Digital Technologies and Mental Health

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ASU’s 8th Biannual Law and Neuroscience Conference:
Mental Health and the Court
Sandra Day O’Connor U.S. Courthouse: Phoenix, Arizona
9 December 2022
The Strategic Landscape for US Healthcare

Technology convergence

Escalating chronic disease burden

Data capture and analysis for better care and outcomes

Precision health (PH)
- Defining disease at the molecular level
- Predisposition risk
- Disease subtyping and optimum treatment selection

Digital health (DH)
- ML/AI for large data analytics
- Clinical decision support
- Empowered patients

Conditions:
- Cardio-vascular, cancer, diabesity
- Mental illness
- Neurodegeneration, dementia

New product/service combinations

Biomedicine

Engineering

Computing
Wearables and Mobile Devices: Key Drivers in Remote Health Monitoring and Care Delivery
Wearables and Remote Health Status Monitoring

Smart Devices for Automated Drug Delivery and Improved Therapeutic Adherence

Propeller Health

Gecko (now Teva)

CapMedic

Biocorp Insair

Help patients get **onboard** with **onbody** injections

Onbody Trainers
- Oral Regimen
- Inhaled Regimen
- Injection Regimen
- Topical Regimen
- Replaceable Device Adhesion Injection Special Sensation.

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Aterica

Veta

EpiPen
Digital Technologies and Aging in Place: Independent But Monitored Living for Aging Populations

Rx adherence

cognitive stimulation

in-home support and reduced readmissions

reduced office visits
Chatbots and Support Robots in Healthcare
AR/VR/MR Neuromodulation in Clinical Care

- injury rehabilitation
- reduce apprehension/distraction in painful procedures
- anxiety, depression, PTSD, phobias
• the majority of events that influence wellness/disease risk and treatment adherence occur largely outside of formal interactions with the healthcare system

• daily decisions by individuals have greater effects on their health than decisions occurring within the healthcare system
Digital Technologies and Mental Health

- two trajectories
- **validated** applications in patient care
- far larger direct and indirect effects on mental health and behavior from pervasive digital dependencies in daily life
  - individuals, institutions
  - long term societal implications
- policy vacuum for oversight and regulation
- complex landscape of new clinical, ethical and legal issues
- new dual-use risks
  - abuse, manipulation and control
  - vulnerable populations
The Urgent Imperative for More Quantitative Metrics to Improve Diagnosis and Treatment in Neurology and Psychiatry
The “DSM Bible” Under Increasing Siege

- criticism for blurring boundaries between normal and abnormal behavior
- imprecision in mapping co-occurrence of personality disorders
- arbitrary diagnostic thresholds
- inadequate taxonomy for clinical staging across the continuum of disease severity
- clinical largesse for misclassification to meet ICD-10 codes to ensure insurance coverage or avoid stigmatization – eating disorders, SUD

10 categories of personality disorders
Identification of (Epi)Genetic Contributions to Neurodevelopmental and Mental Health Disorders: Still A Long Way to Go

- development of polygenic risk scores (PRS)
  - disease predisposition, diagnosis and prognosis
- complex diseases involving hundreds of low penetrance genes plus environmental effects on gene expression (GxE)
- daunting scale and cost of clinical validation studies to establish causality
  - >100,000 patients
Computer Vision, Facial Recognition and New Digital Psychometrics in the Evaluation of Mental Illness

- eye movements
- facial dynamics
- stimulus response reaction and interaction speeds
- speech patterns (rhythm, tone, volume)
- semantic construction
- 256 lead EEG
- brain imaging functional MRI
- altered signal pathways

ML/AI analysis of individual multiparameter responses matched to large-scale analysis of video data banks of patients with clinically validated mental disorders.
The Internet, Social Media and the Road to the Metaverse

- who knows why people do what they do?
  - the fact is that they do!
- the confessional of social media
- these actions can now be traced and measured with unprecedented precision
- with sufficient data the numbers reveal increasingly predictable behavior and individual risk patterns
- blurring of private and public spaces
- blurring of the real and the imaginary
- complex ethical and legal issues
  - consent, privacy, security, surveillance
Toxic Social Media and Mental Health

- ‘clicks’ revenue model drives ‘social contagion’
  - purposeful propagation of controversy, conflict, divisiveness, disinformation
- increased psychological/psychiatric distress, particularly in adolescents
  - anxiety, depression, fear, loneliness, suicidal ideation
  - eating disorders, body dysmorphia
  - gender identity, puberty blockers
- adverse effects of overuse
  - attention-deficit disorders
  - disrupted sleep
  - social isolation and lower emotional and social intelligence
The Neurobiology of Instant, Repeated Gratification

virtual immersion and education in the most plastic phase in the development of human analytical skills and socialization

interactive multiplayer gaming and modulation of reward neurocircuitry
The Road to The Immersive Metaverse
Welcome to Avatar World: Metaverse V. 1
Welcome to Metaverse World:

extended reality (XR): building the virtual sensorium

new virtual experiences: Tamagotchi babies
Welcome to Metaverse World:

ONE OF THESE PEOPLE DOESN'T EXIST

fake identities: new vistas in predation, crime and psychological manipulation

Malicious AI created her picture, yet she has never been seen by a camera. It made her an online profile, yet she has never logged in.

Malicious AI built her to attack you. Now it's time for AI to fight back.

darktrace.com
# Metaverse Market Map

<table>
<thead>
<tr>
<th>Experience</th>
<th>Discovery</th>
<th>Creator Economy</th>
<th>Spatial Computing</th>
<th>Decentralize</th>
<th>Human Interface</th>
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<td>Microsoft</td>
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Health Effects of Ubiquitous Immersion and Dependencies in Digital Environments

- unknown long term socio-cultural implications of new sensory, cognitive and behavior patterns positively reinforced in digital ecosystems
  - individuals, institutions, society
  - the new evolutionary selection pressure? (digital Darwinian fitness)

- atrophy of physical prowess?

- erosion of adaptive resiliency of individuals and institutions to cope with rude intrusions from the physical world?
  - COVID-19 pandemic and spiking of mental illness?
  - climate change angst in Gen Z and Millennials?
“Digital Twins”: The Janus Face of Digital Identities

- Individual Data
- Population Databanks

- intellectual foundation for precision health to improve wellness, disease diagnosis, treatment and outcomes versus
- relentless expansion of opportunities for nefarious exploitation, including use by adversarial nations
‘Big Tech’ and the Global Digital Ecosystem

- increasing pervasive reach of data collection on individuals, institutions, societies and governments
Big Data Analytics

from consumerism to graded levels of surveillance, control and surrender of autonomy?
Validation of ‘Black Box’ ML/AI Algorithms

- regulatory frameworks for ML/AI platforms used for clinical decisions for patient care
  - ‘software as medical device’
- “interpretable AI”
  - uncoupling of learned intermediary from comprehension of how the output(s) for decision opinion(s) were derived
- getting ready for “primetime”?
  - generative adversarial networks and transformer platforms
  - artificial general intelligence (AGI)
Big Data Meets Neuroscience: The Convergent Technological Triad

- Ubiquitous networked connectivities, individual identity and digital twins
- Neuroscience and precision mapping of sensory and cognitive molecular pathways in health and disease
- Artificial intelligence and dual-use implications
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Oversight and Regulation

- Keeping pace with the speed of technological change
- Different incentives for diverse stakeholders
- Legislative sclerosis and technological illiteracy
- Protection of autonomy and privacy
- Data ownership and consent
- Expanded legal and ethical domains of escalating multidimensional complexity