



Transformative Technologies for Improving Mental Health

David Mou, MD MBA

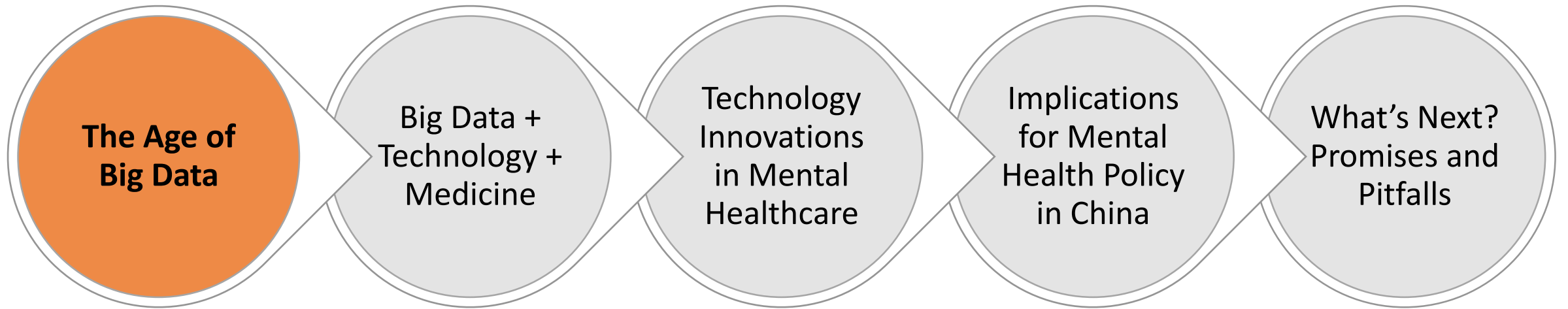
Psychiatry Resident, Massachusetts General Hospital and McLean Hospital
Research Fellow, Nock Lab, Harvard Department of Psychology
Co-founder and Medical Director, Valera Health

Disclosures

- Co-founder and Medical Director for Valera Health, a digital healthcare company

Outline



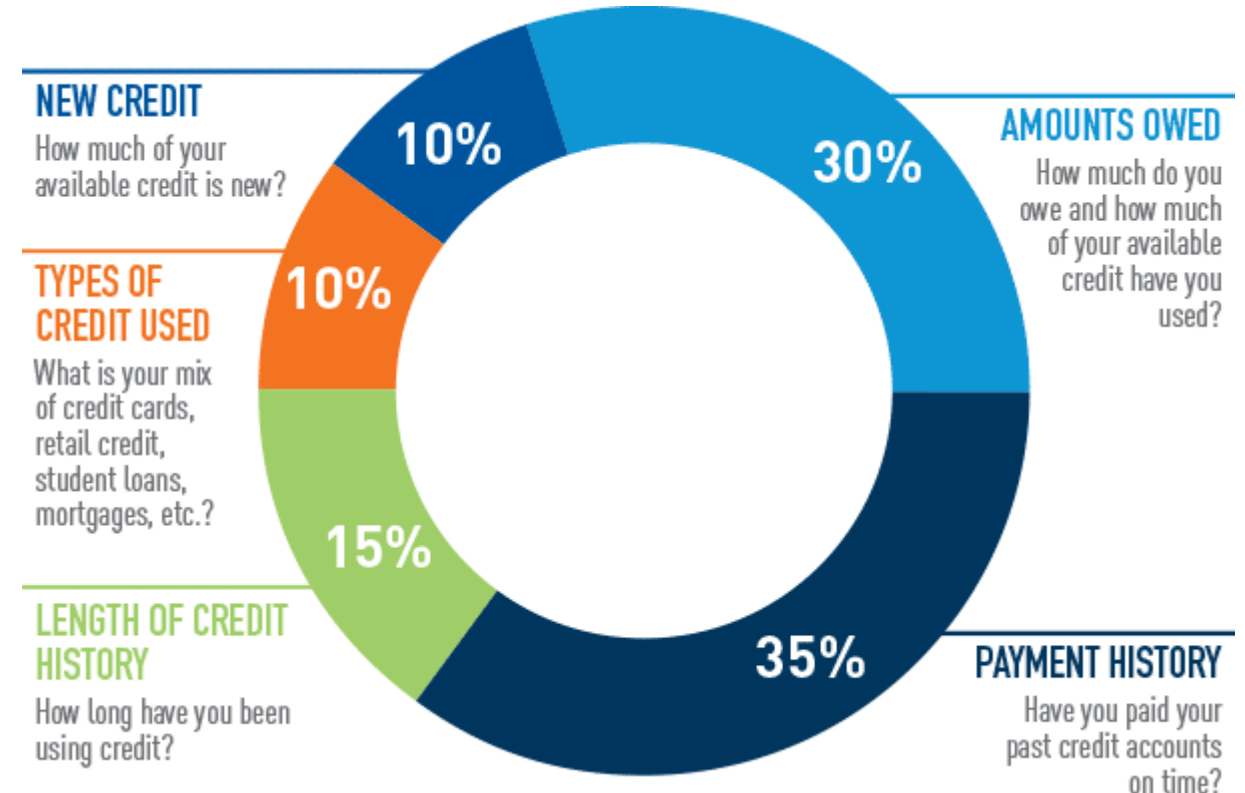


Why did Big Data become such a Big Deal?

- Better and cheaper technology -> More devices and More Data
 - average user touches smartphone 2,617 times a day, looks at screen for 145 minutes
- Smartphones and wearable devices -> More Reliable Data
- Research with new statistical techniques (artificial intelligence, machine learning, etc.) -> Better Analytics

Just a Little Data can Predict Meaningful Behaviors

- FICO-based credit score is based on only 5 variables
- Target can predict when customers are pregnant based on history of purchases
- But this was just the beginning

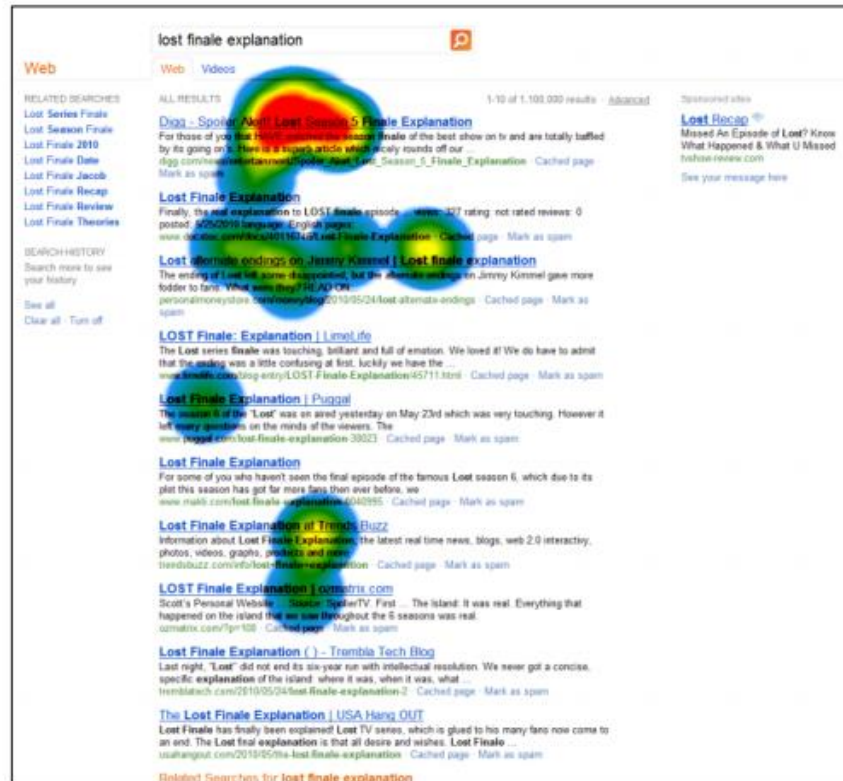


More Data is Still Better: Netflix

- Employs dedicated team to tag movies -> creates 80,000 microgenres
- Tracks browsing and screen scrolling behavior to predict your interest
- 75% of viewer activity is driven by recommendations
- Netflix original shows succeed 80% of the time (vs. 30-40% for traditional TV shows)

Microsoft: tracking cursor movement predicts clicking behavior

Click positions



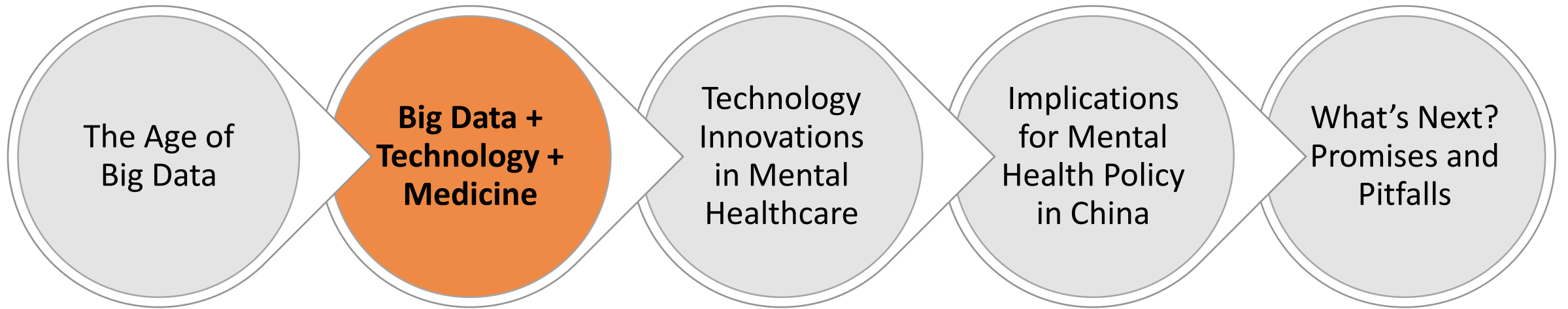
Cursor movement positions



Figure 2. Heatmaps of all click positions (left) and recorded cursor positions (right) for the query [lost finale explanation]. Heavy interaction occurs in red/orange/yellow areas, moderate interaction in green areas, light interaction in blue areas.

Facebook targets ads using at least 98 variables

- Collects vast amounts of data:
 - posts on Facebook
 - third party data (e.g. Experian, news sources)
- Targets ads using at least 98 variables
 - location, age, gender
 - number of credit lines, age of your car, users who are 'heavy' buyers of alcohol
- Does it work?
 - \$40 billion in ad revenue



Preventing Diabetes by Leveraging Social Connection via Technology

- Digital health program to prevent diabetes
 - Wireless Scale + Health Coach + Social Engagement
 - Interactive Lessons
- Within 12 months, patients decrease 5-year risk of type 2 Diabetes by 30% (Su et al, 2016)



Preventing Death from Seizures Using Wearable Device

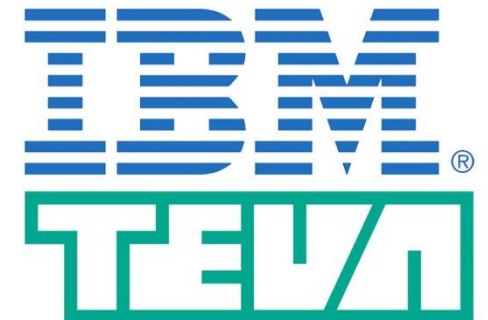
- Prevents deaths from seizures (Dlouhy et al, 2015)
- Embrace can detect 100% of seizures
- FDA approved device for seizure monitoring

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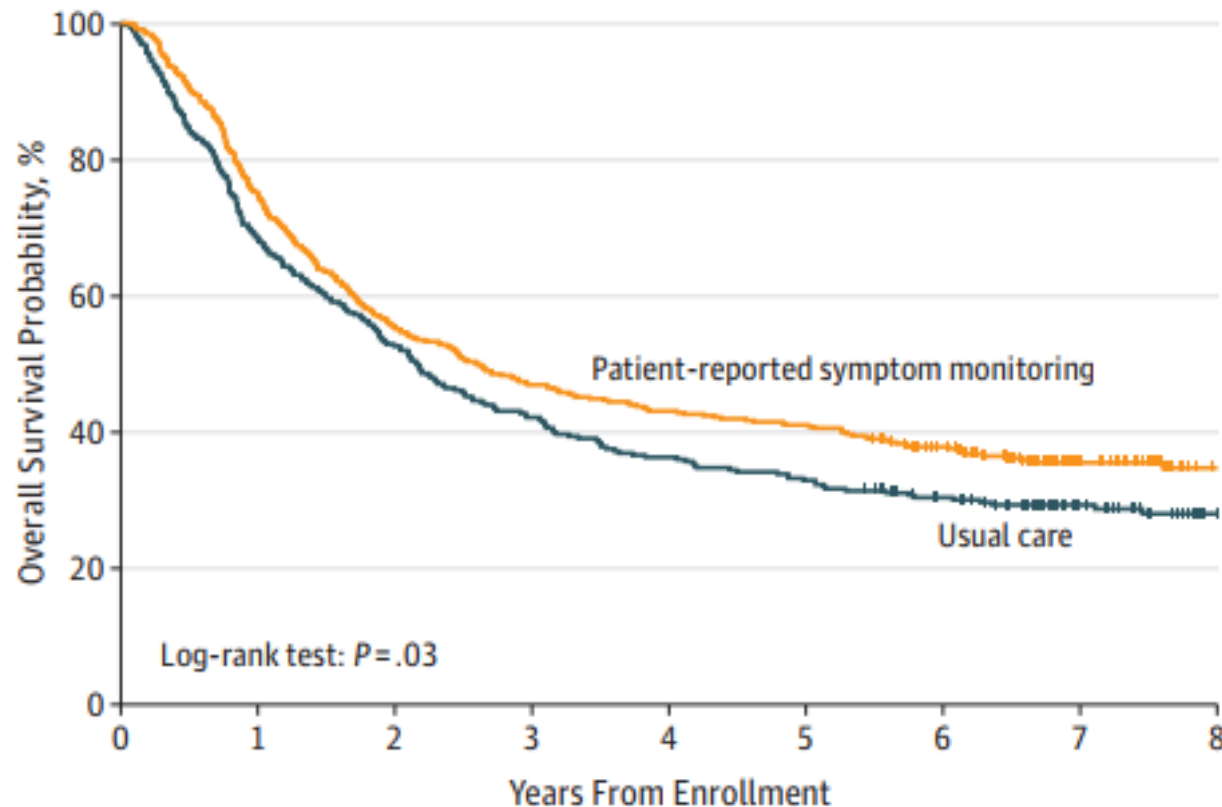
Not Just Startups: Reducing Asthma Symptoms with Big Data

- Teva Pharmaceuticals + IBM Watson
- Integrates data such as weather reports, medication use patterns, to predict asthma exacerbations
- Alerts to prevent exacerbations and ED visits



Low-Tech works too: Monitoring Cancer Symptoms Digitally Improves Survival

Figure. Overall Survival Among Patients With Metastatic Cancer Assigned to Electronic Patient-Reported Symptom Monitoring During Routine Chemotherapy vs Usual Care



Basch et al, 2017



The Age of
Big Data

Big Data +
Technology +
Medicine

**Technology
Innovations
in Mental
Healthcare**

Implications
for Mental
Health Policy
in China

What's Next?
Promises and
Pitfalls

State of Mental Health in the US

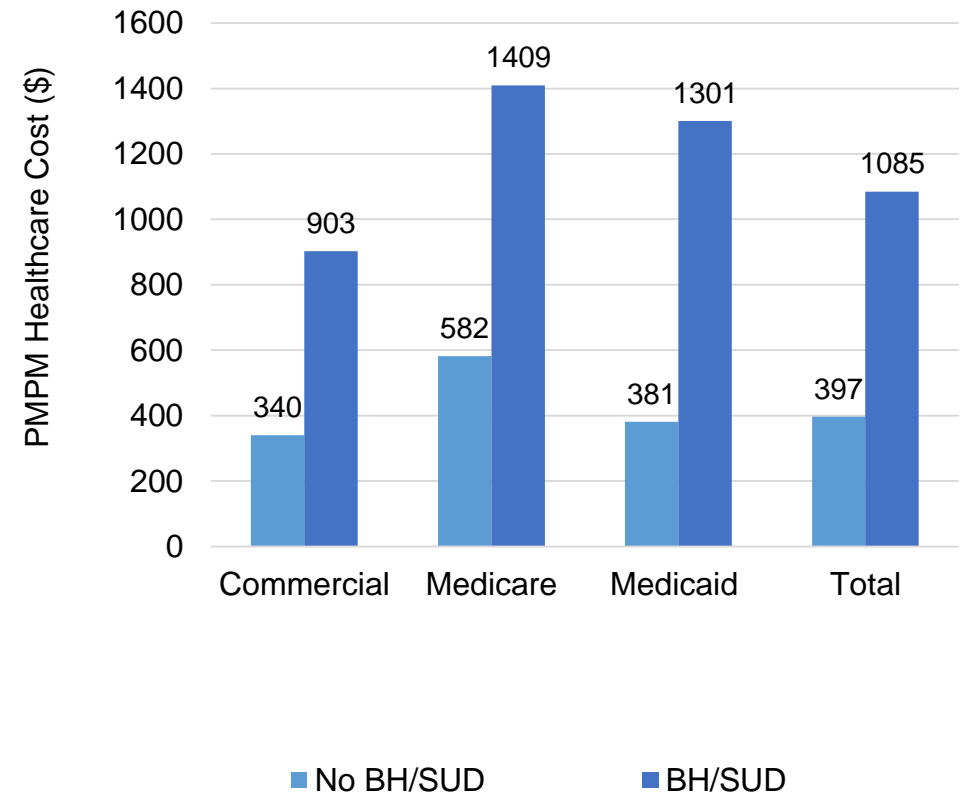
Mental Health and its Many Challenges

- Lack of Providers and Services
 - Long wait times
 - Many providers do not take insurance
- Care is fragmented
 - Lack of coordination between physicians
 - Drop out rates are high (Olfson et al, 2010)
- Reactive rather than preventative
- No biomarkers for clinical entities
- Stigma

Mental Health Conditions Increase Healthcare Costs and Diminish Productivity

- 1 in 5 Americans suffer from a behavioral health condition; half go untreated (Hostetter et al, 2014)
- Patients with a chronic medical condition AND a BH condition are 2-3 times as expensive (Melek et al 2014)
- Depression costs employers \$44 billion annually in lost productivity (Stewart et al, 2003)

PMPM Healthcare Costs by Population and Presence of Behavioral Health Condition - 2012

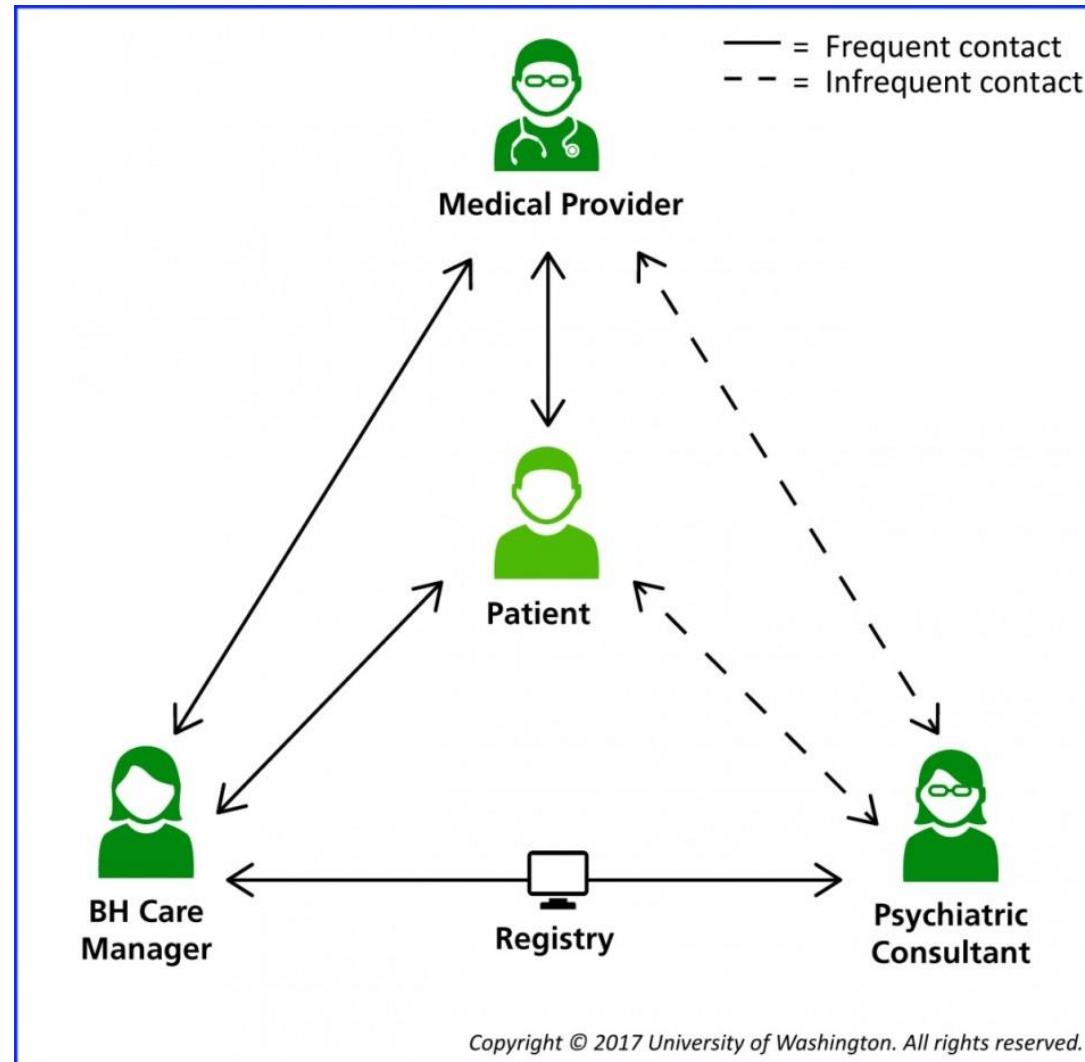


NOT ENOUGH PROVIDERS TO MEET THE DEMAND

Practitioner	Supply	Demand	Shortage
Psychiatrists	45,580	56,980	11,400
BH NP's	7,670	9,590	1,920
BH PA's	1,280	1,600	320
Clinical, Counseling, and School Psychologists	186,710	233,390	46,680
SA and Behavioral Disorder Counselors	85,120	106,380	21,260
MH/SA Social Workers	110,880	138,630	27,750
MH Counselors	120,010	150,000	29,990
School Counselors	246,480	308,130	61,650
Marriage and Family Therapists	30,560	38,250	7,690
TOTAL	834,290	1,042,950	208,660

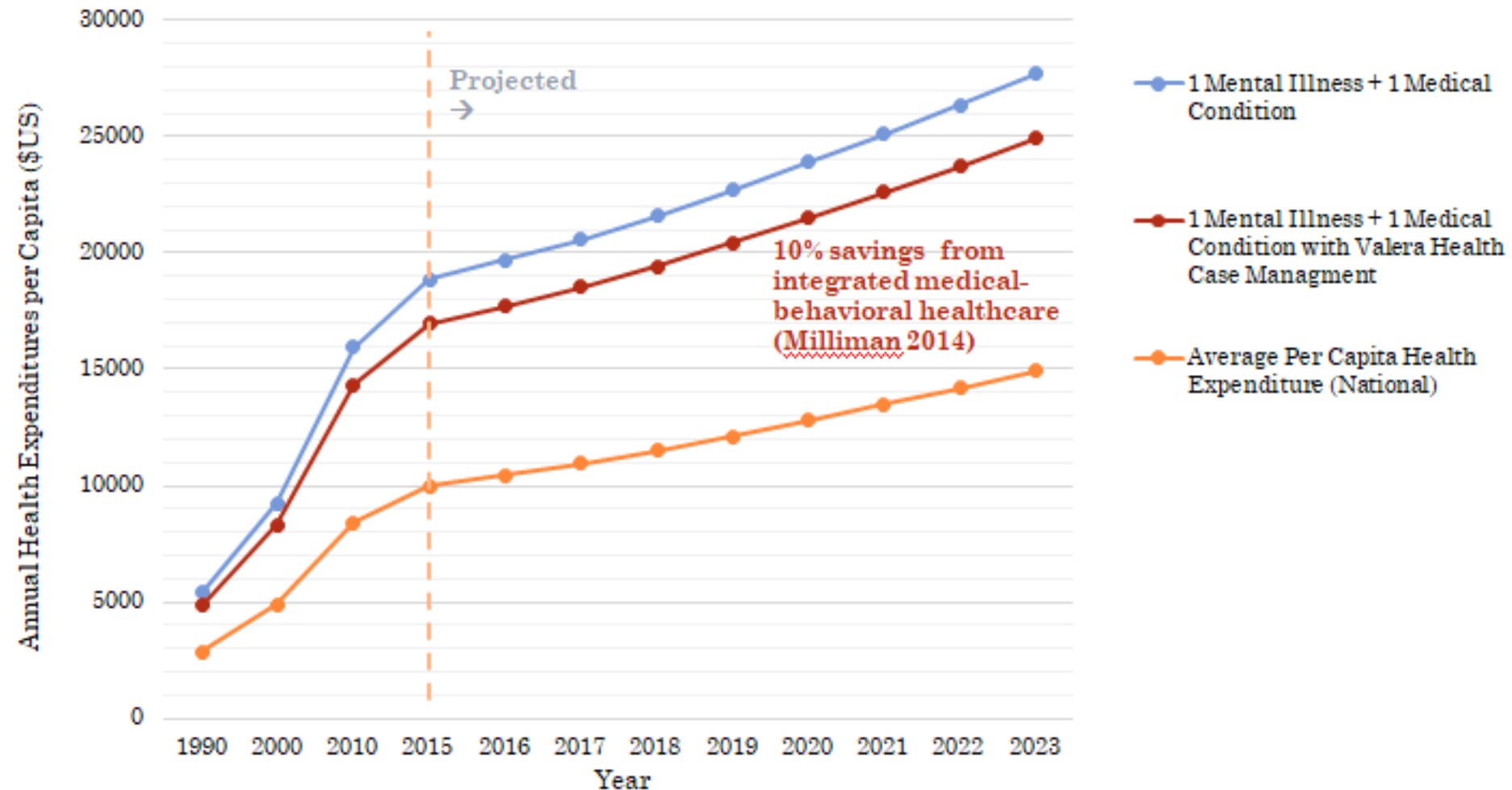
“National Projections of Supply and Demand for Selected Behavioral Health Practitioners: 2013-2025”. (2013 projections). U.S. Department of Health and Human Services 2016.

Team-based behavior healthcare works: the Collaborative Care Model (CCM)



Validated and cost-effective (Archer et al, 2018, Camacho et al, 2016)

CCM is Cost-Effective. Most Savings come from reduced Medical Costs



(Kaiser Family Foundation 2014, Milliman American Psychiatric Association Report 2014)

Yet CCM has been rarely implemented. Why?

- Expensive
 - Pace of transition from fee-for-service to value-based care
 - Uncertain payments for integration of care
- Operationally difficult to transition
 - Requires changes in workflow
 - Role changes for personnel
- Cultural Shift for providers
 - Relatively large shift for psychiatrists

How can Technology + Data
improve Mental Healthcare?

Three Classes of Mental Health Technologies

- Remote Treatment
- Integration within Current Care Delivery Systems
- Predictive Analytics

Remote Mental Health Treatments

DOES REMOTE TREATMENT WORK? DIGITAL INTERVENTIONS ARE EFFECTIVE FOR DEPRESSION

META ANALYSIS: 18 eligible randomized controlled trials of 22 smartphone apps for depressive symptoms, with outcome data from 3,414 participants

RESULTS:

- Smartphone interventions had a moderate positive effect on depressive symptoms
- Smartphone interventions based on CBT, mindfulness, and mood monitoring significantly reduced depressive symptoms

Firth J, Torous J, Nicholas J, *et al.* 2017.

Therapy via the web: Talkspace

- Patients pay \$49/week for unlimited texting therapy (\$79 for talk therapy)
- Large group of patients who prefer texting that have been ignored
- Based on initial assessment, patient is connected with a therapist via matching algorithm
- Over a million patients on platform



Leveraging Social Networks to provide free treatment: 7cups of tea

- Anyone can talk to a trained 'listener' confidentially for free
 - High accessibility
 - Discussions are monitored
- Referral to therapy is an option
- Highly popular: > 23 million conversations

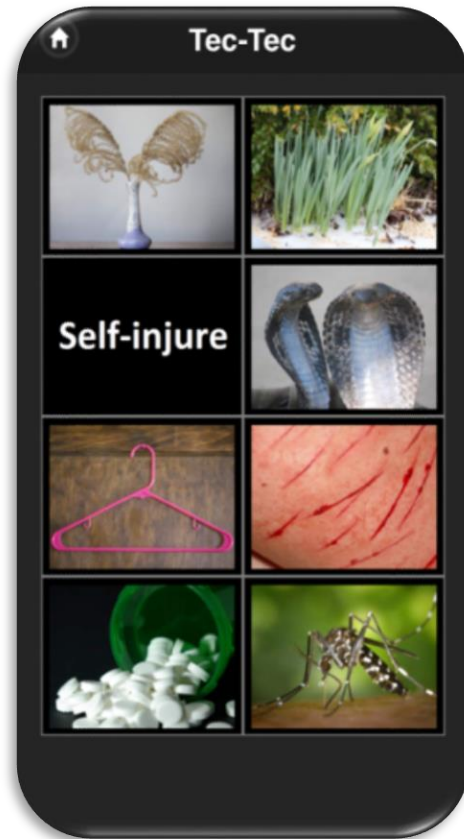


Gamifying mental health treatments: Akili

- Video games that can help treat ADHD by improving specific neuropsychological tasks (e.g. multitasking, set-shifting, etc.)
- Reinventing treatment paradigm: more intuitive and accessible to children
- Currently seeking FDA approval



Reducing Self-injurious Behaviors using a Video Game: Nock Lab



Therapeutic Evaluative Conditioning

Brief, Game-Like Mobile App

Tested in Three Large Web-Based RCTs

Self-Cutting: 42-49% Reductions

Suicide Plans: 21-64% Reductions

Suicidal Behaviors: 20-57% Reductions

Optimizing Mental Health Delivery

Incentivizing Healthy Behaviors with Money: Welltok

- Technologies to incentive patients to engage in healthier activities
- Reduce blood pressure, stop smoking, fill out health assessments
- Enrollment and compliance with program decreases health premiums for employees



Tackling Substance Use Disorders Digitally: Pear Therapeutics

- Digital programs for patients with substance abuse disorders
 - Prizes for abstinence
 - Education
 - Monitoring symptoms
- Monitoring is key for addictions
- Integrates within workflow of care providers
- Partnering with Novartis to improve treatment compliance

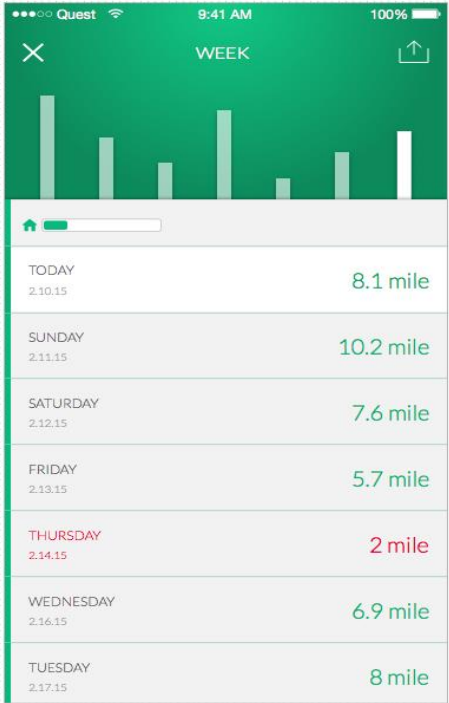
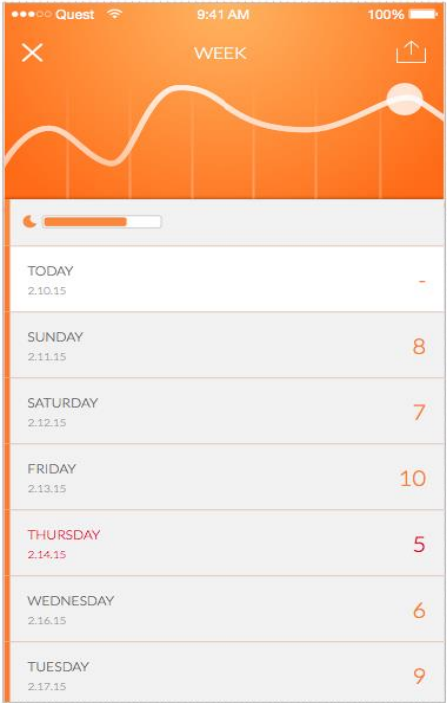
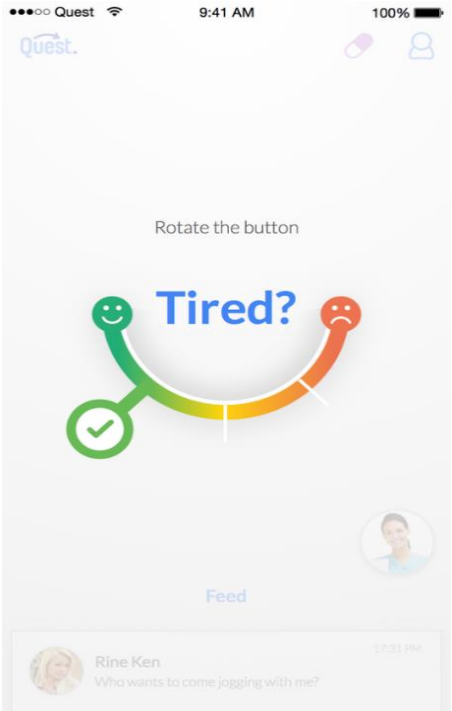
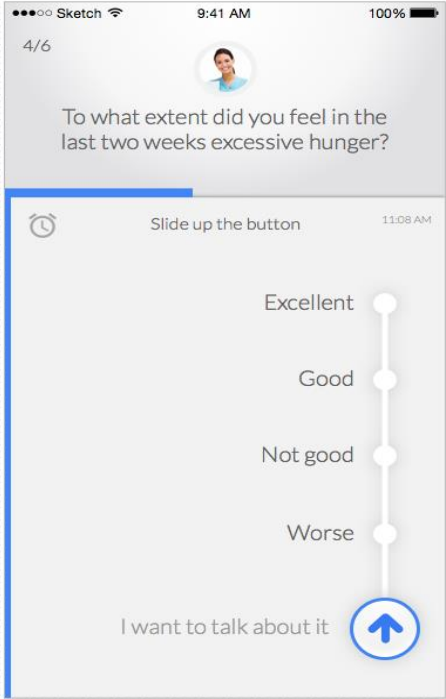


Helping Organizations Implement the Collaborative Care Model: Valera

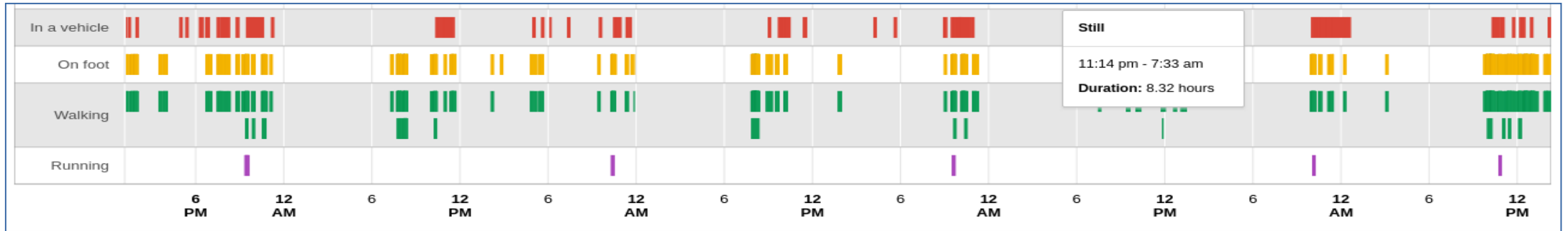
- Digitizing CCM
- Smartphone app for patients
- Dashboard for care managers to monitor patient data
 - Focus on high risk patients
 - Efficient communication
 - Provide educational materials
- Working with accountable care organizations and payers



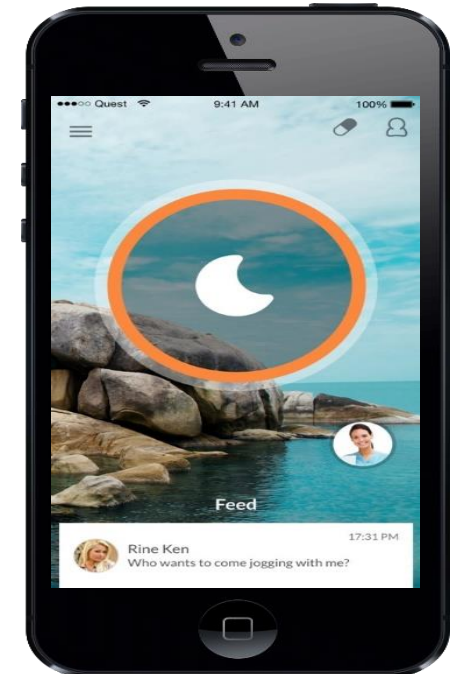
VALERA'S SMARTPHONE APPLICATION COLLECTS INFORMATION FROM PATIENT SURVEYS, AS WELL AS AUTOMATICALLY COLLECTED DATA







If Concerning Patterns Emerge, the Patient's Care Manager is Notified

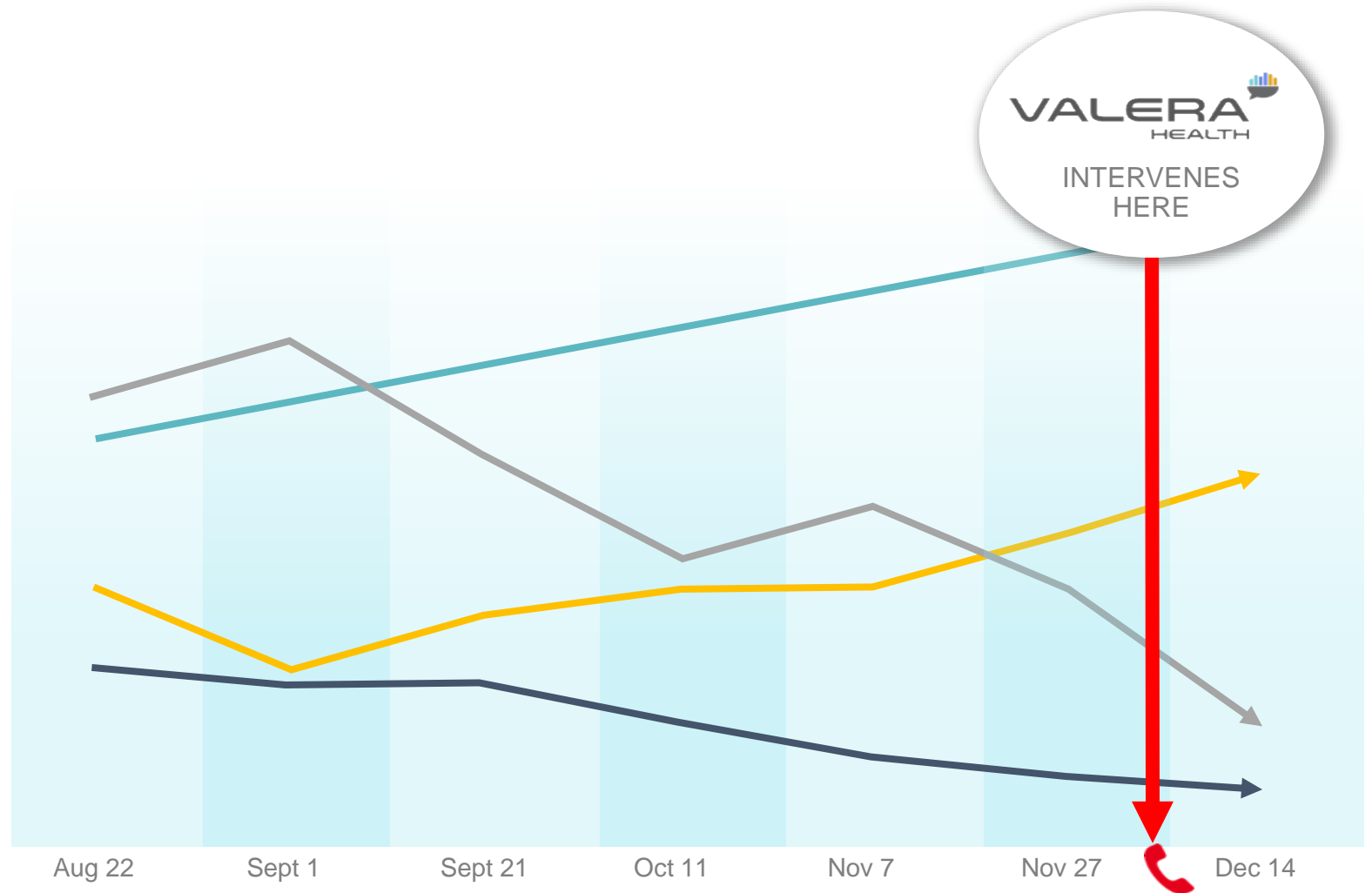


The screenshot shows a mobile application interface for a patient named Venessa Lopez, who has CHF. The interface is titled 'ALERT > VENESA LOPEZ' and includes a 'RESOLVE' button. The main content area is titled 'Report' and explains why the alert was generated. It lists three reasons: 1) Patient has not left home for at least 3 days, following a monthly routine of daily travel to work. 2) Over the last week, a steady decrease in the patient's physical activity, measured by daily number of steps. Patient's average number of steps decreased from 5000 steps a day (+-2000) to 2000 steps a day (+-1000). 3) Following these findings, a PHQ9 was automatically sent to the patient on Wednesday, 1 Jun with a score of 14, which is 6 points higher than the previous PHQ9 that was completed one month earlier, on Sunday, 1 May. A 'Recommendation' section follows, stating: 'This patient may experience a disease deterioration. Please contact the patient within 48 hours to discuss findings and suggest a referral to a relevant health care provider for further treatment.' The interface also shows a sidebar with navigation icons and a 'Current status' section with a vertical timeline of activity icons.



WE CAN DETERMINE WHEN PATIENTS ARE AT RISK OF DECOMPENSATION

- Number of texts 
- Depression score 
- Hours of Sleep 
- Number of steps per day 

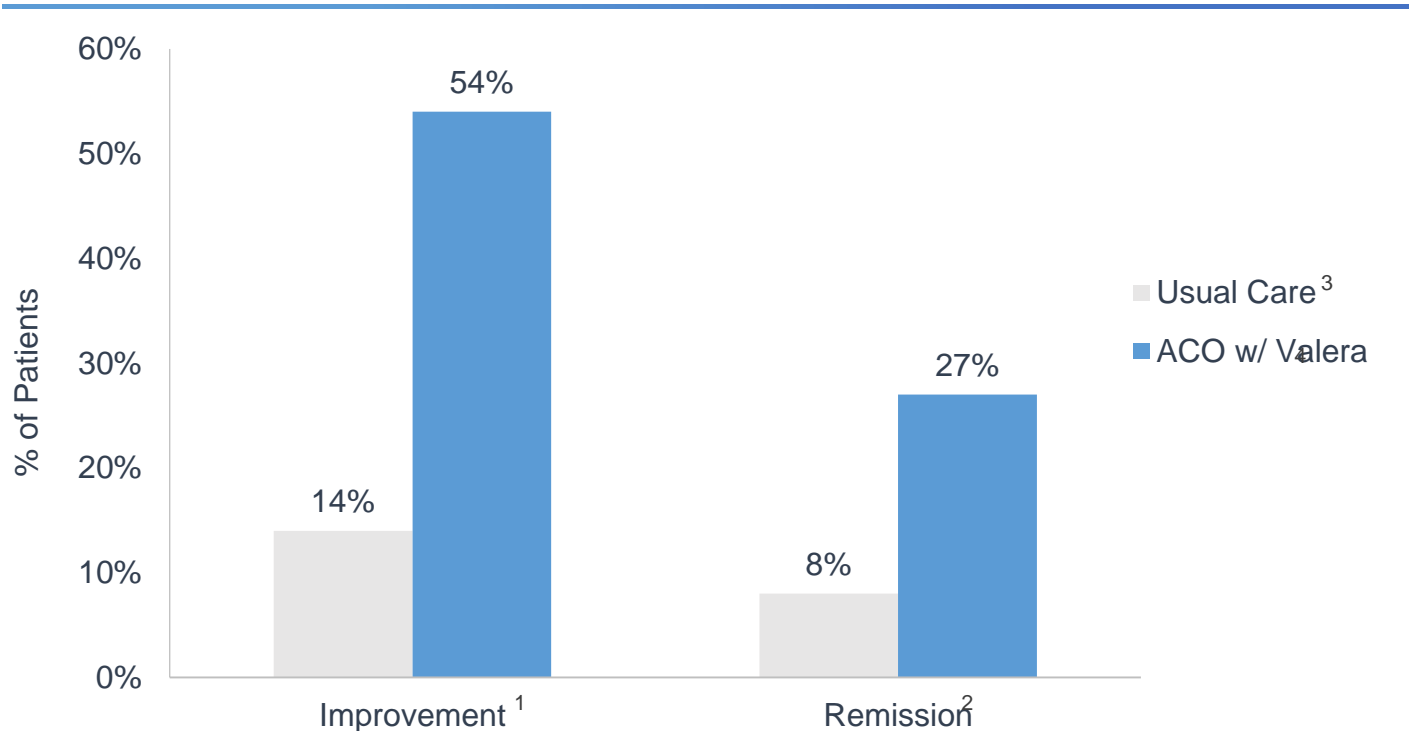


Case Study: Enabling Digital CCM for Montefiore Health System

- Establish CCM for 1,000 patients over 5 primary care sites
- PCP refers patients based on screening surveys
- Outcomes (vs. control):
 - 3 times as many touch points with patients
 - 65% adherence to app activities
 - Case managers can handle 2-3x more patients each



CASE STUDY: ENABLING DIGITAL CCM FOR MONTEFIORE HEALTH SYSTEM



1. Definition of “improvement”: Usual Care: 50% reduction in PHQ-9; Valera ACO client: 50% reduction in PHQ-8 score OR PHQ<10.
2. Definition of “remission”: Usual Care: PHQ Score <5; ACO: PHQ-8 Score <5.
3. MNCM 2016 Quality Healthcare Report. Published in 2016. Accessed 6 April 2017. <http://mncm.org/wp-content/uploads/2017/03/2016-Health-Care-Quality-Report-Final-3.1.2017.pdf>

Key Insights

- Patient Engagement is the common denominator of success
- Basic analysis is often sufficient to affect clinical impact
- Most challenging task: clinical operations

High Resolution Data and Predictive Analytics

'Digital Phenotyping' to predict behaviors: MindStrong

- Based on keyboard usage and scroll patterns
- Correlate patterns with meaningful neuropsychological measures
 - E.g. # of typos and speed of typing can predict executive function
 - Requires no active patient involvement
- Co-founders with deep domain expertise

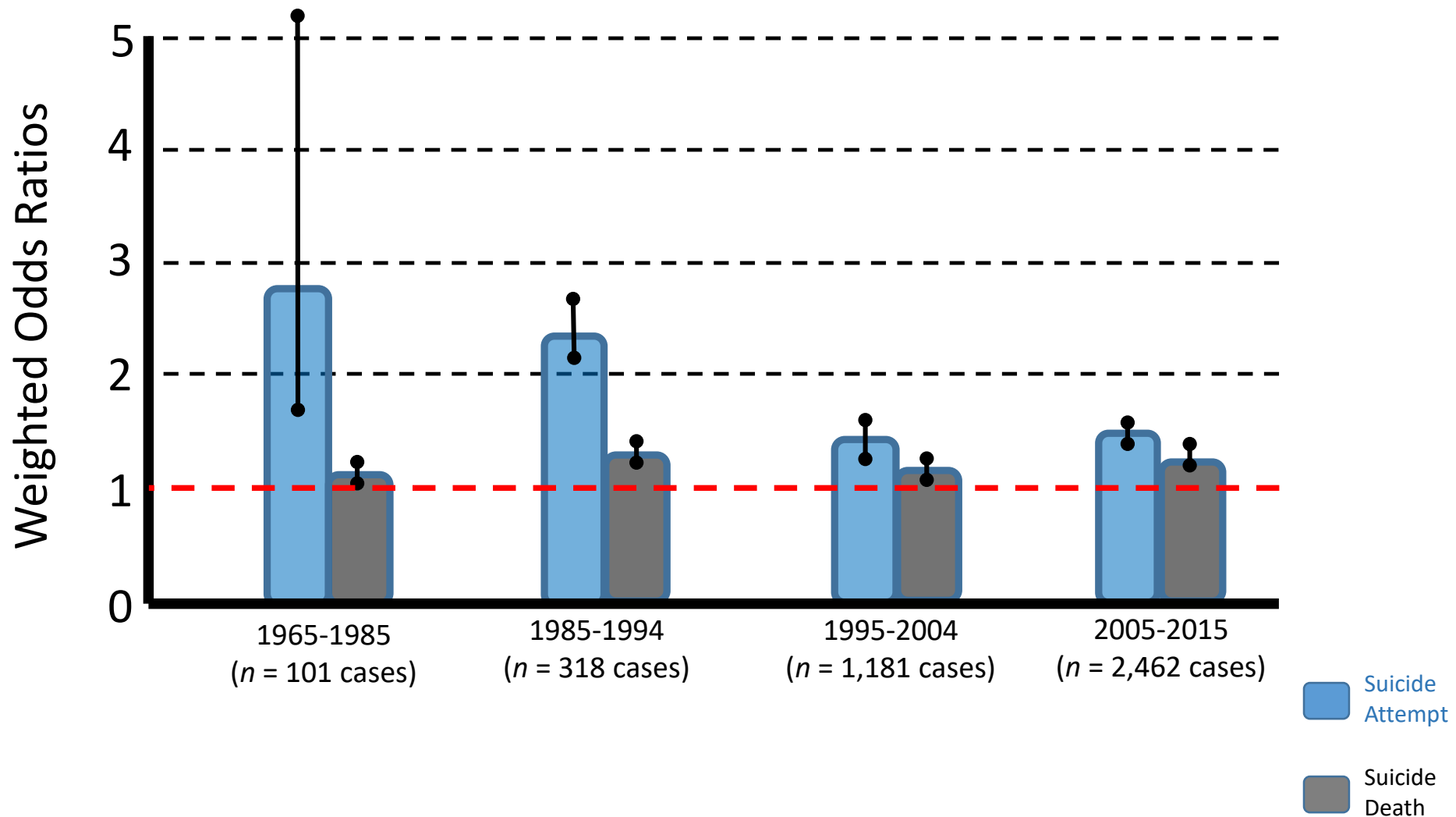


mindstrong

Predicting and Preventing Suicidal Thoughts and Behaviors: Nock Lab

- Suicide is the 10th leading cause of death
- Claims over 45,000 lives a year in the US, over 1,000,000 a year in the world
- Some progress has been made (e.g. identified risk factors), but suicides have only increased
- Study data has been low quality
 - Not enough temporal resolution
 - Mostly retrospective report
 - Difficult to study in real time

Our Ability to Predict Suicide Has not Improved in the past 50 years



Franklin, Ribeiro, Fox, Bentley, Kleiman, Jaroszewski, Chang, & Nock (2017). *Psychol Bulletin*.

Need Better Data: Real-time data from devices reveals features of Suicidal Ideation

- High risk inpatients download smartphone app, which surveys patients every few hours
- Wears wristband device that monitors movement
- What can we learn from high-resolution, real-time data?



Kleiman et al. (2017). Journal of Abnormal Psychology.

Suicidal Ideation Varies Significantly Over Hours

Five subtypes:

1. Low mean, low variability
(low maximum, few non-zero responses)

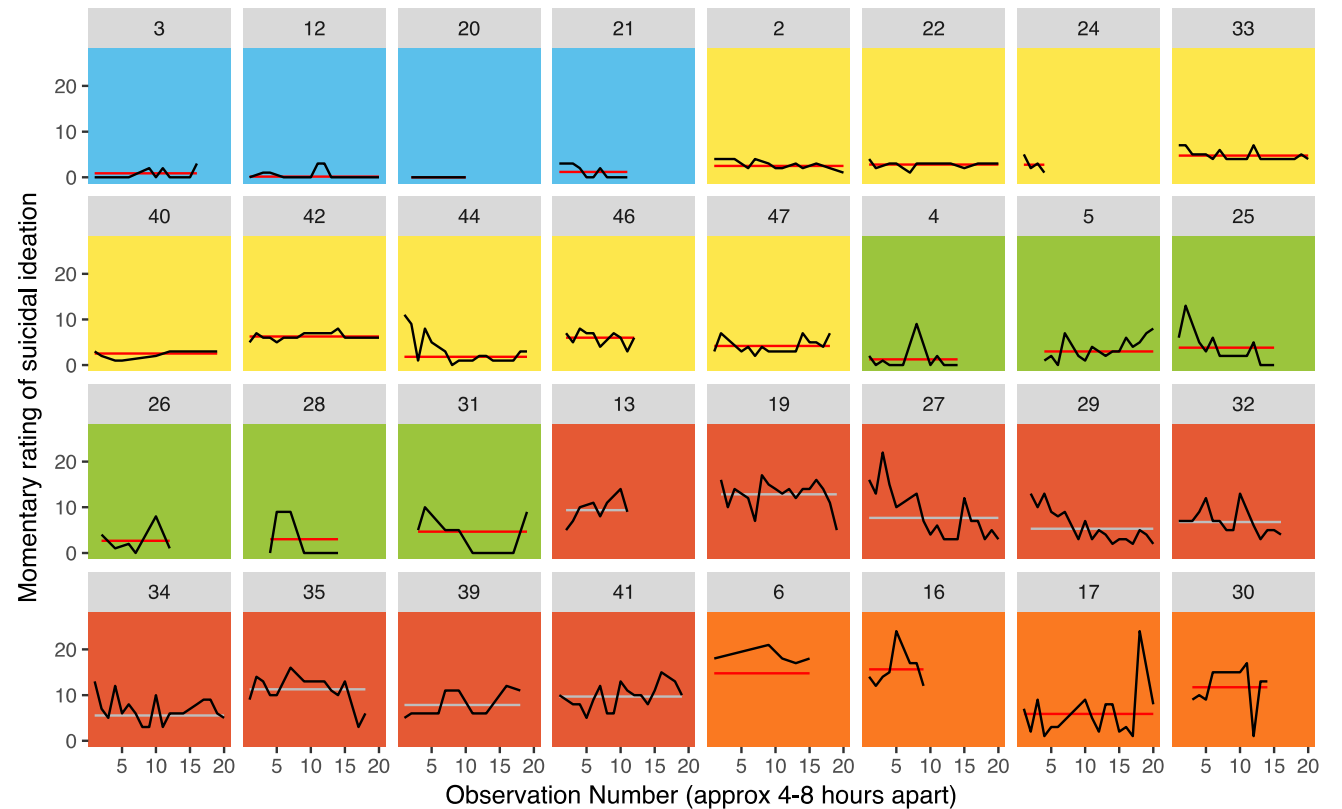
2. Low mean, high variability
(mod. maximum, mod. non-zero responses)

3. Mod. mean, high variability
(high maximum, mod. non-zero responses)

4. High mean, low variability
(high maximum, high non-zero responses)

5. High mean, high variability
(high maximum, high non-zero responses)

Sample 2 (Psychiatric Inpatients)



These five subtypes replicated across both samples.

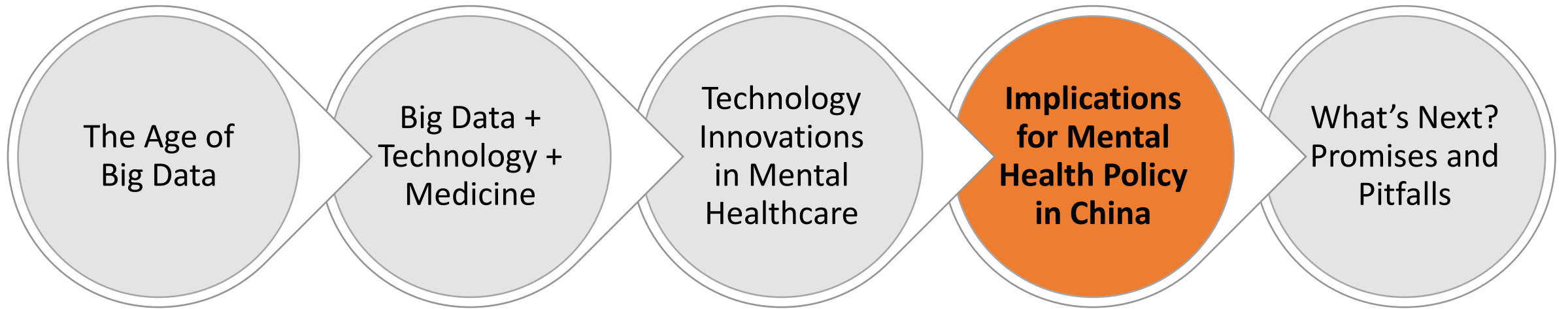
Were most likely to have made an attempt in the month prior.

Next Steps

- Study how patients' SI respond to new treatments (medications, ECT, etc.)
- Integrate information from electronic health records and social media
- Monitor patients outside the hospital in real-life situations
- Build out validated predictive algorithms to inform clinical risk assessments

Summary of technologies for Mental Health

- Remote interventions are effective
- Technologies are more scalable and accessible to patients
- Keys to clinical impact: focus on patient engagement and clinical operations



“China will do more for mental health in the next 10 years than we have done in the past 50”

- a former director of the National Institute of Mental Health

My Serendipitous Foray into Mental Healthcare in China

- Valera won the US China Health Summit Innovation Competition
- Partnership between the Sichuan Provincial People's Hospital (SPPH) and the MGH Psychiatry Academy
 - MGH Psychiatry Academy will be creating training and certification program for psychiatrists
- Visited Sichuan Provincial People's Hospital (SPPH)



Visiting Sichuan Provincial People's Hospital



Obligatory Pictures from a Shameless Tourist



China is well-positioned to become a leader in Mental Health Delivery

- Need is high: 91% of the 173M adults with a mental disorder have never received professional care (Philips et al, 2009)
- Technology is accessible; smartphone ownership is high
- Execution Efficiency in a more top-down system
 - Support of Governor Yin Li
- Strong focus on entrepreneurship
 - Excellent talent
 - Institutional support
- Advantage of being a Second Mover



The Advantages of not being a First Mover in Technology: Digital Currency

- Example: digital payments
 - US: Credit cards, Paypal, Level Up, Venmo, Google Pay, Apple Pay
 - China: WeChat, Alipay

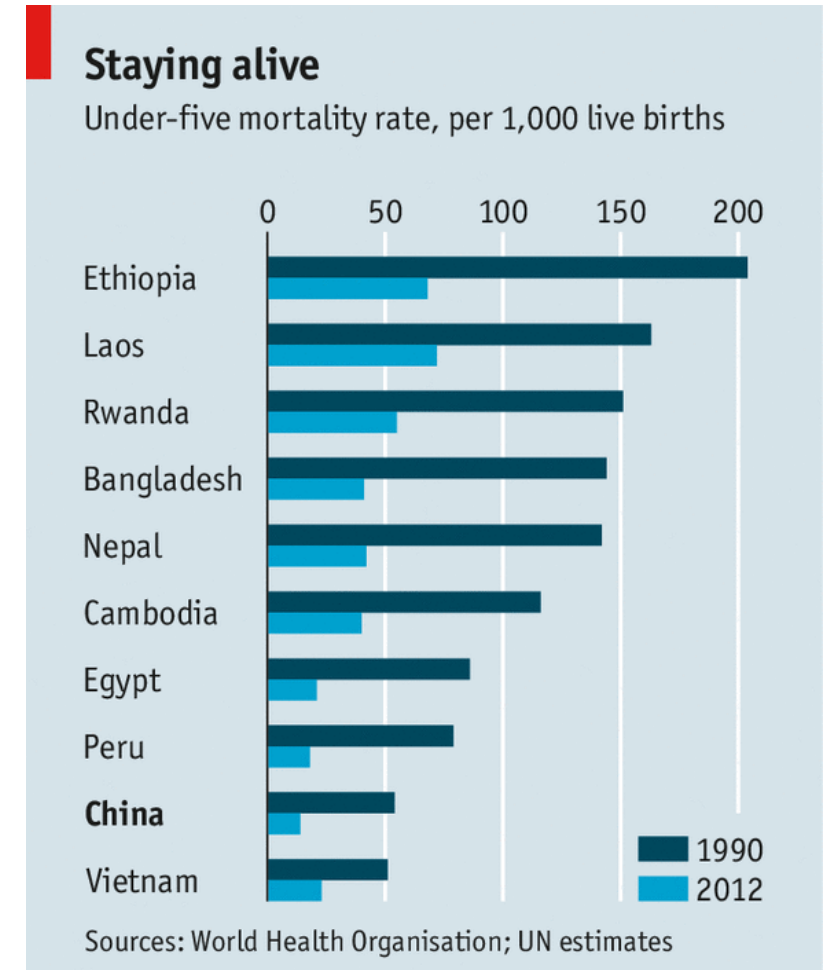


Digital Currency is Simply Better in China

- WeChat used to pay for vending machines, parking, and beggars
- China set to surpass US in digital payments in 2020
- Tech implementation for Healthcare should be similar

China's success with targeted Health Interventions: decreasing infant mortality

- Lowered Infant Mortality
 - Subsidies to mothers who delivered in hospitals
 - Free Vaccines -> 95% of children are vaccinated for measles, rubella, and polio
- Advantages of one-party, top-down governance for healthcare
 - Efficiency
 - Speed



China's Focus on Entrepreneurship

- Rapidly developing startup scene
 - Large population of young entrepreneurs
 - Growth in Funding Sources
- Increasing efforts to build connections with other countries
 - Joint ventures with foreign companies
 - Dr. Jing Ma's efforts to bridge institutions between China and the US



DEPARTMENT OF POPULATION MEDICINE



HARVARD
MEDICAL SCHOOL



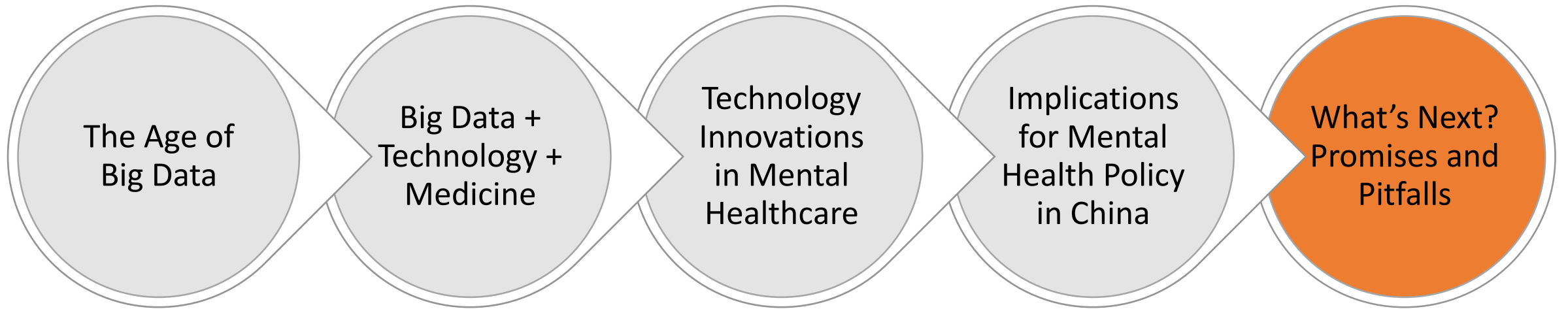
Harvard Pilgrim
Health Care Institute



四川省醫學科學院·四川省人民醫院
Sichuan Academy of Medical Sciences & Sichuan Provincial People's Hospital

Challenges <-> Opportunities

- Insufficient number of care providers <-> train new providers with most up to date materials
- Lack of infrastructure <-> ability to build a more community health-oriented healthcare system
- Lack of commercial pharmacies <-> new delivery mechanisms
- Mental Health highly stigmatized <-> more open to digital solutions for remote care



Is there Room for Concern?

- China's Social Credit System
 - Integrates social media data, purchasing history, criminal records, etc.
 - Behavioral 'nudges' to encourage pro-social behaviors
 - Partnership between tech giants and the government
- Already Happening: FAAMG (Facebook, Amazon, Apple, Microsoft, and Google) have been implicated in:
 - Influencing elections (unknowingly)
 - Becoming more influential than governments
 - Speed of law reform always lag that of technology growth

The Zero-Sum Tradeoffs

- Convenience <-> Privacy
- Population health <-> one-on-one treatment paradigm
- Free will <-> determinism
 - Predictive analytics chips away at free will
 - Studies showing that propagating deterministic beliefs cause immoral behaviors
 - Agency/locus of control for kids important for personal success
 - But is it so bad? the Swedes already know this



Three Take home Ideas

- Technology is poised to make major changes in the way we deliver healthcare, particularly in mental health.
- China is especially well-positioned to become a leader in innovating in mental healthcare delivery.
- The future of Technology in Healthcare is full of Promises and Pitfalls

Thank you!

- Profs. Winnie Yip, Jing Ma, Matt Nock
- Drs. David Rubin, Albert Yeung, Maurizio Fava, and Jerry Rosenbaum, Sara Trowbridge
- Valera Team

Questions?

Appendix

Bibliography

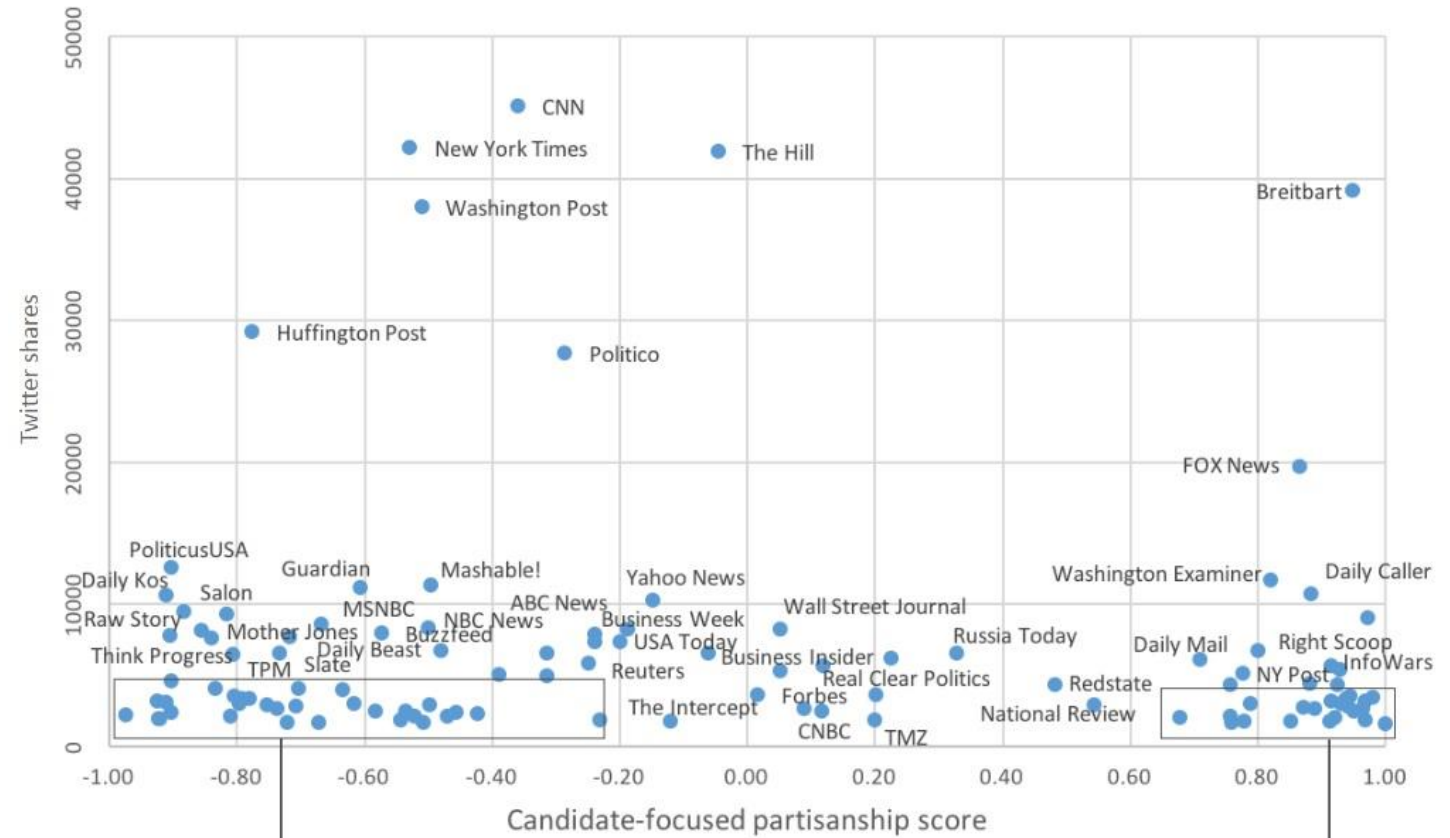
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Big Technology Companies are moving into Healthcare

- Apple
- Amazon
- Google
- Alibaba

The Facebook Megaphone: creating political winners and losers



Addicting Info
 Alternet
 AP
 The Atlantic
 Bipartisan Report
 Boston Globe
 CBS News
 Crooks and Liars
 Daily News
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FiveThirtyEight
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Occupy Democrats
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 SnappyTV
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AllenBWest
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 The Blaze
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 Conservative Treehouse
 Conservative Tribune
 donaldjtrump.com
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 News Ninja
 Newsmax
 The Real Strategy
 teaparty.org
 Townhall

Truthfeed
 Twitchy
 Washington Times
 weaselzippers.us
 Western Journalism Center
 Wikileaks
 WorldNetDaily
 Zero Hedge

A word about my Journey

- Working in startups and clinical care has been challenging
 - Cultural inertia
 - Academic silos
- Entrepreneurship is relatively fast, adaptable, and outcomes driven, but not rigorous
- Academia is rigorous and peer-reviewed, and but slow
- Combination of the two is critical to bring about impact