The Promise of Technology: Will it Bend the Curve?

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Verily Life Sciences

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Mental illnesses occur more frequently, affect more people, require more prolonged treatment, cause more suffering by the families of the afflicted ... and constitute more financial drain upon both the public treasury ... than any other single condition.

JFK
Feb 5, 1963
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

U.S. suicide rate unchanged in 2 decades

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)

2014 Suicides: 42,773
2014 Homicides: 14,249
Mental Disorders Top The List Of The Most Costly Conditions In The United States: $201 Billion

Estimates of annual health spending for a comprehensive set of medical conditions are presented for the entire US population and with totals benchmarked to the National Health Expenditure Accounts. In 2013 mental disorders topped the list of most costly conditions, with spending at $201 billion.

Ten medical conditions with the highest estimated spending in 2013

- Mental disorders
- Heart conditions
- Trauma
- Cancer
- Pulmonary conditions
- Osteoarthritis
- Normal birth
- Diabetes
- Kidney disease
- Hypertension

[Bar chart showing the spending for each condition]
Why have we failed to bend the curve?
Why Have We Failed to Bend the Curve?

Lack of Rx

~44 million people in the U.S. with any disorder; ~10 million “serious”

Underserved

Receive Services

Receive Minimally Acceptable Care

No Benefit

Some Benefit

Full Benefit

Sources: NSDUH (2013); Kessler, Chiu, Demler, & Walters (2005); Wang, Lane, Olfson, Pincus, Wells, Kessler (2005); Merikangas, He, Burstein, Swendsen, Avenevoli, Case, Georgiades, Heaton, Swanson, Olfson (2011), SSA Publication 13-11827 (2014)
Why Have We Failed to Bend the Curve?

Fragmentation

- Psychological Care
- Medical Care
- Social Supports
- Family Support
Why Have We Failed to Bend the Curve?

Delay

Psychosocial Functioning

Psychosis onset

Psychotic Symptoms

Duration of Untreated Psychosis = 74 weeks
Addington et al, Psychiatric Services, 2015
Why Have We Failed to Bend the Curve?

Not only quantity but quality!

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

Lack of training
60% of mental health workforce receive NO training in any evidence-based psychosocial treatment

Weissman MM et al Arch Gen Psych, 2006
Why Have We Failed to Bend the Curve?
Not only quantity but quality!

Treatment depends on the provider’s preference not the consumer’s needs.
Why have we failed to bend the curve?

- 60% not receiving care
- For those who receive care:
  - <1/3 receive optimal care
  - No coordination of care
  - Delay in receiving care
  - Poor quality (lack of measurement, lack of training)
  - Stigma (negative attitudes towards care)
Three Concurrent Revolutions

Neuroscience

Genomics

Technology + Information Science
“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.”
## The Technology Revolution

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphones</td>
<td>64M</td>
<td>2B</td>
</tr>
<tr>
<td>Facebook users</td>
<td>12M</td>
<td>1.8B</td>
</tr>
<tr>
<td>YouTube hrs/day</td>
<td>65K</td>
<td>1.0B</td>
</tr>
<tr>
<td>Google searches</td>
<td>250M/day</td>
<td>&gt; 3.5B/day</td>
</tr>
<tr>
<td>Apps in App Store</td>
<td>&lt;15K</td>
<td>2M</td>
</tr>
<tr>
<td>Analytics</td>
<td>Parametric</td>
<td>Machine Learning</td>
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</tbody>
</table>
Smartphones – Will They Transform Care?

(These are not Verily products)
Can Technology Bend the Curve

<table>
<thead>
<tr>
<th>Issue</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>Apps, online platforms</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>Coordination, continuity</td>
</tr>
<tr>
<td>Delay</td>
<td>Early, continuous detection</td>
</tr>
<tr>
<td>Poor Quality</td>
<td>Evidence-based interventions</td>
</tr>
<tr>
<td>Workforce</td>
<td>Telehealth, training</td>
</tr>
<tr>
<td>Stigma</td>
<td>Education, anonymity</td>
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</tbody>
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Subjective + objective markers of: mood, behavior, cognition
The Quantified Self

**FROM HEAD TO TOE WEARABLE TECHNOLOGY**

**SHIRT**
Conductive thread means a computer is literally built into the fabric of the shirt, providing the processing power for all the other wearable gadgets.

**WRISTBAND**
A sensor that tracks movement to determine the number of steps taken through the day—10,000 is ideal—and how much sleep the wearer gets at night.

**GLASSES**
Overlays navigation directions and information about points of interest directly on to the wearer’s field of vision.

**WRISTWATCH**
Vibrates when a message arrives and displays it on the watch face. Tells the time too.

**HAND**
Embedded under the skin is a chip containing medical records, passport data and credit records. Information is transferred by waving the hand over a suitable scanner.

**TROUSERS**
Also made with conductive thread, the trousers take the energy generated by movement and use it to power the other gadgets.

**SHOES**
GPS chip provides directions using LED lights in each shoe: the left shoe indicates direction, while the right shows distance.
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

Patient Mobile App

Digital Phenotyping Technology Overview
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

(Courtesy of Danielle Schlosser, UCSF)
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
7 Cups is *the* Global Mental Health System

160,000 listeners from 189 countries providing support in 140 languages.

**Users:**
- 41% United States
- 12% United Kingdom
- 9% India
- 6% Canada
- 4% Australia
- 1% Germany
<table>
<thead>
<tr>
<th>7 Cups</th>
<th>Traditional Mental Health</th>
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<tbody>
<tr>
<td><strong>On Demand</strong></td>
<td>Weeks to Months to be Seen</td>
</tr>
<tr>
<td><strong>Free or Affordable</strong></td>
<td>$100+ for single 50 minute session</td>
</tr>
<tr>
<td><strong>No Stigma</strong> – anonymous, no fear of judgment</td>
<td><strong>Stigma</strong> – fear of being judged</td>
</tr>
<tr>
<td><strong>Community</strong> – Key part of Treatment</td>
<td><strong>No Community</strong> – only relationship is with provider</td>
</tr>
<tr>
<td><strong>Unlimited support</strong> – available 24x7</td>
<td><strong>Limited Support</strong> – 50 minutes/week</td>
</tr>
<tr>
<td><strong>Convenient</strong> – app or web; provider in your pocket</td>
<td><strong>Inconvenient</strong> – Drive to office</td>
</tr>
<tr>
<td><strong>Support in 140 Languages and 189 Countries</strong></td>
<td>Support primarily in English and Developed Countries</td>
</tr>
<tr>
<td><strong>Task Shifting + Stepped Care</strong></td>
<td>Very Little Task Shifting and Stepped Care</td>
</tr>
<tr>
<td><strong>Advanced Research Capabilities and Outcome Tracking</strong></td>
<td>Limited Research Capabilities and Outcome Tracking</td>
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19% Growth Month Over Month for 36 Months - 7 Cups
1.5 million people screened online since 2014

34,075 psychosis, 805,795 depression positive screenings

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
Big Data – Machine Learning Insights into Big Problems

- Transferring insights from master clinicians
- Predicting relapse and recovery
- Psychotherapy tools for the developing world
Using Big Data for Decision Support

- **EHR Database**
- **Scientific Literature**
- **Digital Phenotype**

6 y.o. male
Anxiety, social withdrawal, inflammation
Genotype – 16p11.2 microduplication

A ‘Green Button’ For Using Aggregate Patient Data At The Point Of Care
*Health Aff* July 2014 33:71229–1235;
Closed loop learning systems for mental health

Mobile Interventions

CBT, DBT, IPT Coaching Peer Support Crisis Intervention

Learning Engine

Care Management

Coordination Data capture Quality metrics Feedback

Activity Sleep Voice Sociality Cognition

Digital Phenotyping
The Opportunity and Challenge of the Technology Revolution

Value
- Efficacy
- Engagement
- Efficiency

Trust
- Transparency
- Agency
- Responsibility

Empowering Patients and Families With Information
“We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten.”

--Bill Gates Jr.
Thank you!

Organizing the world’s health information and making it universally accessible and useful