, David	Toronto	Generative Modelling	Using a combination of deep learning and statistics to build and fit meaningful computer models from raw data.
Tier 2	Taylor, Graham	Guelph	Machine Learning	Making machine learning systems more effective and accessible.
Tier 2	Zilles, Sandra	Regina	Computational Learning Theory	Designing and analyzing new models and algorithms for interactive machine learning.
Tier 2	Open	Manitoba	Artificial Intelligence for Complex Health Data	Health data

APPENDIX B – UPCOMING FOMD CANADA RESEARCH CHAIRS

Canada Research Chairs: CRCs becoming available in FoMD in next three years

Timing for call for internal candidates (CRC submission date);
Subtract ~one year for external candidates

- October 2019 (April 2020): TBD
- April 2020 (Oct. 2020): Tier 1 - 1; Tier 2 - 2
- Oct. 2020 (April 2021): Tier 1 - 1; Tier 2 - 2
- April 2021 (Oct. 2021): Tier 1 - 0; Tier 2 - 1
- April 2022 (Oct. 2022): Tier 1 - 0; Tier 2 - 1
- October 2022 (Apr. 2023): Tier 1 - 0; Tier 2 - 1

Slide Acknowledgement: Mark Taylor, OoR, FoMD



Appendix 4: Precision Health Education & Engagement Task Force Report



PRECISION HEALTH EDUCATION & ENGAGEMENT TASK FORCE

TASK FORCE MANDATE

The Faculty of Medicine & Dentistry (FoMD) is developing a Precision Health strategy with oversight from the FoMD Precision Health Steering Committee. The Committee established the 'FoMD Education & Engagement Task Force' to develop educational and engagement strategies and recommendations regarding Precision Health for healthcare professionals, researchers and trainees within the Faculty. Please refer to **Appendix A** for details on Task Force membership and meetings and to **Appendix B** for suggested speakers for the FoMD Speaker's series.

GOALS

- 1) To establish a comprehensive and graduated program for educational opportunities in Precision Health for all programs and areas at the FoMD, from undergraduate to senior level of expertise.
- 2) To liaise with Alberta Health Services to provide education on Precision Health to all medical and allied staff and public in Alberta.

BACKGROUND*

The University of Alberta (U of A) has identified Precision Health as a signature area and thus an area of research and training priority. Precision Health and the implementation of its principles and technologies is relevant to every health care discipline. As part of its evolution, our provincial health care system and the FoMD must be responsive to changes necessitated by adoption of Precision Health approaches. Therefore, academic institutions and relevant partners must provide high quality, up-to-date education at all stages of learning – undergraduate, postgraduate and continuous professional development – to facilitate the adoption of Precision Health by an enabled workforce of healthcare professionals.

The composition of future health care teams may be fundamentally different, consisting of traditional health care disciplines, information scientists, implementation scientists, statisticians and engineers. At present, there is no model in Canada for the type of education required for tomorrow's clinicians and researchers to work effectively in this new environment. Alberta could take a leadership role in defining such a model to attract highest quality medical and graduate students from Canada and internationally.

Further, we need to take into account the priorities, concerns and educational needs of other key stakeholders and engage with patients, providers, payers and regulators to enable the successful implementation of Precision Health.

**Content adapted from the Alberta Precision Health Education Working Group, Education for Precision Health: Today and Tomorrow Report, 2018 and the Precision Health for Alberta—A Prospectus, 2017*

GAPS AND CHALLENGES*

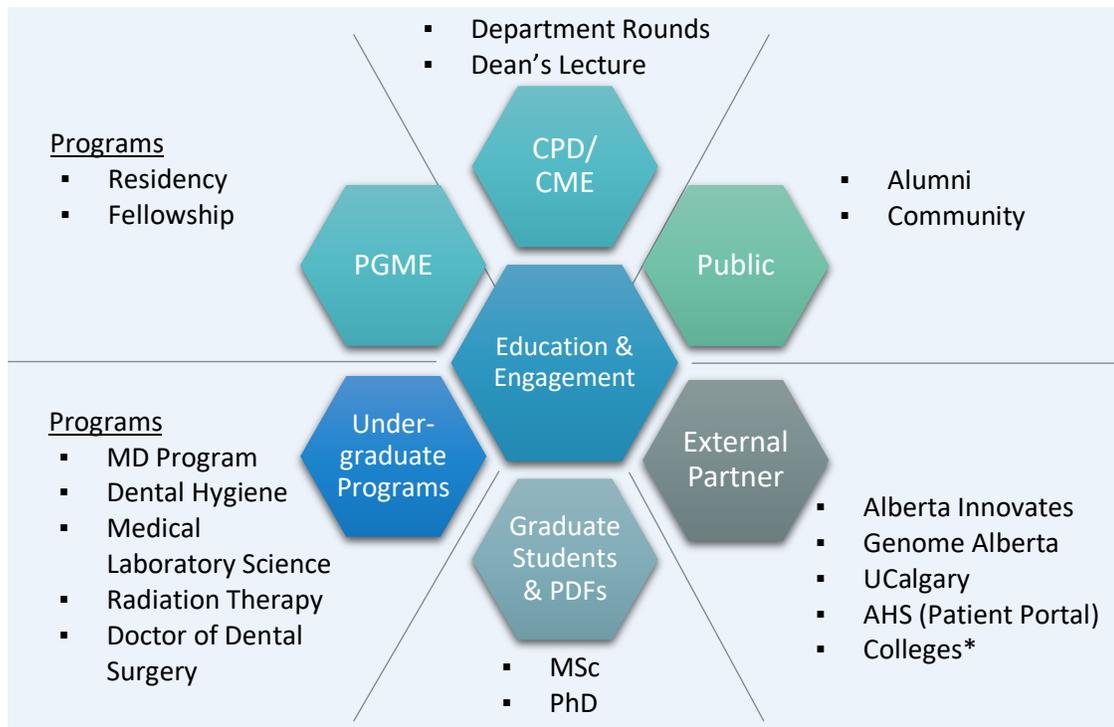
1. The education of healthcare providers in Alberta regarding the meaning and implications of Precision Health is in its infancy at present with few educational programs available.
2. Alberta is limited in the number of content experts available to teach concepts such as genomics, bioinformatics, pharmacogenomics, systems biology and data science at all learning levels, as evidenced by the small number of programs and limited enrolment offered in these areas.
3. Continuous professional development is generally self-directed; therefore, individuals have no specific mandate or accountability to learn about new and evolving concepts that pertain to Precision Health.
4. There are few funded postdoctoral fellowship positions in Canada to train clinical PhD lab scientists and subspecialists in Precision Health. Similarly, there is a shortage of residency positions to train MD Medical Geneticists, and genetic counselors, both in Alberta and nationally. There also is lack of awareness and interest of importance for this training.
5. Public knowledge of specific aspects of Precision Health (e.g. Direct-to-Consumer genetic testing, genome editing by CRISPR technologies) may be greatly influenced by what is portrayed in the media and popular culture. There is significant misunderstanding with respect to the limitations and consequences associated with these technologies.
6. Underserved populations may experience more difficulty accessing information on Precision Health and/or may have had previous negative interactions with respect to research in this area, potentially impacting their future engagement. Awareness, accessibility of equity and access for all populations needs to be addressed.

Alberta needs to be ready to meet these challenges and ensure sufficient qualified individuals are available to teach, implement and practice Precision Health through its health care legislation, professional colleges and laboratory accreditation and education programs.

**Content adapted from the Alberta Precision Health Education Working Group, Education for Precision Health: Today and Tomorrow Report, 2018 and the Precision Health for Alberta—A Prospectus, 2017*

WHERE ARE WE?

The following diagram shows the educational programs and partners that are relevant with respect to Precision Health training and engagement within FoMD.



*CME: Continuing Medical Education; CPD: Continuous Professional Development, PGME: Postgraduate Medical Education; *Royal College of Physicians and Surgeons of Canada, College of Physicians and Surgeons of Alberta, Alberta College of Family Physicians*

RECOMMENDATIONS

Based on meetings of the FoMD 'Precision Health Education & Engagement Task Force' with review of the 'Alberta Academic Health Network (AAHN) Precision Health Education Strategy', the 'Task Force' proposes the following approach to educate and engage faculty members, the physician community, allied health services, the general public and other key stakeholders in Precision Health:

FoMD Precision Health Speaker Series – Workshops - Conferences

1. Develop a Precision Health Seminar and Rounds Series (YEAR 1)

- Include internal & external speakers
- Host a total of 8-10 speakers per year (external ~ every 3 months); please refer to the **Appendix** for a draft list of suggested internal and external speakers
- Achieve balance between basic & clinical research areas
- Ensure interdisciplinarity where possible
- Regularly approach departments and institutes to identify speakers

Precision Health lectures would be embedded in:

- Rounds and Seminar Series of the departments and institutes
- Dean's Lecture Series, for high profile speakers

2. Host Precision Health Workshops (YEAR 1-2)

- Develop intensive multi-disciplinary 'Precision Health Education' boot camps; consider developing within the SPOR SUPPORT Unit framework
- Organize workshops with focus on: omics, sequencing, bioinformatics, artificial intelligence, social & legal implications of omics

3. Organize Precision Health related Conferences (YEAR 2-3)

- Consider 2nd Gairdner Symposium on Precision Health
- Alberta Precision Health Conference (partnering with AAHN)
 - Annual event for clinicians, researchers, staff and trainees from Universities of Calgary, Alberta and Lethbridge, AHS and SCNs

ACTIVITIES FOR FoMD'S EDUCATIONAL PROGRAMS

- 1) Establish a FoMD 'Precision Health Education and Engagement Steering Committee' with representation from key stakeholders to develop metrics and deliverables for the uptake and implementation of Precision Health educational strategies, training and engagement opportunities (YEAR 1)
- 2) Identify champions in Precision Health who are leaders in education at FoMD and in all domains and levels of advanced (health) education, i.e. within undergraduate, postgraduate, continuous professional development, faculty development and department heads to take on a leadership role and/or be part of the Steering Committee (YEAR 1)
- 3) Identify experts who have expertise to teach foundational and advanced concepts of Precision Health (YEAR 1)
- 4) Review Precision Health aspects in existing FoMD programs (YEAR1) with the aim of integrating Precision Health themes and lectures (YEAR 2):
 - a. MD program
 - b. MD with special Training in Research
 - c. Dentistry, Dental Hygiene
 - d. Postgraduate Medical Education
 - e. Graduate Studies (Medical Sciences Graduate Program)
 - f. Medical Laboratory Science (BSc in MLS degree program); this program has recently undergone an overhaul, which offers an opportunity to implement Precision Health approaches
 - g. BSc Radiation Therapy (program partners with AHS CancerControl Alberta)
 - h. Neuroscience (graduate program offered by NMHI)
- 5) Develop new Precision Health educational programs aimed specifically to graduate students who can work and excel in the area of Precision Health (YEAR 2-3)
- 6) Add topics on Precision Health within existing continuous professional development courses and increase training opportunities to support the evolution of Precision Health into clinical practice (YEAR 1-2)
- 7) Focus on developing multidisciplinary collaborative programs for students (YEAR 1-3)

- a) Create collaborative intra-university programs, with for example:
 - Faculty of Science - Computing Science
 - Alberta Machine Intelligence Institute (AMII)
 - Faculty of Engineering
 - b) Create common learning experiences for students from different degree programs
 - c) Engage with existing student groups at FoMD
 - 'B2B - Bench to Bedside Student Association' (collaboration opportunities between graduate students and MD students; platform for translational medicine)
 - Stethoscope (application of ML/AI in health, host workshops and guest speakers)
 - d) Support training opportunities, e.g.
 - NSERC CREATE (Collaborative Research and Training Experience) program, e.g. *'Transforming Data into Actions for Human Value through Artificial Intelligence'* proposal
 - Create more Precision Health studentships, like *TD Bank Financial Group Grant for Health Sciences Interdisciplinary Research*, 2019/20 competition in Precision Health
- 8) Collaborate with other Faculties to integrate Precision Health aspects in existing interdisciplinary programs, e.g.
- a) Digital Humanities (Faculty of Arts)
 - b) Health Sciences Education (Faculty of Education)
 - c) Internetworking (Faculty of Science and Engineering)
- 9) Develop educational programs with accreditation status ranging from Professional Development modules to Postgraduate Certificates and Diplomas up to a Master's in Genomic Medicine, topics could include
- a) Clinical Utility of Personalized Medicine (provide examples of pharmacogenomics)
 - b) Medical Genetic Testing (include also Direct-to-Consumer genetic testing)
 - c) Genomics for Clinical Informaticists
 - d) Genetic Counseling
- 10) Raise the profile of Medical Genetics as a career choice in medicine to increase the number of residency positions and increase the demand for medical geneticists
- 11) Utilize the Genome Canada / Genome Alberta infrastructure to promote Precision Health education training programs (see also Genome Quebec's 'Genomics in Clinical Practices' training program)

STAKEHOLDER/PUBLIC ENGAGEMENT

- 1) Engage AHS in educating its workforce about PH (YEAR 1)
- 2) Collaborate with AHS and Alberta Health in engaging patients, families, and populations in opportunities to learn about Precision Health (YEAR 1)
- 3) Collaborate with patient and health advocacy groups and establish programs around Precision Health to provide support, education, and advocacy for patients and families (YEAR 2)
- 4) Engage the provincial professional colleges (College of Physicians and Surgeons of Alberta, Alberta College of Family Physicians) in discussing the preparation of health care professionals to knowledgeably and competently apply Precision Health approaches (YEAR 2)

- 5) Develop educational material for the general public (YEAR 2-3)
 - a. Create a website including factsheets on Precision Health
 - b. Collect videos and images that visualize aspects of Precision Health
 - c. Address privacy of genetic information, the rights to use the information
 - d. Address ethical and legal concerns, such as the potential for inadvertent effects on family members, increased insurance rates, or increased psychological stress
 - e. Inform about risks of over- or under interpretation of test results
 - f. Specify advantages and limitations of current Direct-to-Consumer genetic tests

CONCLUSION

Interest and knowledge of Precision Health is growing within the FoMD and public. A number of FoMD members are now being approached on a regular basis, to speak on Precision Health both at the University and to the public, but no comprehensive strategy exists currently. This document outlines a strategy for engagement and education for the different programs of the FoMD. Different strategies need to be employed for education of faculty, technical staff, and medical and allied health professionals from junior to senior levels. Liaison with Alberta Health Services is imperative to reach the patients and public to develop an understanding of how Precision Health will change medical knowledge, provision of health care services, and treatment.

APPENDIX – EDUCATION & ENGAGEMENT

APPENDIX A: TASK FORCE MEMBERS

<i>Oksana Suchowersky (Chair), MD</i>	<i>U of A, FoMD; Director, Clinical Genetics, Co-Chair Precision Health Alberta Strategy</i>
<i>Ulrike Brockstedt (Co-Chair), PhD</i>	<i>U of A, FoMD, Associate Program Director Precision Health</i>
<i>Daniel Baumgart, MD PHD</i>	<i>U of A, FoMD, Division Director of Gastroenterology</i>
<i>Derek Emery, MD</i>	<i>U of A, FoMD, Chair Radiology & Diagnostic Imaging</i>
<i>Diane Forbes</i>	<i>U of A, Health Sciences Council, Precision Health Signature Area Lead</i>
<i>Lee Green, MD</i>	<i>U of A, FoMD, Chair Family Medicine</i>
<i>Tracey Hillier, MD</i>	<i>U of A, FoMD, Associate Dean Undergraduate Medical Education</i>
<i>Emily Hoffman</i>	<i>U of A, FoMD, Engagement Coordinator</i>
<i>Deborah James, PhD</i>	<i>U of A; Office of the Vice-President (Research and Innovation); Associate Vice-President, Innovation</i>
<i>Salena Kitteringham</i>	<i>U of A, FoMD, Director, Communications and Marketing</i>
<i>Hanne Ostergaard, PhD</i>	<i>U of A, FoMD; Associate Dean, Graduate Studies</i>
<i>Raja Singh, MD PhD</i>	<i>U of A, FoMD; Director, Alberta Academic Health Network</i>
<i>Lyn Sonnenberg, MD</i>	<i>U of A, FoMD; Associate Dean, Educational Innovation & Academic Technologies</i>
<i>James Young, PhD</i>	<i>U of A, FoMD, Chair Physiology</i>

TASK FORCE MEETINGS

June 28, 2019
 August 9, 2019
 October 8, 2019
 Nov 19, 2019

APPENDIX B: FOMD SPEAKERS SERIES SUGGESTIONS FOR EXTERNAL SPEAKERS – 1ST YEAR

NAME	AFFILIATION	TOPIC	SPONSOR
Ross Upshur	U of T, Dalla Lana Faculty of Public Health	Artificial intelligence, machine learning and the potential impacts of the practice of family medicine	Dean's Lecture
Sir John Bell	Oxford	The role of diagnostics, therapeutics & digital tools in future medicine	Dean's Lecture
Francois Bernier	U of C, Medical Genetics	Provincial large-scale genome project	Medical Genetics Rounds
Gerlinde Metz	U of L, Neuroscience, Canadian Centre for Behavioural Neuroscience	Influence of experience and environment on behavior and brain plasticity	WCHRI or Walter Mackenzie Speaker Fund

SUGGESTIONS FOR INTERNAL SPEAKERS – 1ST YEAR

NAME	AFFILIATION	TOPIC	SPONSOR
Ordan Lehmann	Ophthalmology, Medical Genetics		TBD
Katherine Aitchison	Psychiatry, Medical Genetics	Pharmacogenomics	Psychiatry Rounds
Glen Jickling	Medicine, Division of Neurology	Immune response in stroke	Medicine Rounds
Brian Buck	Medicine, Division of Neurology	Imaging and AI in stroke	Medicine Rounds
David Wishart	Biol. Sciences, Comp Science, LabMedPathol		TBD
Daniel Baumgart	Medicine, Division of Gastroenterology	GI & remote technologies	Medicine Rounds
Amit Bhavsar	Medical Microbiology & Immunology	Childhood cancer toxicity, Pharmacogenomics, therapeutics	TBD
Jacob Jaremko	Radiology & Diagnostic Imaging	AI to automate ultrasound medical image analysis	TBD
Patrick Pilarski	Medicine, Div of Physical Medicine & Rehabilitation	ML, human-machine interaction, rehabilitation technology	Medicine Rounds

Appendix 5: Precision Health Survey



FACULTY OF MEDICINE & DENTISTRY PRECISION HEALTH SURVEY – MARCH 2019

THEMES & TEAMS TASK FORCE GROUP

SURVEY – GOALS

As one of the first three University of Alberta signature areas endorsed by the Dean's Council, the Precision Health initiative aims for better health for Albertans through research, innovation and education. As a first step, the initial focus is on the Faculty of Medicine & Dentistry (FoMD), given that precision health is a Faculty priority and the FoMD will be a crucial component of the university's signature area.

The goal of the survey was to help:

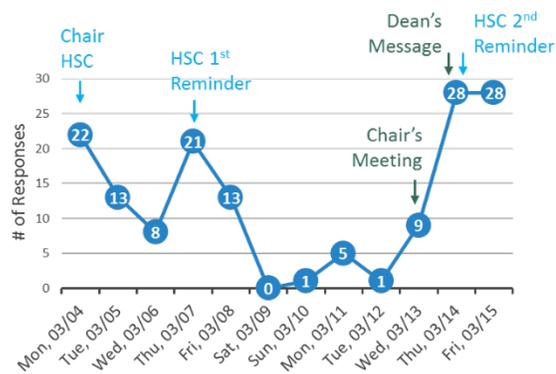
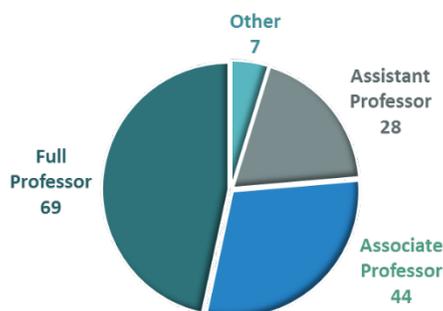
- Identify areas of established Precision Health strength
- Pinpoint gaps in infrastructure / talent where further investment may be needed
- Identify themes and connect teams
- Build the FoMD's Precision Health strategic plan
- Drive major fundraising campaigns

For the purpose of this survey, the following working definition of Precision Health was used: "Precision Health is founded on data and analytics—it is an emerging health model that integrates molecular, clinical and environmental data to improve the diagnosis and treatment of individual patients, as well as to inform the social determinants of health.

The survey was developed by the 'Precision Health Themes & Teams Task Force Group' and sent to 742 Faculty members. In total, 149 members responded, corresponding to an overall response rate of 20%. Please see details below and the following pages for a breakdown of the survey responses for each question.

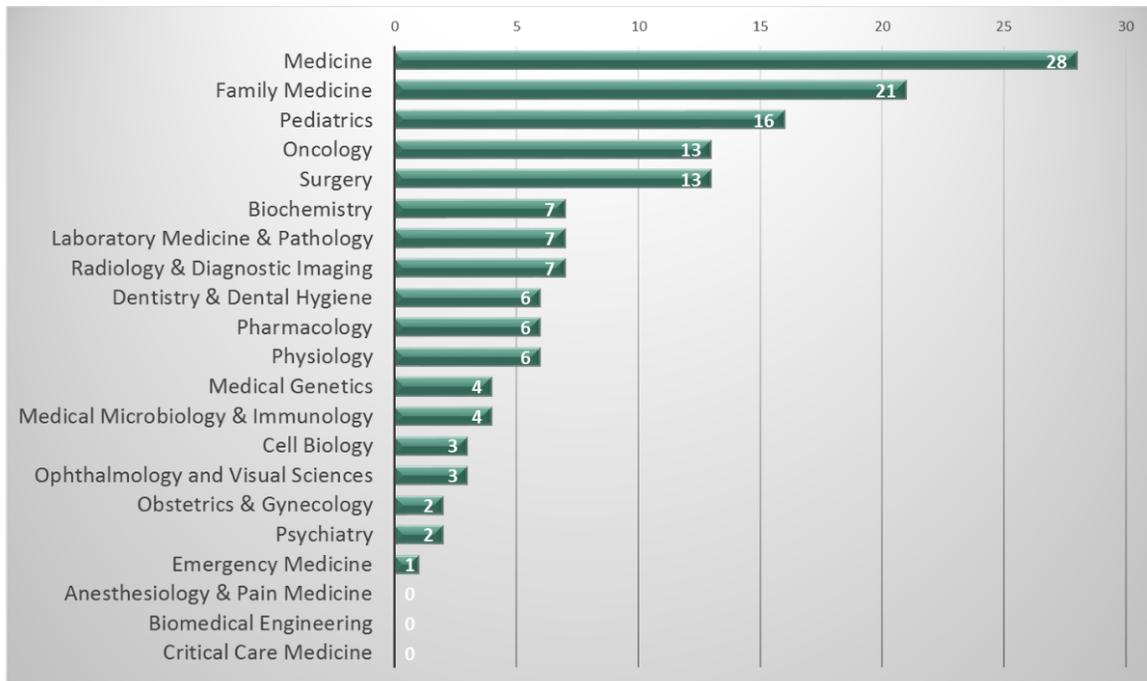
SURVEY – DATES & PARTICIPANT

- Preannouncement: Feb 27th, FoMD Dean's Message
- Sent: Mar 4th & 5th to 742 Faculty members from Chair, Health Sciences Council (HSC)
- Open until Mar 12th, extended until Mar 15th
- 3 Reminder emails
- 149 Responses; \approx 20%



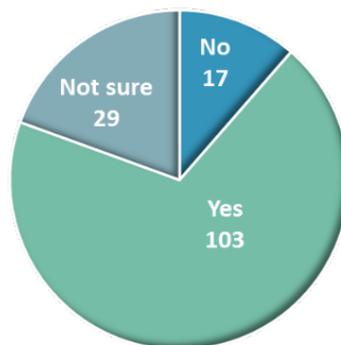
SURVEY – QUESTIONS

- What is your primary **department**?



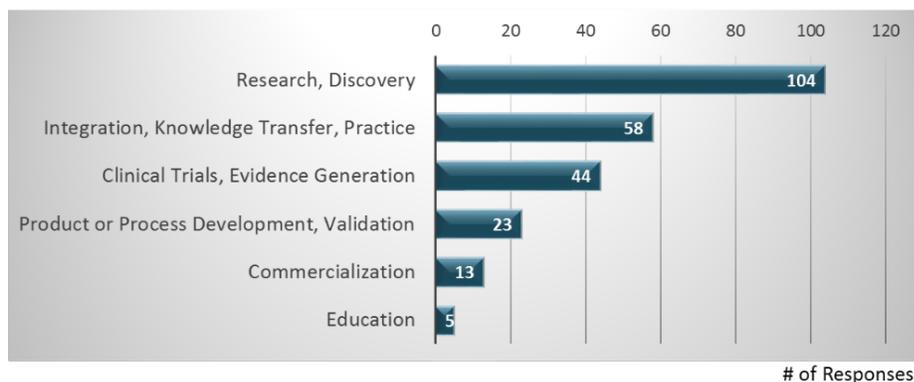
total # of responses = 149

- Does your research **align with the concept** of Precision Health?



total # of responses = 149

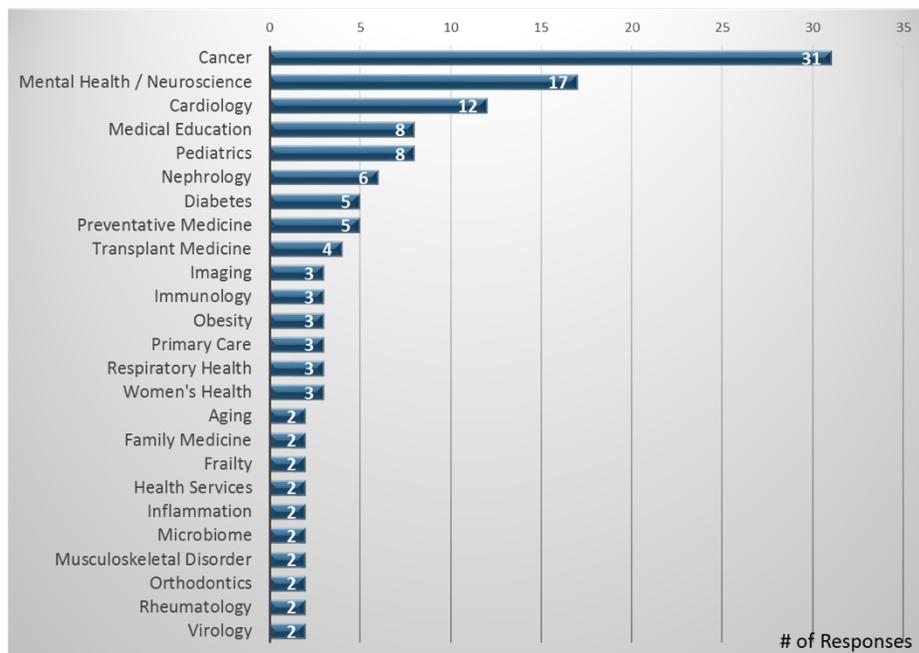
- What is your **main area of interest?** (Option to choose more than one category)



N = 1

AI, Clinical Outcomes, Clinical Research, Communication Technology, Culture of Practice, Digital Health, Implementation Science, Methods and Analytics, Rural Health Delivery & Education

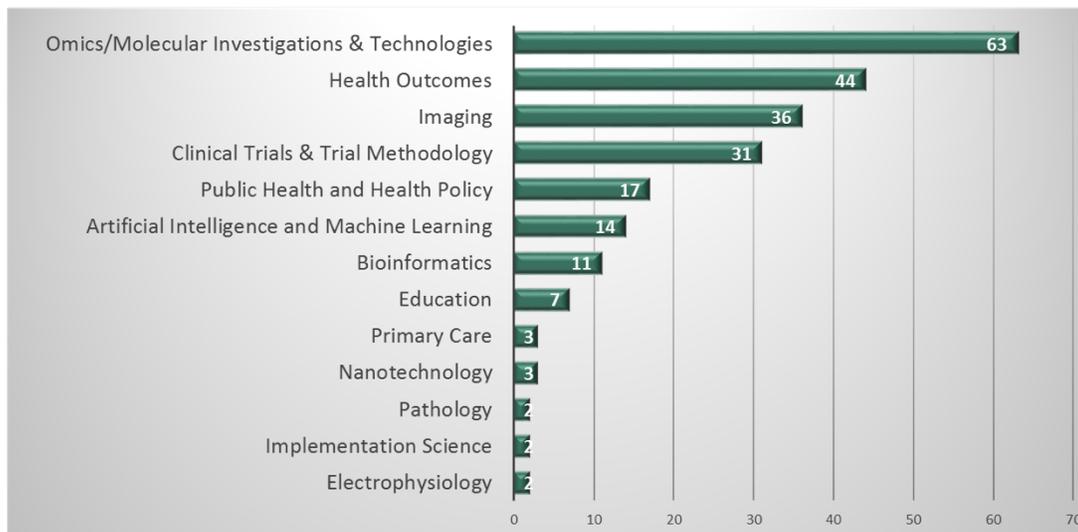
- What is your key **focus area of research?**



N = 1

Acute care, Arthritis, Biostatistics, Cell Physiology, Colorectal Disease, Comparative Effectiveness Studies, Craniofacial Development, Developmental Genetics, Diagnostics, Environmental Health, Gene Editing, Geriatrics, Health System, Knowledge Synthesis / KT, Learning Sciences, Metabolomics, Molecular Biology, Molecular Enzymology, Neonatal Medicine, Neuromuscular Disease, Palliative Care, Retina, Scoliosis, Sleep Medicine, Teleophthalmology, Vascular Biology, Vision Science, Visual Neuroscience, Wound Healing

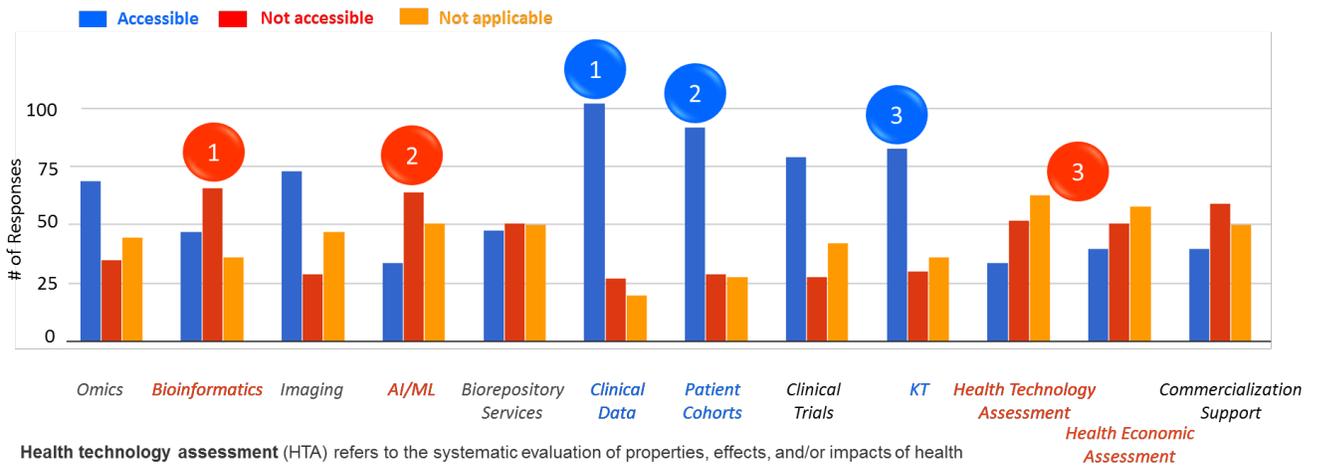
What are your specific **areas of research strength**? (Option to choose more than one category)



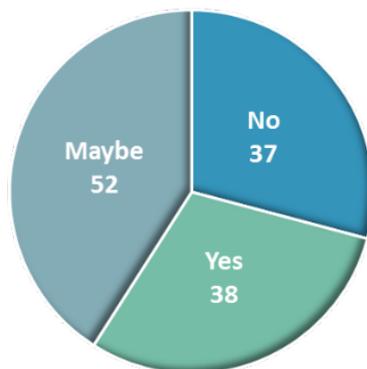
Further areas of specific research strengths (N = 1):

- Access to large patient cohorts with biosamples
- Animal models for psychiatric disorders
- Antisense-mediated therapy
- Biochemistry
- Biostatistical Methods
- Cardiovascular Disease Models
- Cardiovascular Physiology
- Cell Biology
- Clerkship Models
- Cohort Studies
- Collaborative Clinical Research
- Teaching and Learning Dynamics and Environments
- Data Linkage
- Design of inhibitors to block specific protein-protein interaction
- Experimental Models
- Functional Physiological Approaches
- Genome Editing
- Geographic Information Systems
- Knowledge Translation
- Molecular Basis of Disease
- Molecular Genetics
- Molecular studies with the potential to influence clinical trials
- Neurophysiology
- Patient-based Translational Research
- Personalized Genetic Medicine
- Personalized Therapy/t cell transplant for cancer, autoimmune, infectious disease
- Physiological Signal Analysis
- Practice based research networks
- Process Mapping
- Professional Identity Formation
- Quality Improvement
- Risk Prediction
- Sciences & Spatial Analyses and Modeling
- Teaching and Learning Dynamics and Environments

- What research platforms do you currently have access to and/or which ones are not accessible to you?

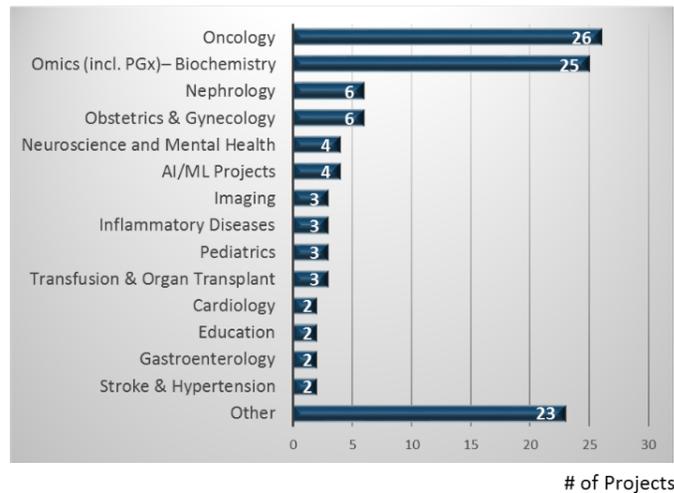


- Do you think there are adequate **opportunities** for you to get involved in Precision Health-related research?



total # of responses = 127

- Please list any Precision Health-related research project(s) you are involved in
 - 84 PIs (\cong 54%) submitted a total of 114 projects, in the following areas of research:



- Further analysis of survey results revealed three essential themes and areas of strengths at FoMD:

- 1) Precision Diagnostics
- 2) Precision Therapeutics
- 3) AI Applied in Health

- Are there any comments you would like to make about the U of A's Precision Health Signature Area?
 - 77 PIs (\cong 50%) submitted comments, please see below for a summary

Positive comments

- Supportive of the initiative(6)

Request for

- More Information on Precision Health (12)
- AI/bioinformatics support, infrastructure & bridge people (10)
- Areas of focus & uniqueness, UofA has to be more visible (6)
- Researchers and clinicians need to collaborate (6)
- Resources, Seed Grants (4)
- Inclusiveness (4)
- How do we set ourselves apart from McGill, UofT, UBC,...(3)
- Commercialization platforms (2)

Criticism

- No opportunities for Primary Care/Family physicians; do not feel included (8)
- Definition too broad, too vague...(5)
- No value in PH (3)
- No focus on education in the survey (3)
- Faculty unprepared (not enough investments in genetics) (2)

GAIRDNER SYMPOSIUM: PRECISION HEALTH



From **Data** to **Wellness**

November 15-16, 2018

8 a.m. - 4:30 p.m.

University of Alberta, TELUS Centre

Edmonton, AB, Canada



GAIRDNER SYMPOSIUM Precision Health - Program**Thursday, Nov 15**

8:00-8:30 am	REGISTRATION
8:30-8:45 am	Moderator: Christopher Power , <i>Vice-Dean, Research, Faculty of Medicine & Dentistry</i> WELCOME David Turpin , <i>President and Vice-Chancellor, University of Alberta</i>
8:45-9:05 am	OPENING KEYNOTE Oksana Suchowersky , <i>Professor, Department of Medicine, University of Alberta; Co-Lead, Alberta Precision Health Strategy</i>
SESSION 1: Precision Diagnostics	
9:05-9:15 am	Chair: Michael Mengel <i>Chair, Department of Laboratory Medicine and Pathology, University of Alberta; Clinical Department Head, Laboratory Services (Edmonton Zone), Alberta Health Services</i>
9:15-9:55 am	David Huntsman <i>Professor, Departments of Pathology and Laboratory Medicine and Obstetrics and Gynaecology, University of British Columbia, Vancouver, BC, Canada</i> Precision Diagnostics and Biologically Informed Prevention Strategies: Under Appreciated Windfalls from Genomic Research
9:55-10:15 am	HEALTH BREAK
10:15-10:55 am	Samuel Sia <i>Professor, Department of Biomedical Engineering, Columbia University, New York, NY, USA</i> Microfluidics for Personal Diagnostics
10:55-11:35 am	Philip Halloran <i>Professor, Department of Medicine, Division of Nephrology, University of Alberta</i> The Molecular Microscope System for Transplant Biopsy Analysis
11:35-11:55 am	PANEL DISCUSSION
12:00-2:00 pm	CATERED LUNCH POSTER VIEWING SESSION
SESSION 2: Precision Therapeutics	
2:00-2:10 pm	Chair: Lynne Postovit <i>Assoc. Professor, Department of Oncology, Division of Experimental Oncology, University of Alberta; Co-Director, Cancer Research Institute of Northern Alberta</i>
2:10-2:50 pm	Bruce Carleton <i>Professor, Department of Pediatrics, University of British Columbia; Director Pharmaceutical Outcomes Programme at BC Children's Hospital, Vancouver, BC, Canada</i> The Role of Pharmacogenetics in Precision Medicine
2:50-3:30 pm	Margaret Mooney <i>Chief, Clinical Investigations Branch in the Cancer Therapy Evaluation Program, National Cancer Institute, Bethesda, MD, USA</i> Focus of NCI/CTEP Clinical Trial Programs in the Era of Precision Medicine
3:30-4:10 pm	Robert Schuck <i>Clinical Pharmacologist, Genomics and Targeted Therapy Group, Food and Drug Administration, Silver Spring, MD, USA</i> The Application of Genomics in Drug Development and Clinical Practice—an FDA Perspective
4:10-4:30pm	PANEL DISCUSSION
6:30 pm	DINNER for speakers and other invited guests, <i>Fairmont Hotel Macdonald</i>

GAIRDNER SYMPOSIUM Precision Health**Friday, Nov 16**

8:00-8:30 am	REGISTRATION
8:30-8:40 am	OPENING REMARKS Cyril Kay , <i>Professor Emeritus of Biochemistry, University of Alberta</i>
8:40-9:25 am	KEYNOTE Janet Rossant <i>President and Scientific Director Gairdner Foundation; Senior Scientist and Chief of Research Emeritus, Hospital for Sick Children, Toronto, ON, Canada</i> From Genomes and Big Data to Stem Cells and Gene Editing - the Tools of Precision Medicine

SESSION 3: Precision Public Health

9:25-9:35 am	Chair: Jeff Johnson <i>Professor and Assoc. Dean (Education), School of Public Health, University of Alberta</i>
9:35-10:15 am	Michael Good <i>Professor, Senior Principal Research Fellow, Institute for Glycomics, Griffith University, Queensland, Australia</i> Vaccine Development for an Insidious Neglected Infectious Disease: Strep A
10:15-10:45 am	HEALTH BREAK
10:45-11:25 am	Philip Awadalla <i>Professor, Department of Molecular Genetics, University of Toronto; Director of Computational Biology and the Ontario Health Study, Ontario Institute of Cancer Research, Toronto, ON, Canada</i> Canada's National Population Cohort for Supporting Genomic and Environmental Interrogations of Age Related Disease - the Canadian Partnership for Tomorrow Project
11:30-12:00 am	PANEL DISCUSSION with Jennifer Vena (<i>Scientific Director, Alberta's Tomorrow Project, CancerControl Alberta, Alberta Health Services, Calgary, AB, Canada</i>)
12:00-1:00 pm	CATERED LUNCH

SESSION 4: Precision Digital Analytics

1:00-1:10 pm	Chair: Randy Goebel <i>Professor, Department of Computing Science; Assoc. VP (Research)/ Assoc. VP (Academic), University of Alberta</i>
1:10-1:50 pm	Alan Karthikesalingam (regrets) <i>Senior Clinician Scientist, Google DeepMind Health, London, United Kingdom</i> Digital Health and Artificial Intelligence for Healthcare
1:50-2:30 pm	Rich Caruana <i>Senior Researcher, Microsoft Research, Seattle, WA, USA</i> Friends Don't Let Friends Deploy Black-Box Models: The Importance of Intelligibility in Machine Learning for HealthCare
2:30-3:10 pm	John Aitchison <i>Professor and Co-Director, Center for Global Infectious Disease Research, Seattle Children's Research Institute, Seattle, WA, USA</i> Systems Biology and Infectious Disease
3:10-4:00 pm	PANEL DISCUSSION and CONCLUDING REMARKS

Each lecture is **40 min**; lectures in one session will be followed by a **20-minute panel** discussion