The Science of Behavioral Health

Bending the curve through innovation
U.S. Burden of Diseases: 291 diseases and injuries

**Leading Categories of DALYs 2010**

1. Neuropsychiatric Disorders
2. Cardiovascular and Circulatory Diseases
3. Neoplasms
4. Musculoskeletal Disorders
5. Diabetes, Urogenital, Blood, and Endocrine Diseases
6. Chronic Respiratory Diseases
7. Other Non-communicable Diseases

**Percent of Total U.S. DALYs**

- Mental and Behavioral Disorders: 13.6%
- Neurological Disorders: 5.1%

The most disabling disorders before age 50

- Mental and Behavioral Disorders
- Cardiovascular and Circulatory Diseases
- Neoplasms
- Musculoskeletal Disorders
- Diabetes, Urogenital, Blood, and Endocrine Disorders
- Chronic Respiratory Diseases
Homicides have dropped from 9.8/100,000 in 1992 to 4.8/100,000 in 2010 (<15,000/yr)

SOURCES: Bureau of Justice Statistics (homicide); Centers for Disease Control (suicide)
Why are we failing to bend the curve?
Fragmented mental health ecosystem

Outpatient
- Primary care
- Community clinics
- Specialty clinics
- School-based centers
- Private practice

Inpatient
- Community/AMC Hospital
- Psychiatric hospitals
- Partial hospitalization
- Prison

Digital
- Self-guided
- Coach-based
- On-demand therapy
- Peer support
- Telepsychiatry
- Crisis support

Residential
- Residential homes
- Substance abuse rehab

Other
- Religious settings
- Wellness centers
- Holistic medicine

* ER / 911 / police
Poor access to high quality care

55% of U.S. Counties have no practicing mental health provider

60% of adults with a mental illness receive no treatment

7 yrs median number of years from onset of depression to treatment initiation

74% of people who do not seek care, believe they can manage their illness on their own

Sources: NSDUH (2013); Kessler, Chiu, Demler, & Walters (2005); Health Resources and Services Administration Data Warehouse; Wang, Lane, Olfson, Pincus, Wells, Kessler (2005)
Old solutions to intractable problems
The Role of Science and Innovation in Disrupting the Paradigms of Healthcare

- Defining the problem
- How we treat the problem
- How we think about the problem
“Uber, the world’s largest taxi company, owns no vehicles.

Facebook, the world’s most popular media owner, creates no content.

Alibaba, the most valuable retailer, has no inventory.

And Airbnb, the world’s largest accommodation provider, owns no real estate.

Something interesting is happening.”

Tom Goodwin, Tech Crunch, 2015
## The technology revolution

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>Now</th>
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<tbody>
<tr>
<td>Smartphones</td>
<td>64 million</td>
<td>3 billion</td>
</tr>
<tr>
<td>Facebook users</td>
<td>12 million</td>
<td>2 billion</td>
</tr>
<tr>
<td>Google searches</td>
<td>250 million/day</td>
<td>&gt;3.5 billion/day</td>
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<tr>
<td>Apps available</td>
<td>&lt;15k</td>
<td>2.8 million</td>
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<tr>
<td>Analytics</td>
<td>Parametric testing</td>
<td>Machine learning</td>
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New data streams influencing how we conceptualize behavioral health
Shifting how we identify markers of mental health may very well redefine it

Instagram photos reveal predictive markers of depression

Andrew G. Reece* and Christopher M. Danforth**
Digital Phenotyping Technology Overview

Raw Data Sources
- Phone / App Usage
- SMS / Call Logs
- Microphone / Audio
- GPS
- Accelerometer
- Temperature / Light
- Active Surveys / Tasks (written, audio, video)

Processed Behavioral Labels
- Sleep (hours, interruptions, etc.)
- Physical Activity (quantity, intensity, etc.)
- Text / Speech Features (natural language processing)
- Vocal Features (paralinguistic analysis)
- Geolocation (home, work, outdoors)
- Social Media (Twitter, Facebook, etc.)
- Mood / Affect

Derived Clinical Insights
- Voice & Speech Markers
- Location Entropy
- Circadian Rhythms
- Social Activity
- Psychomotor Function
- Sleep Quality
- Cognitive Function

Data Storage / Processing

Machine Learning Algorithms

Care Team Dashboard
- Prodrome Markers
- Risk Profile
- Outcome Tracking
The relationship between mobile phone location sensor data and depressive symptom severity

Sohrab Saeb, Emily G. Lattie, Stephen M. Schueller, Konrad F. Kording and David C. Mohr

1 Department of Preventive Medicine, Northwestern University, Chicago, IL, United States
2 Rehabilitation Institute of Chicago, Department of Physical Medicine and Rehabilitation, Northwestern University, Chicago, IL, United States
Automated analysis of free speech predicts psychosis onset in high-risk youths

Gillinder Bedi, Facundo Carrillo, Guillermo A Cecchi, Diego Fernández Slezak, Mariano Sigman, Natália B Mota, Sidarta Ribeiro, Daniel C Javitt, Mauro Copelli & Cheryl M Corcoran

• Derived speech features included a Latent Semantic Analysis measure of semantic coherence and two syntactic markers of speech complexity: maximum phrase length and use of determiners (e.g., which).

• These speech features predicted later psychosis development with 100% accuracy, outperforming classification from clinical interviews.
**An Individualized Risk Calculator for Research in Prodromal Psychosis**

Tyrone D. Cannon, Ph.D., Changhong Yu, M.S., Jean Addington, Ph.D., Carrie E. Bearden, Ph.D., Kristin S. Cadenhead, M.D., Barbara A. Comblatt, Ph.D., Robert Heinssen, Ph.D., Clark D. Jeffries, Ph.D., Daniel H. Mathalon, Ph.D., M.D., Thomas H. McGlashan, M.D., Diana O. Perkins, M.D., M.P.H., Larry J. Seidman, Ph.D., Ming T. Tsuang, M.D., Ph.D., Elaine F. Walker, Ph.D., Scott W. Woods, M.D., Michael W. Kattan, Ph.D.

Received: July 08, 2015
Accepted: March 30, 2016
Published online: July 01, 2016 | https://doi.org/10.1176/appi.ajp.2016.15070890

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**Development and Validation of a Clinically Based Risk Calculator for the Transdiagnostic Prediction of Psychosis**

Paolo Fusar-Poli, MD1,2,3; Grazia Rutigliano, MD4; Daniel Stahl, PhD3,5; et al

**Author Affiliations**

Moving from reactive to proactive with early detection and targeted treatment

Duration of Untreated Psychosis = 74 weeks
Addington et al, Psychiatric Services, 2015
The democratization of healthcare
Do I have depression? Google adds screening quiz to search results

Brett Molina, USA TODAY  Published 1:00 p.m. ET Aug. 24, 2017 | Updated 1:03 p.m. ET Aug. 24, 2017

Google added a depression screening tool to its search results. The tool is designed to help users determine if they may be experiencing symptoms of depression.

The quiz consists of several questions that ask about feelings of sadness, loss of interest in activities, difficulty sleeping, and other symptoms of depression. Users can answer yes or no to each question, and Google provides a brief description of each symptom and what it might mean.

If a user answers yes to certain questions, Google recommends seeking help from a mental health professional. The tool also provides information on how to contact a local mental health provider.

According to the American Psychological Association, depression affects millions of people worldwide and can lead to serious complications if left untreated. The tool is just one example of how technology can be used to support mental health.

Related to this, Google also added a suicide prevention tool to its search results, which provides links to crisis resources and support for those who may be struggling with thoughts of suicide.
Mental Health Screening Tools

Taking a mental health screening is one of the quickest and easiest ways to determine whether you are experiencing symptoms of a mental health condition.

Mental health conditions, such as depression or anxiety, are real, common and treatable. And recovery is possible.

If you're unsure which screen to take, here are some guidelines:

- The Depression Screen is for individuals who are feeling overwhelming sadness.
- The Alcohol or Substance Use Screen will help determine if your use of alcohol or drugs is an area to address.
- The Anxiety Screen will help if you feel that worry and fear affect your day to day life.
- The Youth Screen is for young people (age 11-17) who are concerned that their emotions, attention, or behaviors might be signs of a problem.
2 million people screened online since 2014

2/3 are under the age of 24
3/4 are not receiving treatment

Only ¼ want to receive a referral to a mental health professional, yet 50% want an online or mobile platform to manage their symptoms
Anyone in the U.S. can text 741741

Immediate access to trained crisis counselors

Users may get support for FREE 24/7
31M messages since 2013

75% below age 25

1/3 of messages -- depression and suicide
19% from 10% lowest income zipcodes
9% Native American; 14% Hispanic

> 3K active rescues
PRIME: addressing access, delay, quality, workforce and stigma

Goal setting to motivate healthy behavior

Text-based coaching with mental health professionals

Social networking to encourage engagement

Tracking activity level and outcomes that consumers care about
Consumer products as healthcare products

Allan
@existentialallan

Took another 4 mile walk and talked to 4 people along the way. #PokémonGo may solve obesity and social anxiety in one app.
10:19 AM - Jul 10, 2016

HirezDavid
@uglycatlady

Real talk - as someone with anxiety/depression, the fact that I've spent most of this weekend outside with friends is unreal. #PokémonGo
10:54 AM - Jul 10, 2016

CptNaomi
@CptNaomi

#PokémonGO is gunna cure my social anxiety. Everyone has been so nice. People are not as scary as originally perceived.
11:14 PM - Jul 10, 2016
Healthcare products now designed as consumer products

An entirely new level of entertainment.

From finding your next bottle of wine to wearing a DNA-customized scarf, turn the building blocks of you into interesting insights.

Sharpen the focus on your health.

Through hereditary condition and wellness screening, these products provide insights for you and your doctor.

- **Wine Explorer** by Vinome
- **StartLine** by DNAFit
- **Personalized Scarf** by Dot One
- **Inherited Diabetes Test** by Admera Health
- **Inherited Cholesterol Test** by Admera Health
Harnessing trends in technology and pop culture to improve health outcomes
Prevention strategies informed by behavior change theories, design thinking, and pop culture

Information was disseminated using televised commercials, websites and a “truth tour,” in which youth (the end users) were involved in launching the message.

Counter-industry approach was embedded in the theory of reasoned action: a model for the prediction of behavioral intention, spanning predictions of attitude and predictions of behavior.
FACT:
YOU GET
DOUBLE THE MATCHES
IF YOU'RE NOT SMOKING
IN YOUR PROFILE PICS
Measuring the impact of PSA’s on attitudes and behaviors

The “truth” campaign led to significant increases in awareness of tobacco related knowledge (0% to 68% in a sample of 19,701 youth)

Awareness sig related to anti-smoking attitudes and intention not to smoke tobacco (OR =3.25, p < .01; OR = 4.41, p < .01)

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<tr>
<td>All</td>
<td>28.0</td>
<td>18.0</td>
<td>−35.7</td>
<td>−3.2 (−3.8, −2.6)</td>
<td>−6.8 (−7.5, −6.1)</td>
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<td>8th</td>
<td>19.4</td>
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<tr>
<td>10th</td>
<td>29.8</td>
<td>17.7</td>
<td>−40.6</td>
<td>−4.6 (−5.6, −3.6)</td>
<td>−8.7 (−9.8, −7.5)</td>
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<tr>
<td>12th</td>
<td>36.5</td>
<td>26.7</td>
<td>−26.8</td>
<td>−1.8 (−2.7, −1.0)</td>
<td>−5.1 (−6.1, −3.9)</td>
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The promise of bridging science and technology is that it will enable us to revolutionize mental health care

Shifting from reactive to proactive care by supporting early detection, prevention, and precise interventions

Improving quality of early detection and treatment by using closed loop systems to promote recovery

Enabling greater access by innovating on new delivery models of care

Foster trust and addressing stigma by making the treatment experience more human-centered
Thank you!

Making the world's health data useful so that people enjoy healthier lives.
Appendix
How we approach treatment mental illness

Treatment is often perceived as an art, rather than a science

Lack of measurement based care
“On the basis of clinical judgment alone, mental health providers detect deterioration for only 21.4% of their patients who experience increased symptom severity.”
Fortney JC et al, Psych Serv, 2016

And yet, when we deliver measurement-based care, consumers experience 2-3x superior rates of improves symptoms and remission.

Mental health? To Brain Health

Degenerative to Regenerative
Neuroplasticity: The scientific promise of recovery

Mental health? To
Brain Health

Degenerative to
Regenerative
Mental illnesses result from dysfunction in brain networks. For example....

In depression and PTSD, brain networks are highly tuned to negative information and filter out positive information.

In schizophrenia, brain networks are not interacting smoothly.
The Future of Behavioral Health
Social cognition impairments in depression and schizophrenia
Social decision making influenced by affective displays

Adapted from Campellone & Kring, 2013

1. How much do you expect to enjoy the outcome interaction? (1-7)
   - 1: Not at all
   - 3: Neutral
   - 5: Very much

2. How many points will you send? (0-10)
   (choose between 0 - 10)

3. Bill returns 80% of the points
   Bill keeps 20% of the points

   To see again, press “q” as many times as possible
   To not see again, press “p” as many times as possible

5s 4s 6s

Free Response

Free Response
Neuroplasticity in response to cognitive behavior therapy for social anxiety disorder

KNT Månsson, A Salami, A Frick, P Carlbring, G Andersson, T Furmark, and C-J Boraxbekk
Neuroplasticity in response to cognitive behavior therapy for social anxiety disorder

KNT Månsson¹,², A Salami³,⁴, A Frick⁵, P Carlbring⁶, G Andersson¹,⁷, T Furmark⁵ and C-J Boraxbekk⁴,⁸
Neuroplasticity-based cognitive training repairs neural networks responsible for interpreting social information.
How might we embrace technology to bend the curve?
Improving quality of care by using **closed loop systems** to promote recovery

Too much information?

Better information to empower providers and consumers to predict and preempt clinical events
Verily is a subsidiary of Alphabet focused on life sciences and healthcare. Our mission is to make the world's health data useful so that people enjoy healthier lives.
1 in 5 individuals are affected by a mental illness, yet only 40% report receiving treatment\(^1\).

50% of all mental illness begins by the age of 14 and 75% by the age of 24\(^2\).

Neuropsychiatric diseases represent the most disabling diseases in the U.S.

Depression has risen from the 5\(^{th}\) leading cause of disability in the U.S. to the first leading cause of disability worldwide\(^4\).

\(^1\)WHO; \(^2\)Kessler, 2005; \(^3\)U.S. Burden of Disease Collaborators, JAMA, 2013; \(^4\)WHO