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Chairman Latta, Ranking Member Schakowsky, and members of the subcommittee, thank you for this opportunity to speak about the transformational innovations, leveraging the "Internet of Things (IoT) occurring at The Ohio State University's Spine Research Institute.

I would like to thank Chairman Latta for his support and leadership. We are fortunate to have Chairman Latta, as well as Congressman Bill Johnson, as two champions of innovation representing the interests of Ohioans on the House Energy & Commerce Committee

Ohio State & SRI Overview

My testimony today will highlight the way in which The Ohio State University Spine Research Institute (SRI) is coordinating the communication of advanced sensors, imaging and modeling through the internet to help prevent and better treat spine disorders.

Spine disorders, worldwide, are the most disabling condition known to humankind, and are responsible for over 100 million lost workdays per year in the United States alone. The condition will affect 80% of the population at some point in their lives, and is the second leading cause for physician visits. We spend over $100 billion a year on low back injuries alone in the U.S. Despite increasing treatment costs, the source of the disorder is often difficult to pinpoint resulting in spine surgeries, which are frequently unsuccessful.

At the SRI our mission is to quantitatively understand the causal pathways for spine disorders and to use this information to both prevent and treat spine disorders. The SRI is unique in that it is a true collaboration between engineering and medicine. This collaboration has resulted in important breakthroughs, which have contributed to the prevention of countless workplace injuries and improved the lives of patients.

The use of innovative technology to collect and exchange data through the IoT has made all of this possible. I would like to highlight three specific examples of how we are using technology associated with the IoT to make a positive impact in this important area.

IoT & Innovation at The Ohio State University

Clinical Lumbar Motion Monitoring (cLMM): First, assessing the degree of impairment associated with low back disorders has traditionally used subjective measures that can often lead to unnecessary or improper treatments.

We have developed smart wearable sensing devices that are capable of quantifying the extent of a low back impairment. The Lumbar Motion Monitor is an innovative sensor worn on the back while the patient essentially plays a video game with their back. The sensor tracks the patient's spine motion patterns and wirelessly transfers it to our laboratory servers via the IoT where it is compared to our spine motion databases. This comparison permits us to quantify the patient's spine function and document the degree of impairment. This information is sent to the physician to assist in diagnosis and clinical decision-making. The test can be repeated after treatments to objectively track the effectiveness of the treatments.

This system is currently used to evaluate spine patients at the OSU Wexner Medical Center and is being tested at the Ohio Bureau of Workers' Compensation. This device has reduced costs by preventing unnecessary biomedical imaging, has prevented patients from being reinjured by mitigating premature return to work, and has prevented unnecessary surgeries.

The Biodynamic Workplace Spine Model: In the second example, we use advanced sensors and biomechanical modeling to prevent spine injuries in the workplace. We can simulate work and objectively evaluate occupational risk in our laboratory. Workers perform their job while a variety of smart sensors measure how they move, how they activate their muscles, and monitor the forces they exert with their hands and feet. This information communicates with our sophisticated personalized biomechanical models via the IoT. These models allow us to understand the forces imposed on the spine tissues during work and help us understand "how much exposure to specific work tasks is too much exposure." Using this approach, we are able to redesign work tasks and objectively evaluate the effectiveness of interventions.

We have used this approach to help numerous companies including Honda, Ford, Toyota, BMW, Boeing and many others reduce back disorders. Our work with Honda has been recognized by industry experts and Forbes magazine for reducing injuries throughout North America by 70% over just a five-year period. A current project with the Ohio Bureau of Workers' Compensation has developed occupational pushing and pulling guidelines that will be soon be distributed throughout the State via the IoT.

Personalize Biodynamic Model: A final example of our use of technology related to the IoT involves predicting the outcome of spine surgeries before the surgery takes place. By combining IoT data from wireless motion, force, and muscle activity sensors with a patient's own biomedical imaging data from CT or MRI, we are able to build precise person-specific computational models of a patient's spine. These models can be used to better understand the root cause of a patient's injuries and to help the surgeon choose the best treatment options. This personalized modeling has the potential to improve the current success rate for spinal surgeries.

In addition, this virtual modeling can be made tangible by simply sending the data to a 3D printer. We are able to print exact models of patient spines to help the surgeon better understand the patient's specific anatomy and are exploring the use of this technology to print custom spinal implants.

How is IOT Helping?

These are just a few of the many examples of how the SRI has been using advanced sensors and modeling enabled by the IoT to better diagnose, treat and prevent spine injuries. Improvements in sensor technology and internet communication have made all of this work possible and are rapidly accelerating the pace of research and development. New developments in mobile computing and wearable technologies will connect our work in the laboratory with clinicians and patients in ways never before possible, while social media and app development make our research applications accessible to the masses where it can help the most people.

Potential "road-blocks"

Many of these advancements have been made possible through the compilation of massive amounts of data regarding the unique aspects of the patient's tissue architecture. However, one of the biggest challenges in this work involves getting access to patient information because of patient protection laws. While patient identity protections are certainly necessary, they also create significant hurdles in attempting to assemble large databases of patient outcomes and hamper the effectiveness of machine learning efforts.

Another significant roadblock is sustainable federal funding for long-term research efforts such as these. While I think it is important to acknowledge and thank Members of this committee for their support of robust federal funding of research programs in the recently passed FY2017 Omnibus

Appropriations bill, I must state that this type of research is enabled by careful, long-term, evidence-based, building of a scientific infrastructure. Given the lack of certainty in federal research funding in recent years, these and future efforts could be in serious jeopardy.

How Congress Can Help?

While we have enjoyed great success in our endeavors, the roadblocks just discussed are a significant impediment to further advancements. We see two areas where Congress could help advantage the impact of the IoT as applied to spine research. First, the HIPAA and patient privacy laws bureaucratic burden should be considered in light of advancements that will help patients. A process that protects patient's rights yet still enables the efficient creation of large biomedical databases based upon anonymous patient data would greatly enhance the discovery process.

Second, these types of scientifically based advancements are only possible through a long-term commitment to research. It is not possible to perform independent objective research without consistent funding. Inconsistent Federal support for funding this type of research is a major threat, both to this type of research and U.S. competiveness globally, and I urge Congress to consider the long-term societal health and financial benefits of funding these types of efforts.

I would like to thank the Committee again for their time and giving me the opportunity to explain how our research can reduce and prevent patient pain and suffering, reduce medical costs, and reduce costs to industry.

I look forward to the Committee's questions.