Current Developments In Diagnostic Methods Of Concussions

Concussions have been a hot topic for the past few years, with more evidence coming to light all the time of the damaging and long term consequences that come from them. The most popular definition of a concussion is “any disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific symptoms and often does not involve loss of consciousness”. A main issue has been being able to accurately diagnose the concussed, and assign a severity. There isn’t currently a grading system that has enough evidentiary support behind it to accurate diagnose the severity. The most prevalent current diagnostic method relies on observation and self-reporting of symptoms by the concussed persons. As Professor Franck stated in his lecture, there are almost two million people every year that sustain traumatic brain injuries and that results in a steep $60 billion price tag. While athletes may be the most popularized victims of concussions, concussions can happen to anyone. Something like falling down the stairs or out of bed could cause more damage than initially thought. A lot of new research points to unforeseen future consequences from concussions, and if there is an accurate medical diagnosis of one it makes the symptoms easier to manage. Concussions are a broad injury that could happen to anyone, from the young to the elderly, and for that reason more research needs to be done so the magnitude of the effects can be understood. There’s a possibility that death or disability will result in an untreated, or ignored concussion. However, there are current methods to diagnose, and they range from very simple to technologically complex. There are computer aided analysis methods available, machine imaging to track biological changes, mental and physical tests, as well as just a simple observation from medical or trained professional about the mental and physical state of the concussed.

While there are some very broad spectrum ways to diagnose, some researchers look to the smallest of cells to predict concussions. In his lecture, Professor Christian Franck speaks about using computer-aided imaging as well as mechanical engineering to be able to see secondary injuries to the brain. These biological responses to the injuries are much harder to detect and need to use sophisticated software. Research found compression and tension of an impact will affect neurons and cause different proteins to be produced that indicate damage. The program searched to be able to develop predictive simulations for traumatic brain injuries using data found from the biological tests. These would be a computer model that predicts the outcome of injuries based on the impact and how much strain and stress it would cause the neurons. A database could be built and cross-referenced to help understand severity as well. This would allow for better diagnosis immediately after contact. If you can match a simulation that has

already been done with the impact on the person, there's a good chance you can get an accurate diagnosis with more technical evidence to back it up.

Machine imaging, usually to track biological changes, can also be used. There have been measured pathophysiological changes that the body undergoes after trauma to the brain. Markers like altered neural membrane conductivity, glucose metabolism, or a change in cerebral blood flow can all be traced. These changes aren't well understood now, and a lot of data comes from animal testing, but testing in human could be in the future. These would be tracked using medical imaging. While more well-known tests like MRI and CT scans can be helpful in identifying fractures or brain bleeds, they're not very useful in a concussion diagnosis. A different test called a functional MRI (fMRI) can be useful though. These tests can track magnetic differences in the blood based on how much oxygen is in them and use that to find differences in the cortical networks. fMRIs found differences between the cortical networks in concussed individuals versus their baseline. A quantitative EEG has been promoted as something that could detect changes in physiology post-concussion. This is a method you would need baseline data for beforehand, so you can compare post-concussion data to it. Researchers used Shannon-entropy of the peak frequency shifting to analyze the EEGs, and saw reduced values in multiple parts of the brain. The differences in the EEGs were gone by forty-five days' post-concussion. Technology like magnetoencephalography (MEG) could also be useful in mapping out the brain. Like the name implies this machine uses electrical impulse from neurons to track magnetic field changes to give us a picture. The MEG is less distorted by physical hindrances, like hair, so it can give better maps of the brain based on the electrical activity. The disadvantages to these methods would be that they're expensive and hard to utilize in a non-medical setting.

Mental baseline tests like the King-Devick tool (KD) are being widely utilized to assess concussions in schools and organized sports. This measures the speed of rapid number naming by having participants read off three numbered cards that look different as fast as they can. These trials are then timed and averaged out with errors accounted for. The Sport Concussion Assessment Tool (SCAT) is also a computer-based visual assessment that puts results on the post-concussive symptom scale. It is a combination of other methods and has no reliability reports done yet. The SCAT has both short and long term recall tests, and goes a little bit more in depth than a KD test. A more physical test is called a modified repeat high intensity endurance (RHIET) test. The RHIET found a statistically significant difference in KD scores before and after the test, indicating that the KD would be lower if taken right after an athlete was taken out of play to be tested. Even with that slight disadvantage, the KD successfully identified asymptomatic players that were still concussed. Researchers out of New Zealand ran a study in which they combined these three things to test in a rugby league. They had athletes being evaluated fill out a pre-assessment that consisted of a history of concussions, a post-concussive symptom scale baseline as well as two KD trials, with the fasting one being the score that

counted for the baseline. Part of the study needed a medical clearance to return to play, something that is very important for recovery. The successful results of the study are promising in league sports. The disadvantage is that it might only be applicable in league sports, as baseline tests are needed to be able to compare post-concussion data. However, this would allow diagnoses right after the incident. That way care can be started as soon as possible so the concussion won't increase in severity.

Finally, there are the simple methods that are currently in use. While they can be used to diagnose a concussion, they are not completely accurate as some concussions are asymptomatic. Starting with being able to identify a concussive impact is the most important. The first part of every method reviewed was noticing there was a potential for a concussion in the first place. For athletes, that means coaches watching for whiplash movements or head impact; for non-athletes that could mean knowing when you hit your head. There is also the possibility of an impact not to the head causing concussive symptoms. Loss of consciousness is the most widely-known symptom, but there are lots of others as well. One thing most of the studies agreed on was that a loss of consciousness isn't necessary to have a concussion. Physical signs also include balance issues and moving slower than usual. Self-reporting symptoms can also be useful. There is a higher chance of concussion if one has already been sustained, as well as longer recovery times if another concussion develops. Even mild symptoms can reveal a deeper injury, so anything that is uncharacteristic, like being more tired than usual, sensitive to light and sound, or being more distracted could be signs of concussion. It's also important to recognize that each concussion needs to be assessed on a case by case basis. Two concussions, even within the same person, aren't guaranteed to show the same symptoms, so anything out of the ordinary needs to be taken into account. This means that with these methods, there needs to be a hypervigilance taken in recognizing symptoms. Even if someone might have just not slept enough, or be under stress, if there was a force to the head or body then there could be injury.

Through a review of available literature, it appears as though we are getting closer to being able to accurately diagnose concussions. At this point, the researchers out of the Sports Performance Research Institute New Zealand have what appears to be the best results for immediate diagnosis. A combination of the techniques, both simple and a little more complex are going to be the best option. While complex technology can be helpful in researchers understanding and find data to help more accurately diagnose concussions, it's not a realistic diagnostic method to use in a helpful timeframe. In future research, they might want to look into more accessible technology too to diagnose these in a better location, like right on the field. Trying to tough something out is very common among athletes, and being able to diagnose in real time could prevent people from trying to keep going at the risk of injuring themselves more. There needs to be more research done into the consequences of concussions especially. There is such a large impact from traumatic brain injuries, with symptoms that could last years, and

permanent changes to the brain and behavior. As currently seen in a lot of professional football players, concussions can have long-lasting effects that are completely detrimental to someone's mental and physical health. Youth run a greater risk for a concussion, and this is even more harmful considering their brains are still developing. As youth sports become more popular and more competitive, there needs to be data on the risk that these children are at later in life.