Learning for Life Week 7 Summary 11-7-18

Topic: The Brain, Neuroscience and Technology: The World Ahead

Speakers: John Rogers PhD and Shai (Steve) Xu MD, MSC

"New directions in science are launched by new tools much more than by new concepts."

F. Dyson

This week's lecture gave us examples of how innovation in the engineering lab has produced devices that not only allow us to study the brain more effectively, but also provide novel sensors that are altering the way diagnosis and rehabilitation are occurring in patients. John Rogers explained how he has transformed rigid traditional electronic sensors into devices that can be applied to biological systems with their inherent properties of irregular surfaces and fluidity. He told us how his lab has transformed rigid silicon into micro-thin slivers attached to an elastic surface which, when combined with tiny electrodes, can measure brain activity and provide electrical stimuli from the surface of the brain. Previously, only crude electrical mapping could be performed; now with these advanced tools, thousands of electrical channels can be monitored allowing for much more precision in the measurement of neural activity. A clinical application of this innovation is occurring in epileptic patients who undergo surgery to remove the abnormal seizure-inducing part of the brain.

Utilizing design engineering principles, John has also been able to produce surface sensors which can measure everything from heart rate to swallowing frequency and sweat production. These are being employed and studied in the neonatal ICU where infants who used to be tethered to wires and machines can now be monitored remotely with wearable tattoo- like sensors, freeing them up to be held and move around more easily. In the adult patient, similar devices are being used in the Shirley Ryan Ability lab to monitor recovery in stroke patients. Remote monitoring of things like speech, movement and swallowing will allow the medical team to continue following the patients once they have been discharged from the rehab center. If decline is occurring, the team will know it and can intervene.

Steve continued to share the tremendous number of potential applications of these unique sensing devices. A particularly important example is infants born with cerebral palsy, a condition where the brain is deprived of oxygen during or shortly after birth resulting in motor and sensory deficits. To date, the average age of diagnosis of cerebral palsy (CP) occurs around age 17 months and is made by trained providers performing a "general movement assessment" on the infant. Not only is the training difficult, but the diagnosis will be limited by access to a trained assessor and is subject to human error. If we can apply sensors that track infant movement as early as a few days or weeks after birth, we may be able to diagnosis CP much earlier, and we know that early intervention improves outcomes. Other examples like measuring swallowing in patients with dysphagia, or measuring "talk time" in patients with dementia were also highlighted. Of course, volumes of data from all kinds of sensors needs to be

analyzed quickly and translated into useful information for the medical team. Computer data analytics can help with this.

This lecture today gave us a glimpse of where medicine is headed. When physicians have access to all kinds of individualized data on a patient, they can begin to provide truly "personalized medicine". As so many of the other lecturers have pointed out throughout this series, when interdisciplinary collaboration occurs, amazing things happen.

Take Home Points:

1. Remarkable engineering work has led to the development of devices and sensors that can be applied to biological systems with wide reaching clinical application.
2. Precise remote monitoring of patients with these sensors will revolutionize diagnosis and treatment.
3. Computer data analytics will permit medical teams to make sense of the volumes of data that will be coming in on individual patients and allow for truly personalized medicine.