Conference Report - ‘Digital Health: From Science to Application’ (by Keystone Symposia) 2019

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Background

‘Digital Health: From Science to Application’ was the first conference that focused on Digital Health and organized by Keystone Symposia. Hence, there was a broad range of subjects and one of the conference’s purposes was to ‘shape’ the abstract definition of the big buzz word ‘Digital Health’. The meeting was held in Keystone Conference Center, Keystone, Colorado on 21-25 January 2019.

The attendees were clinicians, computer scientists, and scientists from the industry (from start-ups to giant pharma companies) all in all around 120 participants.

The schedule of the conference was quite unusual; The morning session started at 8 AM and lasted till noon, and then we went on a long lunch (=ski) break. Afterwards, we had an evening session that lasted from 4:30 PM until 8 PM.

The first evening was a welcome mixer, and during the next four days, we had two sessions (morning\evening), in each of them focusing on a different topic. Each session had both main speakers’ talks (40 minutes each), and short talks (15 minutes each), all selected out of the posters. Moreover, there were two keynote speakers talks in the mornings of the first two days. In addition, on the third day, we had a workshop ‘Strategies for Successful Digital Health Implementation’ (that wasn’t a huge success).

The sessions were:

- The Science Behind Digital Technology
- Digital Health and Genomics Convergence
- Applications of Digital Health to Personal Wellness
- Applications of Digital Health Technologies to Drug Development
- Developing Cohort Studies with Multiscale Multidimensional Data
- Specific Disease Applications of Digital Health
- Regulatory and Reimbursement Pathways
- Digital Health – What’s the Value Proposition?

Many of the speakers presented their company’s product (Many of them had a smartphone application). The conference had a relatively small number of participants and we all stayed in the same hotel in a tiny ski village (without any ‘big-city’ stimulus). This enabled the attendees to communicate and mingle, and I found myself talking with most of them.
**Personal Note:**
Thanks to the ‘isolated’ location, the Keystone Symposia created a unique atmosphere which led the foundations to interact with various people. In my perspective, the conference covered a variety of topics, and I believe that next year, the organizer's will narrow the context of ‘Digital Health’ and create a more focused meeting.

![Poster & Coster](image)

*Figure 0: Poster & Coster, I was a looked chubby because I overdressed with “Gatex”. It was (-)18 Celsius degrees outside.*

**Digital: Shaping the Future of Health**
**Sue Siegel, CEO of General Electric ventures**

A talk from a perspective of digital health investor (Sue Siegel represents the Venture Capital of General Electric). Digital health companies raised 8.1B dollar in 2018. She presented the main vectors of the ‘Digital revolution’ and mentioned that usage of apps for healthcare purposes is increasing:

![Digital Health Diagram](image)

*What is Digital Health?*

*Harnessing digital technologies & data to improve healthcare: Cost, Quality & Access*
In her perspective, we will see more applications on medical data that are passively collected (for example counting your steps by your smartphone). She pointed out that one of the challenges is to make the insights that can be derived from that data concerning a patient mental status interpretable to a physician.

**A Computational Method to Integrate Electronic Health Records and a Multi-Scale Biomedical Knowledge Network for Automated Stratification and Follow-Up of Patients** (Short Talk)  
**Sergio E. Baranzini**, University of California, San Francisco, USA

SPOKE (Scalable PreciOn Medicine Knowledge Engine, [http://spoke.ucsf.edu/](http://spoke.ucsf.edu/)) is a network that contains more than 50 years of biomedicine and human health research. At the basis of SPOKE is a network - the “nodes” model the layers that make up a human (genetics, epigenomics, proteins, tissues, organs, clinical phenotypes, environment, lifestyle, etc.), and “arcs” represent the various types of relationships amongst them (Figure 1-Right).

The authors connected the Electronic Health Record (EHR) cohort of UCSF to SPOKE and then used this as an ‘enrichment’ graph. By propagating a patient’s connections through this network, they generated a network profile for each patient (See Figure 1-Left).

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**Figure 1:** (Right) An illustration of SPOKE network  
(Left) An illustration of the interaction of EHR & SPOKE.

The patient profiles are used to stratify patients into a disease landscape, which can be used as a tool for uncovering novel biological information, for diagnostics of patients, for predicting patient trajectories, and for designing personalized treatments (Figure 2)
Figure 2: An example of clustering the signatures of patients with Posttraumatic Stress Disorder (PSTD), and finding most similar signatures such as BiPolar Disorder \ Schizophrenia etc.

**Digitizing the Genome for Personal, Research and Clinical Uses**

**James Lu**, Co-founder & SVP, Applied Genomics Helix

Helix is a well-funded start-up (raised $300M), and its purpose is to be the ‘marketplace’ of the insights of your DNA sequencing results. They already have more than 35 available apps on their website (https://www.helix.com/). James presented the ‘Nevada Project’ (https://healthynv.org/), which tries to create a large health determinants database of hundreds of thousands of individuals. It is led by Helix and another ‘Renown’ institute. They try to engage the people through recreational products, the clinical return of results and research participation. The ‘Nevada Project’ purpose is to encourage discovery and accelerate translational research to improve individual and population outcomes.
Helix decided to focus in northern Nevada since it has a unique advantage for studying population health - there is only one primary hospital system in that geographical region, there is multi-generational diverse population and the world-leading environmental research institute is located there (Desert Research Institute).

This led to collecting an enormous amount of data: 1M patients with EHR (400K patients >5yr EHR), 60 years of environmental data, socioeconomic data and genetics, which Helix would be in charge of.

Lu presented initial results of their genetic research, based on a cohort of 20K patients (Figure 3).

![Figure 3: Initial results of genetic research based on a cohort of 20K Patients](image)

**Digital Phenotyping and Contextualized Genomics within Ada, an AI Patient and Clinical Decision Support Tool (Short Talk)**

**Lee Stopak**, Head of Genetics, Ada Health GmbH, Germany

Ada is a smartphone application that enables personal health guide with symptom assessment functionality that empowers users to learn and make more informed decisions about their health. Ada is an ‘expert rule’ system developed by physicians and engineers. It spans over 1000 conditions and over 5000 associated findings covering ~10000 ICD-10 codes (The formal diagnosis). It already has more than 5M users, and 9M completed assessments. Ada is integrated into the patient’s EMR records, and practically gives a probabilistic score for the patient’s diagnosis (See Figure 4). The next step of Ada is to integrate genetic information from...
genetics third-party providers (Helix \ 23andMe \ Ancestry \ Veritas Genetics) and be able to personalize Ada assessments even more (See Figure 5).

**Figure 4:** Illustration of Ada diagnosis mechanism based solely on the patient’s symptoms.

**Figure 5:** Effect of genetics on Ada’s performance on a case of Behcet’s syndrome patient, who tested positive for genetic variant HLA-B51. There are three panels of the same case. On the left is a genetics agnostic panel (Behcet reaches 6th place), in the middle a genetics-supported panel where the patient is heterozygous for the variant (Behcet is in 3rd place), and on the right is a
Making sense of Health Data
Ida Sim, University of California, San Francisco, USA

Ida Sim is a primary care physician and co-directs Informatics and Research Innovation at UCSF’s Clinical and Translational Sciences Institute. Her claim is this talk is that since most of the American population suffer from a chronic disease (60% of Americans have at least one chronic disease, 40% have two or more chronic diseases), they should be treated in a more personalized approach.

Sim claims that causality is a hard task, and randomized control trials tell us only about the ‘average’ task (and requires many resources). She presented the concept ‘N of 1 trial’ - multiple crossover trials, usually randomized and often blinded, conducted in a single patient (See Figure 6). The key elements of a typical ‘N-of-1” are the comparison of two or more interventions in a sequential, randomized assignment (control for temporal and ordering effects) on the same patient and using systematic measurements of outcome.

She presented the implementation of this concept for patients suffering from chronic non-malignant pain (>100 M Americans), and tried to answer the question whether pain patients should use personalized ‘N-of-1’ studies to find the optimal dose of medication that works for them. That can be done by utilizing the Trialist App (https://www.youtube.com/watch?v=zVH5TlXeK1Q, https://itunes.apple.com/us/app/trialist/id670319718?mt=8) that enables the patient to record his/her current treatments, and give feedback on his/her current status (Improvement \ deterioration) by answering a questionnaire. Then, with the results, the app can recommend which of the alternative treatments affect more positively on the specific patient.

Ida is also a board member of ‘Vivli’ project (https://vivli.org/) that developed a global data-sharing and analytics platform and focuses on sharing individual participant-level data from completed clinical trials to serve the international research community.
Measuring Happiness and Health using Social Media

Christopher M. Danforth, University of Vermont, USA

Danforth presented several of his studies in which he tried to create an instrument that measures the happiness of large populations in near real time. The basic mechanism behind his method is using a feature extraction techniques that utilize sentiment analysis on a large scale social media platforms - Twitter, Instagram, Facebook etc. (see Figure 7).

Figure 7: An illustration of the feature extraction methods for both Twitter, Instagram.

Using this analysis, Danforth can generate more insights in state/country level (see Figure 8), and he argued that such a tool can be extremely useful for measuring different reforms in the municipal level (for example measuring the effect of budget allocating to low-level neighborhoods).

Figure 8: An illustration of the summing of

Danforth’s group developed an online tool named ‘hedonometer’ which is based on people’s online expressions, capitalizing on data-rich social media. For their first version of hedonometer.org, they are using Twitter as a source but in principle they wish can expand to any data source in any language, and create an API for other researchers (See Figure 9).
Figure 9: A snapshot from the ‘hedonometer’ website (http://hedonometer.org/), which contains the label of a different event. For example, we can see that the Mass Shooting in Las Vegas in 2017 was the unhappiest event in the last 10 years, whereas Christmas day of 2009 was the happiest one. We can see that in comparison to 2009, the US population is a little bit less happy nowadays.