# Tech giants enter mental health

In September 2015, the Director of the National Institute of Mental Health (NIMH), T. Insel, announced his departure from the NIMH to lead Google's Life Sciences Mental Health Division. His decision attracted global attention. Interestingly for the field of mental health, Google intends to only back innovations expected to be ten times ("10x") better than competitors. Indeed, mental health care and research are beset with myriad challenges that may be better tackled using the informatic capacity that tech giants can leverage.

The field of mental health captures arguably the largest amount of data of any medical specialty, given that it encompasses behaviour, the brain and the mind. The physical neuroscience of psychiatry is augmented by high-resolution neuroimaging of various modalities, as well as "omic" data including genomics, epigenomics, proteomics, microbiomics and metabolomics. The growth of such big data aggregation in psychiatry provides unprecedented opportunities for exploration, descriptive observation, hypothesis generation, and prediction for clinical, research and business/operational issues. The scale of data outputs, however, means that computer models are required to assist humans to find and comprehend meaning and delineate non-obvious patterns – converting data to information, knowledge and wisdom.

Computerized analysis of complex human behaviours such as speech may present an opportunity to move psychiatry beyond reliance on self-report and clinical observation toward more objective measures of health and illness in the individual patient. A recent pilot study used automated speech analyses to predict later psychosis onset in youths at clinical high-risk for psychosis[1]. The analysis assessed for semantic coherence and two syntactic markers of speech complexity. These speech features predicted psychosis development with 100% accuracy and outperformed classification from structured clinical interviews.

Electronic health records (EHRs) have changed the landscape of clinical data collecting and sharing, facilitating more efficient care delivery. They provide multiple types of data about individual patient encounters, as well as longitudinal data about a patient's medical history over an extended period of time (see Hayes et al[2] in this issue of the journal). An example of the value of EHR data comes from a study which developed a statistical suicide risk stratification model[3]. The model resulted from examining suicide attempts and completed suicide in a large cohort of patients who underwent assessment in a regional health service. Researchers compared EHR-based predictions of suicidal behaviour at 3 months with clinician predictions, which were based on a checklist. The model derived EHR was superior (area under the ROC curves, AUC=0.79 vs. 0.58 using the checklist).

Big biomedical data are currently scattered across databases, and intentionally isolated to protect patient privacy. Linking big data will enable physicians and researchers to test new hypotheses and identify areas of possible intervention[4]. An example of the value of data linkage between genomics and EHRs comes from a large-scale application of the phenome-wide association study (PheWAS) paradigm[5]. The researchers scanned for associations between 2,476 single-nucleotide polymorphisms (previously implicated by genome-wide association studies as mediators of human traits) and 539 EHR-derived phenotypes in 4,268 individuals of European ancestry. Several new PheWAS findings were identified, including a cluster of association near the NDFIP1 gene for mental retardation, and an association near PLCL1 gene for developmental delays and speech disorder.

With the number of smart devices (i.e., smartphones and tablets) reaching into the billions worldwide, there are increasing opportunities to harness their power and multifunctionality for clinical use. There are now several examples of psychoeducation-based products in use for depression, bipolar disorder, dementia and psychological distress. Smartphones also have capacity to offer telemental health functions. These functions are increasingly viewed as useful opportunities for more rapid patient-clinician engagement and offering services to geographically isolated areas. They are reported to be as good as in-person care for diagnosis and treatment in comparative and non-inferiority studies. However, there are concerns about effects on the therapeutic alliance, and more research is required in specific populations (i.e., geriatric, child and minorities)[6]. With the huge number of "apps" available to patients and clinicians, it is important to use sensible approaches to analyzing clinical value. A Mobile App Rating Scale has been developed[7], and there are websites available which appraise digital mental health programs.

Recent years have seen the rise and miniaturization of many wearable sensors, for personal health care, fitness and activity awareness, as well as the wireless networking of these devices with EHRs and smartphones. These innovations also coincide with the popularity of patient-owned health records, community-based management of disease aiming to avoid hospitalization, and finally participatory health care, where patients are hypothetically empowered for health behaviour change through accessing their own health data. Smart and connected health care aims to accelerate the development and use of innovative approaches that would support the much needed transformation of health care from reactive and hospital-centered to preventive, proactive, evidence-based, person-centered and focused on well-being rather than disease.

The opportunities afforded by tech giants moving into mental health, with their capital, digital and data analysis tools, and human resource talent pools, provide much hope for mental health sufferers around the world. While the encounter of electronic approaches with health is not without its risks, surrounding data privacy, use and storage, its potential is overt[8]. The engagement of tech giants also raises many questions for how we train our next generation of researchers and clinicians. Convergence science involves the transdisciplinary integration of fields including computer science, physics, engineering, medicine, chemistry, mathematics, the arts and biology; synergy between government, academia and industry is also critical. Convergence psychiatry involves embedding convergence science into the clinical mental health care setting by closer integration of scientists, clinicians and industry, as well as enhanced education of health professionals.

This approach is critical, given modern psychiatric research problems are characterized by their complexity, multi-systemic nature and broad societal impact, hence making them poorly suited to siloed approaches of thinking and innovation. Care must be taken to ensure researchers and clinicians are exposed to these frontier fields, and potential mechanisms include hackathons (intensive collaborations with coders, designers and managers on projects to meet a specific brief), multidisciplinary research groups, educational systems involving convergence science concepts, and industry-academic collaborations.

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# Should psychiatry deal only with mental disorders without an identified medical aetiology?

Is psychiatry at risk of “losing” part of the conditions it deals with, once their “organic” or genetic origin is identified? The recent removal of Rett syndrome from the DSM-5 autism spectrum disorders category illustrates this issue.

Rett syndrome is a neurodevelopmental disorder characterized by autistic symptoms, cognitive and motor abnormalities and decreased brain growth during childhood[1]. Most cases of the syndrome are caused by a mutation in the MeCP2 gene, although not everyone who has an MeCP2 mutation develops the syndrome[1]. It was originally included in the DSM-IV as a disorder with autistic features of unknown aetiology. Now that its genetic origin has been identified, the main rationale for removing it from the DSM-5 has been that it is considered a distinct entity with a specific aetiology.

The history of medicine contains several other examples where the discovery of the specific aetiology of a mental disorder (or a clinical condition once thought to fall within the realm of mental illness) led to its removal from the framework of psychiatry. In the 19th century, after the psychiatric symptoms of general paresis were attributed to neurosyphilis, that became the first psychiatric disease with definite organicity. Once this finding was confirmed, general paresis was progressively forced out of the field of psychiatry. Further, in 1943, penicillin was proved to be highly effective against primary syphilis. At that juncture, psychiatry definitively “lost” the treatment of general paresis.

However, if knowing the “organic” or genetic cause of a disorder is a rationale for its exclusion from the DSM, the very future of our specialty is at risk, since in time, as more specific underpinnings of mental disorders are identified, we may “lose” several of the clinical conditions we deal with. Currently, 10-20% of patients with autism spectrum disorders and 40-60% of those with severe intellectual disability are found to have clinically significant copy number variations or deleterious *de novo* mutations[2,3], and these rates continue to increase[3]. Removing disorders with a known medical aetiology from psychiatry makes as little sense as suggesting that, because some gastric ulcers can be caused by bacteria, they no longer belong in the field of gastroenterology.

Most of us would agree with the principle that without brain there is no mind. Beyond this frame, the mind-brain debate remains inextricable. In a broad sense, mind or “psyche” may be conceived as a subjective phenomenal-experiential realm[4]. The specificity of the conditions classified as psychiatric disorders lies in the peculiarity of the elements that compose them, i.e. mental symptoms that cannot be simplistically reduced to brain dysfunctions. Mental symptoms are rooted in both the natural and social sciences, caused by a blending of biological, semantic and social components[5]. In point of fact, clinical specialties are not grounded simply in our understanding of human biology. Rather, they emerge in complex ways in response to a variety of conditions and situations. Some specialties involve special skills (cardiac surgery) or disorders of organs (nephrology) or systems (gastroenterology). Other specialties arise in response to a type of disorder (oncology) or to stages of the life cycle (geriatrics). Psychiatry is for diagnosing and treating mental disorders.

During the 19th and 20th centuries, a schism arose between neurology and psychiatry, and the two went their separate