Digital Phenotyping

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With Personalised Medicine we can develop new treatments through the use of knowledge and new technologies. By using genetic knowledge about the disease and the individual patient, we can diagnose diseases more precisely and target treatment more accurately.
THE PRECISION MEDICINE INITIATIVE

“Doctors have always recognized that every patient is unique, and doctors have always tried to tailor their treatments as best they can to individuals. You can match a blood transfusion to a blood type — that was an important discovery. What if matching a cancer cure to our genetic code was just as easy, just as standard? What if figuring out the right dose of medicine was as simple as taking our temperature?”

- President Obama, January 30, 2015
FACT SHEET

Precision Medicine

Building on President Obama’s vision to ‘think big’ to solve big problems, today the Administration is announcing the Precision Medicine Initiative, a bold new research and development effort to advance our understanding of disease and develop new tools to treat disease. Launched with $215 million in funding in the 2016 Budget, the Precision Medicine Initiative will pioneer a new model of patient-powered research that promises to accelerate biomedical discoveries and provide clinicians with new tools, knowledge, and therapies to select which treatments will work best for each individual.

Most medical treatments have been designed for the “average patient.” As a result of this “one-size-fits-all-approach,” treatments can be very successful for some patients but not for others. This is changing with the emergence of precision medicine, an innovative approach to disease prevention and treatment that takes into account individual differences in people’s genes, environments, and lifestyles. Precision medicine gives clinicians tools to better understand the complex mechanisms underlying a patient’s health, disease, or condition, and to better predict which treatments will be most effective.

- Creation of a voluntary national research cohort: NIH, in collaboration with other agencies and stakeholders, will launch a national, patient-powered research cohort of one million or more Americans who volunteer to participate in research. Participants will be involved in the design of the Initiative and will have the opportunity to contribute diverse sources of data—including medical records; profiles of the patient’s genes, metabolites (chemical makeup), and microorganisms in and on the body; environmental and lifestyle data; patient-generated information; and personal device and sensor data. Privacy will be rigorously protected. This ambitious project will leverage existing research and clinical networks and build on innovative
Digital Phenotyping

“Continuous and unobtrusive measurement and inference of health, behavior, and other parameters from wearable and mobile technology”

- BIOSIGNALS
  - Glucose
  - Blood pressure
  - Weight
  - ...

- BEHAVIOR
  - Physical Activity
  - Location
  - Social Activity

- COGNITION
  - Reaction time
  - Attention
  - Memory

- MEDICINE
  - Prescriptions
  - Adherence
  - Effect

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Digital Phenotyping: What?

- Diet
- Smoking
- Alcohol
- Exercise
- Adherence to treatment

![Diagram showing digital phenotyping concepts](attachment:image.png)
Digital Phenotyping: When?

Preventive
- promoting healthy lifestyle
- early detection
- preventive measures

Treatment
- continuous monitoring
- context-aware treatment

Chronic Disease Management
- early warning signs
- self-care ("empowerment")
- treatment adherence

Diagnostics
- symptom detection & correlation
- prediction of illness

Rehabilitation
- proactive monitoring
- early warning signs
- just-in-time treatment

Patient trajectory
Digital Phenotyping in Mental Health

- Self-assessment and monitoring
- Visualisation and feedback
- Overview and patient data
- Configuration and feedback
- Self-assessment
- Sensor data
- Questionnaires
- Advanced data analysis
- Machine learning
- Predictive analytics

CACHET | Copenhagen Center for Health Technology
RAHMIS

• **Background**
  - Mental health is becoming the leading burden of disease (WHO)

• **Aim**
  - Reducing the rate and duration of **re-admission** among patients with unipolar and bipolar disorder

• **Partners**
  - Psychiatric Center Copenhagen
  - DTU Compute
  - Monsenso

• **Supported by the Innovation Fund Denmark (IFD)**

• **Technology development**
  - Data collection
  - Mood forecasting
  - Cognitive Behavioral Therapy (CBT)

• **Randomized Clinical Trial (RCT)**
  - blinded randomized trial (N= 200+200)
  - primary: rate of re-hospitalization and duration of hospitalizations.
  - secondary: severity of depression (HDRS) and mania (YMRS) & functional assessment (FAST)
RADMIS

- Smartphone-based monitoring & cognitive behavioral treatment (CBT)

- Monitoring
  - self-assessment – mood | sleep | stress | medicine | ...
  - sensor data – physical activity | mobility | social activity | phone usage | voice features

- Predicting
  - mood forecast
  - relapse of depression

- Intervention
  - visualizations | medication | actions-to-take | triggers | early-warning-signs
  - psycho-education
  - context-aware CBT | behavioral activation | thought parking
Voice & Mood

Collection of voice features in naturalistic setting
- N=28 | 12 weeks
- HDRS
- YMRS
- 179 clinical visits
- Observer-based clinical rating scales such as the Hamilton Rating Scale (HAMD)
- YMRS (speech amount and rate) are both related to changes in HAMD (psychomotor retardation) and item number six on the HDRS (depression)
- Changes in speech have been suggested as sensitive and valid measures of depression and mania in bipolar disorder. The present study aimed at investigating (1) voice features collected during phone calls as objective markers of affective states in bipolar disorder and (2) if combining voice features with automatically generated objective smartphone data on behavioral activities and electronic self-monitored data would increase the accuracy as a marker of affective states.
- Voice features collected in naturalistic settings using smartphones may be used as objective state markers in patients with bipolar disorder.

Classification accuracy were not significantly increased when combining voice features with automatically generated objective data

“Voice features collected in naturalistic settings using smartphones may be used as objective state markers in patients with bipolar disorder.”
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“Continuous and unobtrusive measurement and inference of health, behavior, and other parameters from wearable and mobile technology”

Healthcare Challenges

Chronic diseases management
Accounting for 2/3 of all healthcare spend worldwide – and increasing – chronic disease management is and will be the main focus of health.

Preventive and predictive health
Obesity, lack of physical activity and unhealthy lifestyle are the major factors for health problems and needs to be addressed early

Regulatory
Legal and regulatory demands for protecting patient privacy, data, and safety will be enforced heavily as digital and personalized health emerge

Evidence & outcome-based health
New business models both for suppliers and vendors will be tied to clinical evidence and real-world patient outcome (efficiency)

Technology Opportunities

Personalized technology
Engaging, patient-centric, and participatory technology can deliver interventions tailored to the individual and sustain engagement “beyond-the-pill” outside traditional care settings.

Digitalization
The ubiquity of digital health and communication technology drive new models for virtual and semi-automated doctor-patient contact.

Health IoT
Pervasive, mobile and wearable technology for sensing and engaging with patients create a unique platform for personalized health delivery

Big data analytics
Computing power and advanced analytics and learning algorithms drive insight and prediction of patient behavior, treatment, and care costs