WELCOME!

Precision Health at the University of Michigan aims to improve health care by developing more effective and comprehensive approaches, from discovery to prevention to treatment to implementation. We are excited to share progress across the initiative from January 2019 to January 2020.

The initiative focuses on building the data resources, computational environments, analytical tools, and implementation platforms that can be used across many areas of science, as well as educating researchers in precision health tools and methods. By promoting multidisciplinary collaboration among faculty across the university, Precision Health enables researchers to explore ideas that historically were not considered. The Precision Health platform seeks to remove obstacles to exploring these new ideas, so that researchers can focus on novel concepts knowing the necessary infrastructure is in place.

This report highlights accomplishments in building the infrastructure researchers need to engage in precision health science: infrastructure that includes access to health data, a HIPAA-compliant computing environment, and consulting services on how to use the data. Providing a diverse group of scientists the resources they need requires a collaborative and innovative approach among teams across the university, which Precision Health is proud to promote.

Much more work needs to be done to enable the transformative science that will improve patient care, but we are encouraged by the meaningful work being done in developing a participant community, building a data analytics platform, establishing a health implementation process, and creating a workforce educated about precision health. We are also heartened by the support we’ve received from committed and thoughtful donors.

As you flip through the pages of this report and learn more about this initiative, we hope you are encouraged by the progress and excited about the potential to influence disease prevention and treatment and health outcomes for people and communities around the world.

Michael Boehnke, PhD  
Co-Director
Richard G. Cornell  
Distinguished University Professor of Biostatistics  
School of Public Health

Sachin Kheterpal, MD, MBA  
Co-Director  
Professor of Anesthesiology,  
Associate Dean for Research Information Technology  
Medical School

Jenna Wiens, PhD  
Co-Director  
Associate Professor of Computer Science and Engineering  
College of Engineering
The complex data that comprise the foundation of precision health science require the development and deployment of sophisticated analytical tools to retrieve, clean, manage, analyze, and visualize these data.

In partnership with an expansive cross-campus team, Precision Health has developed the Precision Health Analytics Platform. The Analytics Platform is a suite of tools, services, and datasets that gives researchers across campus access to big data and the support needed to analyze that data. The platform includes:

- **DataDirect**
  DataDirect is a self-serve software tool that enables researchers to access and explore clinical data from the Michigan Genomics Initiative (MGI), and perform cohort discovery from the electronic health records of more than 4 million unique patients.

  DataDirect is managed by Michigan Medicine’s Data Office for Clinical and Translational Research, which oversees access to several institutionally supported tools, and also provides customized datasets through a secure and compliant process.

- **Linked Data**
  Using Data Office tools and resources, the Analytics Platform provides access to genetic and clinical data on approximately 80,000 patients. This includes the ability to link electronic health record phenotype data to genotype data and the facilitation of genetic analyses.

  Researchers can access data in a secure, virtual, high-compute Linux- or Windows-based environment.

  Precision Health also strategically acquires and integrates data based on feedback from investigators across campus. The Analytics Platform includes the following linked data:

  - SureScripts (prescription fulfillment data for MGI population, and up to 500,000 total)
  - Cancer Registry
  - Michigan Death Index
  - Emergency Department Datamart
  - Opioids survey data from Precision Health’s Precision Opioid Prescribing Use Case
  - Geolocation data + NaNDA (National Neighborhood Data Archive)
  - Curated dataset for the Machine Learning in Health Care conference
  - Genome-wide genetic data for all MGI participants
  - Limited curated datasets for whole-exome and targeted DNA sequencing

- **Yottabyte**
  The Yottabyte Research Cloud is a private cloud environment that provides a secure and flexible computing enclave to enable analysis of sensitive datasets restricted by federal privacy laws, proprietary access agreements, or confidentiality requirements. The system is built on Yottabyte’s composable, software-defined infrastructure platform and represents U-M’s first use of software-defined infrastructure for research, which allows on-the-fly personalized configuration of computing resources.

- **Armis2**
  The Armis2 high-performance computing environment is a pilot service composed of task-managing administrative nodes and standard Linux-based two- and four-socket server class hardware in a secure data center. It’s connected by both a high-speed ethernet (1 Gbps) and InfiniBand network (40Gbps). HIPAA-aligned Turbo Research Storage provides a secure parallel file system for temporary data. Armis2 has 48 GPUs.

- **Research Scientific Facilitators**
  Precision Health research scientific facilitators are on hand to guide investigators across campus through processes that allow them to assemble datasets in a virtual, HIPAA-compliant server environment. Facilitators help researchers navigate self-serve tools such as DataDirect and EMERSE, find other ways of assembling clinical data (through the Data Office), submit biospecimen inquiries, assemble subject survey data, and identify and integrate additional data lakes for centralized use.
THE PLATFORM IN ACTION

U-M researchers immediately capitalized on the analytics platform to advance their research. Our research scientific facilitator consulting services have already shown significant campus impact and utility.

Upon release of the Analytics Platform, requests for large datasets began immediately, coming from a variety of schools with varying research interests. The research scientific facilitators perform consultations and respond to requests for clinical data, genetic data and analyses, re-contact data, and biospecimens.

Through our research scientific facilitator consulting services, more than 100 researchers across campus received deskside assistance.

TOTAL CONSULTATIONS: 108

- 62 (57.4%) MEDICAL SCHOOL
- 14 (13%) SCHOOL OF PUBLIC HEALTH
- 12 (11.1%) COLLEGE OF PHARMACY
- 12 (11.1%) COLLEGE OF ENGINEERING
- 2 (1.9%) COLLEGE OF LITERATURE, SCIENCE, AND THE ARTS
- 2 (1.9%) SCHOOL OF INFORMATION
- 1 (0.9%) SCHOOL OF PUBLIC POLICY
- 1 (0.9%) SCHOOL OF NURSING
- 1 (0.9%) MICHIGAN ROSS
- 1 (0.9%) INSTITUTE FOR SOCIAL RESEARCH

Our data storage services have proved to be a valuable resource. We now have more than 290 users, 76 of whom are students, with an additional 30 students from the College of Engineering using our data for classroom coursework.

DATA SERVICES IN ACTION

Clinical pharmacy has been using Precision Health’s streamlined request process for genetic data, and combining it with patient re-contact, to confirm a variant that has detrimental toxic effects when given to patients. Biostatisticians from the School of Public Health and physicians at the Medical School are likewise using MGI biospecimens to create a novel targeted sequencing panel.

ISR has shared U.S. Census data along with the American Community Survey, but now, with the collaboration of Precision Health, ISR (as well as many individual researchers and groups of researchers) can link clinical data of Michigan Medicine patients to those of NaNDA (National Neighborhood Data Archive) data elements to deepen their research. NaNDA data elements are available for all Michigan Medicine patients.

The Cancer Registry has worked with Precision Health programmers to make Cancer Registry data available through DataDirect, so researchers have an easier time filtering their cohort of interest.

WORKING TO EXPAND OUR FOOTPRINT

Precision Health at the University of Michigan believes that the most effective approach to patient care is an integrated one that involves expertise across disciplines to consider the social, environmental, genetic, and behavioral impact on disease and disease progression. Thus, we are working to involve researchers from all 19 schools and colleges and a number of centers to advance precision health science across campus.

Throughout the year we engage in outreach efforts to make our investigators aware of our resources. Our efforts in 2019-20 included 12 roadshows with 225 participants.

<table>
<thead>
<tr>
<th>AUDIENCE</th>
<th>PARTICIPANTS</th>
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<tbody>
<tr>
<td>Survey Research Center</td>
<td>16</td>
</tr>
<tr>
<td>Center for Healthcare Outcomes &amp; Policy</td>
<td>14</td>
</tr>
<tr>
<td>Clinical Pharmacy</td>
<td>15</td>
</tr>
<tr>
<td>Michigan Institute for Data Science</td>
<td>28</td>
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<tr>
<td>Michigan Integrated Center for Health Analytics &amp; Medical Prediction/Data &amp; Methods Hub</td>
<td>18</td>
</tr>
<tr>
<td>National Clinician Scholars</td>
<td>15</td>
</tr>
<tr>
<td>T32 Training Grant Awardees</td>
<td>7</td>
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<tr>
<td>Epidemiology/Environmental Health Sciences/Health Behavior and Education</td>
<td>14</td>
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<tr>
<td>Biostatistics</td>
<td>14</td>
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<tr>
<td>Center for Statistical Genetics</td>
<td>60</td>
</tr>
<tr>
<td>Industrial &amp; Operations Engineering/Electrical Engineering &amp; Computer Science/Electrical &amp; Computer Engineering</td>
<td>14</td>
</tr>
<tr>
<td>AI Lab</td>
<td>10</td>
</tr>
</tbody>
</table>
COMMUNITY PARTICIPANTS VITAL TO ADVANCING PRECISION HEALTH

At the heart of precision health science is the ability to study large populations to better understand disease, and translate these findings into meaningful treatments.

The Michigan Genomics Initiative (MGI), Precision Health’s participant cohort, provides valuable patient data for Precision Health researchers. With approximately 80,000 participants, it’s currently one of the world’s largest opt-in, multi-use, participant-focused precision health patient cohorts.

MGI integrates novel datasets with participants’ electronic health records and genetic data, allowing researchers to learn more about disease trajectory based on a number of health, behavior, and socioeconomic factors. Researchers from across U-M have access to this information via the Precision Health Analytics Platform, and, once receiving approval from the institutional review board, they are able to re-contact participants as necessary to expand their research.

While Precision Health leadership continues to diversify the cohort in the areas of race, ethnicity, age, and disease type, MGI currently offers:

- ~ 80,000 participants who have consented to being re-contacted, to gather additional information or request participation in additional studies
- A participant community enriched in a number of disease areas, including many cancers
- Linkable data on genetics, prescriptions, patient surveys, and geolocation
- A growing cohort, which is increasing by 10,000 participants per year

TAKING DISCOVERIES TO THE BEDSIDE

Precision Health confronts a key challenge of research by taking a head-on approach to health implementation.

For precision health to impact patient care, it must 1) translate novel discoveries and machine-learning models into better therapies and better outcomes for patients in the clinic and 2) devise direct, intuitive processes for physicians in implementing precision health strategies, so precision health-based alerts and interventions streamline clinicians’ work instead of adding to it.

Through key partnerships and collaborations, Precision Health’s Health Implementation Workgroup has devised the overall processes by which promising precision health discoveries can be integrated into Michigan Medicine patient care and health systems throughout the state of Michigan, as well as informing improvements in health care nationwide. Long-term health implementation projects demonstrate the value of a multidisciplinary approach and the breadth and depth of expertise at U-M that help make the initiative successful.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>COLLABORATORS</th>
</tr>
</thead>
</table>
| Predictive analytic tool for C. difficile infection (CDI) | • College of Engineering  
• Infection Prevention & Epidemiology  
• Clinical Intelligence Committee  
• Health Information Technology & Services  
• Office of Clinical Informatics  
• Department of Learning Health Sciences |
| Sepsis Prediction Tool | • College of Engineering  
• Michigan Medicine Quality Department  
• Improving Sepsis Outcomes (Michigan Medicine)  
• Department of Learning Health Sciences |
| Multimorbidity-Weighted Index (MWI) | • U-M Medical Group |
| Readmissions | • U-M Medical Group  
• Michigan Medicine Quality Department  
• Office of Clinical Informatics  
• Clinical Intelligence Committee  
• Health Information Technology & Services  
• Department of Learning Health Sciences  
• UMH Care Management |
| Surgical Site Infections (SSI) | • Infection Prevention & Epidemiology  
• Others |
To meet these challenges, we must prepare the next generation of great scientists and providers. Current U-M faculty and staff also need to be educated about the mechanisms to integrate their efforts across the discovery, treatment, and health continuum. To address these needs, Precision Health offers a range of diverse and exciting learning opportunities for students, faculty, and providers. Our 2019-20 programming included a symposium featuring top researchers from across the country that highlighted the work of our 2018 Scholars Award winners and other precision health work on campus. Our seminar series offered lectures and discussions on a range of topics to demonstrate the breadth and depth of precision health at the University of Michigan.

LEARNERS PARTICIPATED IN THE PRECISION HEALTH SEMINAR SERIES AND SYMPOSIUM
The program’s goal is to train a cadre of precision health scientists to apply advanced, multidisciplinary knowledge in the pursuit of improving patient and population health. To date, 11 students have enrolled from the Colleges of Engineering (2) and Pharmacy (1), the School of Information (2), and the Medical School (6).

The certificate program aims to develop competencies across these key areas:

- Ethical, Legal, and Social Implications of Precision Health
- Data Science and Predictive Health Analytics
- Biosocial Determinants of Health/Policy/Economics
- Human Genetics in Health and Disease/Molecular Medicine
- Bioinformatics/Computational Genomics
- Consumer Health Informatics and Healthcare Systems Engineering for Precision Health

Drawing on the expertise at U-M, the program includes courses offered through the following departments, schools, and colleges:

- School of Public Health
- Department of Learning Health Sciences
- College of Engineering
- College of Literature, Science, and the Arts
- School of Information
- Medical School
- College of Pharmacy
- Rackham Graduate School

Mariana Masteling Pereira
Biomedical Engineering PhD student
The following publications, presentations, and grant submissions are findings of studies Precision Health funded with its 2018 Investigators Awards.

Stephanie Bielas, PhD, Stephen Parker, PhD: “Genetic modulators of opioid exposure in human neurologic development”

PRESENTATION:
NIDA Genetics and Epigenetics meeting, January 13-14, 2020

RELATED GRANT SUBMISSION:
March of Dimes, R01 NIH National Institute on Drug Abuse

Sriram Chandrasekaran, PhD: “Personalized therapies for drug-resistant infections using a multi-scale host-pathogen model”

PUBLICATION:

UPCOMING PRESENTATION:
Biomedical Engineering Society annual meeting, San Diego, October 14-17, 2020

RELATED GRANT SUBMISSIONS:
National Institutes of Health - NIAID - R21
Title: Characterizing the properties of highly effective drug combinations against tuberculosis using machine-learning

National Institutes of Health - NIAID - R01
Title: A multifactorial pipeline to dissect combinatorial drug efficacy in tuberculosis

Anne Fernandez, PhD: “Precision Prevention of New Persistent Opioid Use Following Surgery: A machine learning-based treatment approach”

RELATED GRANT:
R21/R33 Mechanism
Leveraging electronic health records to identify risky alcohol use prior to surgery
Submission June 2019; NIH-DHHS-US-19-PAP07675
04/01/2020 – 03/31/2015; Impact Score - 17 $1,588,355

Lars Fritsche, PhD, Bhramar Mukherjee, PhD: “Development of an Open Repository of Polygenic Risk Scores (PRS) with an Interactive Visual Catalog”

PRESENTATION:
ASHG 2019 Annual Meeting, October 15-19, 2019, Houston, TX: “PRSweb – An Interactive Visual Catalog for Polygenic Risk Scores”

Jeffrey Hodgin, MD, PhD: “Digital Pathology and Image Analysis for Lupus Nephritis”

POSTER/PRESENTATIONS:
Precision Health Symposium, May 29, 2019, University of Michigan: “Digital Pathology and Computer-aided Quantitative Analysis for Lupus Nephritis” (poster)
Lupus Conference, August 8, 2019, University of Michigan: “Digital Pathology and Image Analysis for Lupus Nephritis” (presentation)
Grand Rounds - Duke Nephrology, January 24, 2020, Duke University: “Computational Pathology for FSGS and MCD” (presentation)

Yi Li, PhD: “Predictive Modeling of Opioid Use Among Surgical Patients”

POSTER/PRESENTATIONS:
Precision Health Symposium, May 29, 2019, University of Michigan: “How BMI modifies the association between opioid use and clinical factors: A new statistical approach with the soft-thresholding operator” (poster)

Scott Pelletier, PhD, Ben Hampstead, PhD: “Using quantitative neuroimaging to enhance clinical prediction in Alzheimer’s disease”

PUBLICATIONS:

Emily Mower Provost, PhD, Melvin McGinnis, MD: “Automatic Speech-Centered Behavior Recognition to Support Mental Health Monitoring”

PUBLICATIONS:

PRESENTATION:
Interspeech 2019, Graz, Austria

RELATED GRANTS:
NSF: SCI-INT: Measuring Emotions from Ambient Sound in Unstructured speech Recordings to detect variation in MENTal Health (MEASURE-MENT), $1,200,000, 12/10/2019
NSF: RI: Small: Speech-Centered Robust and Generalizable Measurements of “In the Wild” Behavior for Mental Health Symptom Severity Tracking. $500,000, 11/13/2019

K. Alex Shorter, PhD: “Understanding Cardiac Health through Innovative Wearable Sensing”

RELATED GRANT SUBMISSION:
NSF: An Enhanced Understanding of Cardiac Healthy using Wearable Sensors and Extended Persistent Monitoring. Directorate: Smart and Connected Health (SCH)

Scott Pelletier, PhD, Ben Hampstead, PhD: “Using quantitative neuroimaging to enhance clinical prediction in Alzheimer’s disease”

UPCOMING PRESENTATION:
Biomedical Engineering Society annual meeting, San Diego, October 14-17, 2020

RELATED GRANT SUBMISSIONS:
National Institutes of Health - NIAID - R21
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NSF: An Enhanced Understanding of Cardiac Healthy using Wearable Sensors and Extended Persistent Monitoring. Directorate: Smart and Connected Health (SCH)
ENGAGING COMMUNITIES TO IMPROVE PATIENT CARE

Precision Health takes seriously its mission to serve the local community and to expand research focused on underserved populations to enhance patient care.

Through community outreach and education events, Precision Health is connecting with groups that we may not traditionally encounter through Michigan Medicine. These events help educate underserved communities about the important roles they can play in improving health care, and allow us to share valuable resources and information with attendees.

In 2019, Precision Health and our affiliate programs participated in 11 community events in Southeast Michigan, helping us reach more than 8,200 community members.

<table>
<thead>
<tr>
<th>EVENT</th>
<th>LOCATION</th>
<th>NUMBER OF ATTENDEES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women of Color Task Force Career Conference</td>
<td>Ann Arbor, MI</td>
<td>630+</td>
</tr>
<tr>
<td>Men’s Fellowship Breakfast</td>
<td>Ann Arbor, MI</td>
<td>75</td>
</tr>
<tr>
<td>Washtenaw County Heart Walk</td>
<td>Ypsilanti, MI</td>
<td>150</td>
</tr>
<tr>
<td>Ann Arbor African American Downtown Festival</td>
<td>Ann Arbor, MI</td>
<td>500</td>
</tr>
<tr>
<td>Cancer Survivors Celebration</td>
<td>Ann Arbor, MI</td>
<td>325</td>
</tr>
<tr>
<td>Juneteenth</td>
<td>Ann Arbor, MI</td>
<td>200</td>
</tr>
<tr>
<td>Sri Venkateswara Temple</td>
<td>Novi, MI</td>
<td>100+</td>
</tr>
<tr>
<td>Fresh Flint Festival</td>
<td>Flint, MI</td>
<td>500+</td>
</tr>
<tr>
<td>Researchpalooza</td>
<td>Ann Arbor, MI</td>
<td>3,500</td>
</tr>
<tr>
<td>YpsiFest</td>
<td>Ypsilanti, MI</td>
<td>1,800</td>
</tr>
<tr>
<td>Michigan Cultural and Diversity Festival</td>
<td>Dearborn, MI</td>
<td>100+</td>
</tr>
</tbody>
</table>

Precision Health at U-M facilitates collaborative faculty research in many areas, from cancer to mental health to metabolic disease and more.

To test, as well as develop, our resources and structures, we fund use cases employing novel techniques and technologies focused on key disease areas that significantly impact the population. Our current projects address how opioid prescribing impacts future opioid dependence; the relationship among sensor data (such as blood pressure monitoring), genetic data, and health outcomes; and the use of mobile technology in improving mental health care.

Participants provide access to their electronic health records, administrative records, and other linkable data sources, as well as a biological specimen, to further characterize this study population, whose data U-M researchers may draw on in future studies of diseases and therapies.

Between August 2018 and December 2019, 123,448 patient contacts occurred through a combination of in-person recruitment at Michigan Medicine clinics and community events, phone calls, postcards, emails, and advertisements on social media outlets. In total, 6,742 people enrolled in the study.

SENSOR DATA AND HEALTH

The Michigan Predictive Activity and Clinical Trajectories (MIPACT) Study is using sensor data from Apple devices (such as the Apple Watch and iPhone), health and wellness surveys, blood pressure monitoring, and health and genetic information to understand the relationship between sensor data and different health outcomes.

Participants are asked to wear an Apple Watch, take their blood pressure using an electronic blood pressure cuff, and perform a guided breathing activity on the Apple Watch, daily for up to 45 days and then monthly for the next three years.
Participants had a wide range of medical comorbidities, including 10% with diabetes mellitus, 27% with depression, and 33% with hypertension.

MOBILE TECHNOLOGY IN MENTAL HEALTH CARE

The PROMPT team's collaborators, from across U-M, worked to establish study measures that best capture comprehensive data from participants. The team also worked with an outside developer to create a smartphone application to collect participant outcomes and assessments, and communicate with other associated applications (e.g., FitBit, HeadSpace, and SilverCloud). This application also provides a dashboard for participants to see enhanced, individualized feedback about their mood and health behaviors. Along with the Research Data Warehouse staff and a Precision Health staff expert, PROMPT has established a daily data pull protocol to identify patients on the waitlist for care at Michigan Medicine Outpatient Psychiatry and University Service. This allows the study team to track contact with potential participants and confirm participant progress throughout the study.

The team completed the Information Assurance process for all apps used in the study (HeadSpace, Silvercloud, and MyDataHelps). Recruitment will begin as soon as the procurement process is complete. (April 2020 update: in response to changes in clinical processes due to COVID, all protocols have been updated to be entirely virtual, i.e., without in-person patient contact.)

PROMPT Principal Investigators Srijan Sen, MD, PhD, and Amy Bohnert, PhD, MHS, have also presented at numerous local and national events. The team developed educational materials, which are available in English, Spanish, and Arabic, for surgery, dentistry, storage/disposal, and managing pain without opioids.

In 2019, the Precision Opioid Prescribing use case increased its U-M collaborators from two to eight. Partners now include the Medical School, School of Public Health, College of Engineering, School of Dentistry, College of Pharmacy, Ford School of Public Policy, Penny W. Stamps School of Art & Design, and the School of Music, Theatre & Dance (SMTD). Several Blue Cross Blue Shield Quality Collaboratives are also involved in the use case. The study team has secured Data Sharing Agreements (DSA) with the State of Michigan's Department of Licensing and Regulatory Affairs (LARA) and Surescripts to obtain prescription drug monitoring program (PDMP) data for participants in the Michigan Genomics Initiative (MGI) and in the Michigan Surgical Quality Collaborative. Researchers have started combining PDMP data with MGI genetic and health data, which will allow for refinement of current post-surgical opioid prescribing recommendations.

The use case team has also developed naloxone prescribing pathways and are currently working with the Michigan Emergency Department Improvement Collaborative to implement these in 10 emergency departments across the state. Through a partnership with the School of Dentistry and Romesh Nalliah, BDS, MHCM, Associate Dean for Patient Services and Clinical Professor of Dentistry, they also developed prescribing recommendations for routine and surgical dental extractions, concluding that zero opioids are recommended for any type of dental extraction. In addition, they finalized a DSA with LABA to receive PDMP data from 90 dentists to be enrolled in a dental continuing education study.

The team developed educational materials, which are available in English, Spanish, and Arabic, for surgery, dentistry, storage/disposal, and managing pain without opioids.

Take back events were held on April 27 and October 26 (see graphic below for details).

In May and October 2019, the study cohosted the “Opioids: Policy to Practice” and “Stigma and Access to Treatment” summits in collaboration with Harvard University. During the “Opioids: Policy to Practice” summit in May, students from SMTD performed scenes from Painless: the Opioid Musical, which was created to educate youth on the risks of opioids. This fully orchestrated musical was written by SMTD student Jacob Ryan Smith, and consists of 12 songs with two original casts. It was recently added to the Michigan Department of Health and Human Services Michigan Model for Health curriculum, and will be performed at schools throughout the state in the coming year.

• VA Health Services Research and Development Spotlight on Pain Management National Webinar
• International Summit on Suicide Research
In addition, PROMPT Co-Investigator Adam Horwitz, PhD, received a MICHRI KL2 Career Development Award related to mobile technology for suicide risk assessment and intervention, building on the PROMPT infrastructure.

PRECISION OPIOID PRESCRIBING

The vast majority of individuals who become dependent on prescription opioids receive their first dose following surgical care. Precision Health’s Precision Opioid Prescribing use case focuses on understanding the factors that put people at risk of long-term opioid use, so these patients can be prescribed alternative pain management strategies when having surgery.

In 2019, the Precision Opioid Prescribing use case increased its U-M collaborators from two to eight. Partners now include the Medical School, School of Public Health, College of Engineering, School of Dentistry, College of Pharmacy, Ford School of Public Policy, Penny W. Stamps School of Art & Design, and the School of Music, Theatre & Dance (SMTD). Several Blue Cross Blue Shield Quality Collaboratives are also involved in the use case. The study team has secured Data Sharing Agreements (DSA) with the State of Michigan’s Department of Licensing and Regulatory Affairs (LARA) and Surescripts to obtain prescription drug monitoring program (PDMP) data for participants in the Michigan Genomics Initiative (MGI) and in the Michigan Surgical Quality Collaborative. Researchers have started combining PDMP data with MGI genetic and health data, which will allow for refinement of current post-surgical opioid prescribing recommendations.

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• 2019 Precision Health Symposium
• 2019 Pritzker Consortium Annual Meeting
• Apple Health
• SharpBrains Virtual Summit
• 2019 National Network of Depression Centers Conference
• National webinars on the topic of “Understanding Links among Opioid Use, Overdose, and Suicide”
2019 INVESTIGATORS AND SCHOLARS AWARDS

Precision Health has two competitive grants programs—Investigators Awards and Scholars Awards—to support the development, growth, and enrichment of precision health tools, resources, and applications.

2019 INVESTIGATORS AWARDS

With Investigators Awards, Precision Health aspires to generate meaningful, groundbreaking, multidisciplinary research projects that advance the field of precision health through the use and/or enrichment of U-M Precision Health data, tools, methods, and techniques. Precision Health funded 10 two-year, $300,000 Investigators Awards in 2018 and seven in 2019. The 2019 recipients and their topics comprise:

**Developing an Early Warning System for Treatment of Postpartum Hemorrhage Using Time-Series Machine Learning Models**

“While the maternal mortality rate has decreased throughout the developed world, in the US, the maternal mortality rate is increasing. As a team of experts in managing postpartum hemorrhage, machine learning, and systems design at the University of Michigan, we plan to develop a machine learning model that will help us build a better early warning system for postpartum hemorrhage and improve the safety of maternal care.” – Thomas Klumpner

**Characterizing and Understanding Time-varying Functional Connectivity States via Network Science and Deep Neural Networks**

“Our work will bring the tenets of precision medicine to the critically important study of dynamic functional connectivity (dFC). The field of dynamic functional connectivity is a newly booming and exploratory branch of neuroscience aimed at understanding how the connectivity in functional brain networks may change over time. The overarching aim of our work is to shake up the existing statistical paradigms with entirely new approaches. Our work may lead to better and earlier non-invasive diagnostics for various psychiatric disorders and may help to better understand their functional origins in the brain.” – Danai Koutra

**Synthesizing Tumor Infiltrating Lymphocyte Patterns with Genomic Measurements for Head and Neck Cancer Survival**

The aim of the project is to develop a clinically feasible protocol to classify patients into risk-stratified groups, based on tumor infiltrating lymphocyte (TIL) spatial infiltration, for precision therapy. This project will apply a newly developed machine learning algorithm to quantify the spatial distribution of TILs in the microenvironment of head and neck squamous cell carcinomas (HNSCCs).

**Personalized Data-Driven Balance-Training Instruction and Assessment for Older Adults**

“We are very excited to work with an interdisciplinary team to develop and test algorithms that automatically progress older adults through home-based balance exercises for both preventive and therapeutic applications. We hope that our findings will inform the design of a smartphone balance trainer that can complement clinic-based balance rehabilitation programs.” – Kathleen Sienko

**Precision Counselor: Natural Language Processing for Enhanced Behavior Counseling**

“Patient-centered behavioral counseling is a cornerstone of our health care delivery system. We are very excited to embark on this collaboration involving expertise in both artificial intelligence and motivational interviewing to start developing computational methodologies that can assist counselors in their interventions.” – Rada Mihalcea

**Developing an Early Warning System for Treatment of Postpartum Hemorrhage Using Time-Series Machine Learning Models**

THOMAS KLUMPNER, MD, Clinical Assistant Professor of Anesthesiology and Obstetrics and Gynecology

KARANDEEP SINGH, MD, MMSc, Assistant Professor of Learning Health Sciences, Internal Medicine, Urology, and Information

DANAI KOUTRA, PhD, Assistant Professor of Electrical Engineering and Computer Science

CHANDRA SRIPADA, MD, PhD, Associate Professor of Psychiatry and Philosophy

**Synthesizing Tumor Infiltrating Lymphocyte Patterns with Genomic Measurements for Head and Neck Cancer Survival**

LAURA ROZEK, PhD, Associate Professor of Environmental Health Sciences

MAUREEN SARTOR, PhD, Associate Professor of Computational Medicine and Bioinformatics

ARVIND RAO, PhD, Associate Professor of Radiation Oncology and Computational Medicine and Bioinformatics

**Personalized Data-Driven Balance-Training Instruction and Assessment for Older Adults**

KATHLEEN SIENTKO, PhD, Professor of Mechanical Engineering

XUN HUAN, PhD, Assistant Professor of Mechanical Engineering

**Precision Counselor: Natural Language Processing for Enhanced Behavior Counseling**

RADA MIHALCEA, PhD, Professor of Electrical Engineering and Computer Science

KENNETH RESNICOW, PhD, Professor of Health Behavior & Health Education

VERONICA PEREZ-ROSAS, PhD, Assistant Research Scientist, Electrical Engineering and Computer Science
“About half of the human genome is made up of repetitive elements. For most of these repeats, however, we know almost nothing about whether they have normal roles in neurobiology or whether they contribute to human disease. We have designed an innovative set of studies that will define variation in this ‘missing’ half of the genome and link it to Precision Health resources, to allow us to discover how repeat variation contributes to human disease.” – Peter Todd

*Co-funded by Precision Health and the A. Alfred Taubman Medical Research Institute

“When it comes to Precision Health, we have tremendous opportunities to advance scientific discovery and implementation with the right technical, clinical, regulatory, and communication strategies. If we can increase multidisciplinary collaboration, we can bring cohesion and momentum to this new but fragmented field, and establish a strong, stable foundation for future precision health discoveries.”

Marshall S. Runge
Executive Vice President for Medical Affairs and Dean of the Medical School

2019 SCHOLARS AWARDS

This award aspires to expand the field of precision health by cultivating a cohort of promising early-career researchers (doctoral students, postdocs, fellows, residents, or trainees) and spark new collaborative research avenues by engaging early-career investigators with tools and data to support their work.

Precision Health funded 12 Scholars Awards in 2018 and nine in 2019, for up to $80,000 each. The 2019 recipients and their topics include:

LAUREN BEESLEY, MS, PhD, Postdoctoral Research Fellow, Biostatistics
Correcting Selection Bias and Disease Status Misclassification in Electronic Health Records Research with Applications to the Michigan Genomics Initiative

This project will develop a statistical framework for analyzing electronic health record data: one that can account for both phenotype misclassification and address bias due to patient selection.

SARAH GAGLIANO TALIUN, PhD, Postdoctoral Research Fellow, Biostatistics
Leveraging Local Genomic Ancestry to Enhance Polygenic Risk Scores for Schizophrenia in Admixed Individuals

The goal of this research is to leverage local ancestry to construct polygenic risk scores for schizophrenia and for bipolar disorder in admixed individuals, to reduce disparity in genetic mental health research between European and under-represented samples.

JESSICA GOLBUS, MD, Cardiovascular Disease Fellow, Internal Medicine-Cardiovascular Medicine
Virtual Application-supported Environment To Increase Exercise (VALENTINE) After Phase II Cardiac Rehabilitation

This prospective, randomized-controlled trial aims to understand how wearable devices, combined with behavioral health theory, enable personalized care for patients with cardiovascular disease in later phases of rehabilitation.
“Traumatic brain injury affects so many people, both young and old. With this [Scholars Award], and funding from the Massey Foundation, we hope to make it easier for physicians to help each individual patient based on their precise condition.” – Mark Burns, PhD, mentor of Alyse Krausz

“Gliomas are tumors that start in the glial cells of the brain or the spine and compose about 30% of all brain and central nervous system tumors and 80% of all malignant brain tumors. We will build statistical models to predict post-treatment time-to-recurrence, an invaluable task which will not only guide physicians in making informed personalized treatment strategies but also shed light on the biological mechanisms underlying disease progression and outcomes.” – Shariq Mohammed

“This project, the first-ever meta-analysis between the genetics of type 2 diabetes and psoriasis, will employ machine learning to assess the risk of patients with one disease developing the other, with the goal of better managing and treating metabolic and autoimmune comorbidities.

“This highly multidisciplinary engineering/medicine research applies a novel single-molecule protein counting platform to enable massively parallel rapid measurements of a large number of circulating blood biomarkers in critically ill patients. The obtained data will provide critical information for precisely predicting the early onset and trajectory of the time-sensitive severe immune disorder that often follows emerging cancer immunotherapy involving chimeric antigen receptor T (CAR-T) cell infusion.” – Katsuo Kurabayshi, PhD, mentor of Yujing Song

By identifying molecular features associated with various phenotypes, this project aims to optimize treatment for patients with “oligometastatic” prostate cancer and allow for patient-specific therapies.

This research will help improve non-small cell lung cancer diagnosis by targeting exosomal miRNA pathways, and enable precision treatment via combined knowledge of biomarkers, exosome mechanisms, and patient heterogeneity.

MEDICAL SCHOOL: $2.27M
COLLEGE OF ENGINEERING: $1.8M
SCHOOL OF PUBLIC HEALTH: $1.15M
BIOMEDICAL ENGINEERING: $971K
COLLEGE OF LITERATURE, SCIENCE, AND THE ARTS: $130K
SCHOOL OF INFORMATION: $49.5K
UMOR: $43K

**PRECISION HEALTH GRANT FUNDING DISTRIBUTION BY SCHOOL**
2018-2019; Two rounds of Scholars Awards and two rounds of Investigator Awards
INVESTING IN THE FUTURE OF HEALTH RESEARCH

A key way precision health research differentiates itself is that its focus is not on one particular disease, part of the body, or treatment type. Rather, it is an approach that dismantles established silos and transforms them into unified networks. Traditionally, donors and funding organizations envision their contributions going to a specific disease or treatment—something tangible, with a defined and measurable outcome.

The concept of giving to develop computing infrastructure, to grow a cohort of research participants, or to expand a database is a relatively new avenue to support health care and battle disease. Also uncommon is the concept of investing in discovery itself. Much precision-health research is not geared toward a predetermined end point. Instead, important research activities such as gathering data, building and testing machine-learning models, and analyzing outcomes can yield novel, even unexpected results.

In the past year, Precision Health has been fortunate to benefit from two forward-thinking patrons who understand the potential of precision health and recognize its methods as the new direction of health research.

KAHN FOUNDATION

A portion of a $20 million gift from The D. Dan and Betty Kahn Foundation expands collaboration among researchers at the University of Michigan, Technion—Israel Institute of Technology, and the Weizmann Institute of Science in Israel to help enhance quality of life for the aging population through precision health. Researchers from the three institutions will study factors that contribute to common, recurring infections in the elderly, including urinary tract infections and respiratory infections. They will also study how the immune system changes as people age.

Precision Health Co-Director Jenna Wiens (College of Engineering), Faculty Advisory Committee member Betsy Foxman (School of Public Health), and Lona Mody (Michigan Medicine) represent U-M on the joint research team, whose members are pooling their strengths in data science, immunology, and infectious diseases. Through this collaboration, the team will develop machine learning tools to model trajectories of aging, as well as creating a large, deidentified dataset relevant to the aging population, which can be shared securely across institutions.

TAM FOUNDATION

The Richard Tam Foundation has supported bipolar research since 2014, helping fuel the collection of genetic samples and other data from people with and without bipolar illness. A $5.8 million gift from the Tam Foundation in September 2019 expands and harnesses the power of this massive dataset and allows researchers to mine that trove of information, and combine it with other data, using advanced tools created for Precision Health.

Of this gift amount, $500,000 is earmarked specifically for Precision Health, to create a Tam Precision Health & Bipolar Collaboration Fund.

Precision Health Co-Director Sachin Kheterpal says the gift “is a model for future gifts, where we’re able to demonstrate the value of researching individual diseases, marrying that research data with the Precision Health platforms we’re building, and thereby increasing the potential for hundreds of researchers to benefit from the overall impact.”

Judith Tam, president of the Richard Tam Foundation, explains that the gift was inspired by the combination of U-M’s strength in studying bipolar disorder and its investment in precision health.

“Precision health could help doctors figure out the right medicine to give to a particular patient, much more quickly, and could expand their toolbox through new discoveries. We’ve got brilliant people here, and I’ve seen the passion in their eyes when they talk about their research. They’re not just doing their work and going home. They are on fire.”

Judith Tam
President, Richard Tam Foundation
In March 2019, Precision Health launched its membership program, with the aim of building a collaborative community of researchers from a range of disciplines across campuses. Members, who include not only U-M faculty, but graduate student researchers and researchers outside U-M, have access to tools, data, and services to support their research. Precision Health will facilitate training and education sessions for members and plan networking opportunities.

Precision Health provides support for members’ career development, such as funding assistance for R01 boot camp (sponsored by the Medical School Office of Research). Precision Health will cover the $3,500 cost for non-Med-School-affiliated members who are accepted into the program and who complete an R01 application within a year of program completion.

For members who apply and demonstrate need, we offer travel grants for precision-health-related symposia and conferences. All members have access to development opportunities, including grant writing support, and funding opportunities, both internal and external. Members can also receive support in publicizing significant findings and publications.

118 MEMBERS REPRESENTING 8 SCHOOLS
- Michigan Ross
- College of Engineering
- School of Information
- College of Literature, Science, and the Arts
- Medical School
- School of Nursing
- College of Pharmacy
- School of Public Health

41 FULL PROFESSORS
23 ASSOCIATE PROFESSORS

55 GRANTS AND AWARDS TOTALING $64M

439 ARTICLES
325 CITATIONS

IN TOP JOURNALS:
- American Journal of Human Genetics
- American Journal of Medical Genetics
- Anesthesiology
- BioMed Central publications
- Cancer Cell
- Cell
- Cell Reports
- Diabetes
- JAMA publications
- Journal of Investigative Dermatology
- Nature publications
- Nature Communications
- Nature Genetics
- Public Library of Science (PLoS) publications
- Scientific Reports
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