You know I think the office based evaluation has come a long way, I really believe strongly that there is not many concussions that we can’t figure out. If you ask the right question, do the right exam, look at the right – understand how to interpret neurocognitive testing, very importantly, and understanding you know vestibular-ocular function and how we look at that, when you put that all together we can come up with very coherent treatment pathways and trajectories. And that’s what I’d like my lecture to focus on today is how we do this in an office based setting.

I do want to disclose the fact that I am a codeveloper and Board Member of ImPACT. There are many other good computer based neurocognitive tools out there and obviously you all need to review that, use the best tool for your setup that fits you.

The goals of my lecture again I want to discuss really first start off by talking about how it takes a village to manage this injury and talk about the different components of expertise you need to have as referral sources, and how we have a community of different experts in understanding how to evaluate and treat this injury. I want to discuss the role, again of the clinical interview, vestibular ocular screening, and computer based neurocognitive testing and how we put this all together into a coherent way of understanding injury. For the first time really starting to discuss this concept of targeting pathways. I want to discuss really how we’re starting to look at different subtypes of concussion, and then based on those subtypes come up with different treatment and rehab approaches. And that’s a lot of what these next 2 days are going to be about by the way.
And I want to start off by presenting a case study. This is a typical case that I see on a regular basis, well maybe not in a professional athlete but I’m going to show a professional athlete here and this is the kind of stuff we see in clinic all the time. Start off with a case, and introduce the case and talk about how we do our evaluation and come back to the case at the end of the presentation. But here we go. So a 27 year old professional baseball player, he has had 4 concussions in his past in 2003, he was beaned by a fastball, reportedly had symptoms for 7 days, went back to play. In 2005, again hit in the head with a fastball in his helmet, symptomatic for 5 days then returned to play. In 2008 foul tip off the bat, facemask he’s a catcher. He had symptoms for 15 days, then returned to play. Then in 2010 he took a foul into the facemask while catching, had symptoms for about 30 days and then went back to play. And interestingly in 2011 this individual had these idiopathic symptoms where he’d get a foul tip to the facemask and reported some vision change, reported some slowing, reported some fogginess, feeling detached. They didn’t know what it was, they didn’t even think about concussion because that had been cleared the year before. But after these events in 2011 his batting average would drop over the course of 2-3 weeks and he’d not do very well performance wise, and also had these symptoms. So he went to an ophthalmologist who found no structural problems and basically he just played the entire 2011 season with these, you know in hindsight, concussion symptoms but it was never recognized or dealt with. I should say this athlete had a history of motion sickness, car sickness, I’ll talk about that. No other medical or psychiatric history, academically he was drafted at the age of 16 out of Venezuela so there’s not much academic history but he did have a history, or no history of learning disability or ADD and was generally a good student. He had a concussion on March 11, 2012. I’m going to get back to this case later on. When
he comes and sees us in Pittsburgh, what okay I’m sorry. So on March 11th, talking about the injury he had in 2012, he took a foul tip to the facemask, it was a linear blow, again had symptoms much like he had in 2011 where he’s dizzy, bilateral blurred vision, went to the emergency room, the CT scan was normal. He rested for 3 weeks, with really very little improvement and then he was sent to us about three and a half weeks after he was taken out of play and was just essentially resting.

So when he comes to see us in Pittsburgh, I want to talk about sort of our model of care and how we approach this injury. First of all I can tell you that we’re starting to get, we’re doing a lot in terms of how we assess concussion and computer based neurocognitive testing is a piece of it, it’s not the entire picture. Obviously when we evaluate this injury we want to focus in terms of our thinking a neurocognitive function which is critical but is a piece of it. We also use exertion obviously as a way of understanding this injury and we do that systematically, you’ll be learning much more about that. We focus on symptoms, not only do they have symptoms, don’t they have symptoms, but how do these symptoms fit together. And most importantly where, based upon the symptoms we can start to figure out where the aberrant signal is coming from, what system of the brain is not working properly to produce the symptoms that we’re asking about, and how to those symptoms fit together.

We’ve now been focusing a lot as well on looking at ocular motor functioning as well as vestibular functioning. And quite frankly I think we’re at a point here where we can really put this stuff together and we’re starting to really understand recovery looks a little different when we started using all these different aspects of assessing this injury. Our model at UPMC is as follows. The
neuropsychologists are the gate keepers. We’re the clinicians in the office, we’re seeing these patients, we get referrals from emergency rooms, pediatric practices, certified- we have 83 athletic trainers thank goodness at UPMC, we could not be doing this without athletic training, they’re, throughout you know we get referrals from them obviously, primary care physicians. They come to us but we have a whole treatment team here. Primary care in sports medicine Dr. Kelly Anderson and Dr. Dave Stone are on our staff, PM&R we have medication experts. All these folks do medication stuff. Vestibular and physical therapy has become a huge component of our program. If we sense a vestibular/ocular dysfunction we’re going to send them for treatment with our vestibular people after a period of time, after we understand if it’s not getting better, we’re going to start treatment in that respect. Neuro-radiology you’ll hear from Dr. David Conklin tomorrow he talks about what we’re doing imaging wise. If there’s any other comorbid conditions, Dr. Maroon. Obviously neck stuff we have orthopaedic neurosurgery involved. And another component that’s very important that many of you may not realize is behavioral neuro-optometry. A lot of work we’re now doing with the ocular system and when we see binocular vision dysfunction that doesn’t get better we’re treating it in a very active way with vision therapy. So that is our model. We see 18,000 cases a year here. And quite honestly you know this injury, I know we’re a referral center so we see patients that come you know that are not doing well, but we find that these treatments that we’re talking about here are not uncommonly needed. Not everyone gets better really quickly with this injury. I feel strongly that we need to strive for this model across the country and it doesn’t need to be neuropsychology here. Primary care, PM&R, neurology, I don’t care who you are but if you’re the expert, no on owns concussion. Neurology doesn’t own it, neuropsychology doesn’t own it,
PM&R doesn’t own it, it’s the smartest person in the room, the one that has been meaning in terms of their training, they’ve been trained on this, all these folks that are here, we have so many different disciplines. I agree with Dr. Lowe that we can’t be in fighting across disciplines with this injury. We need concussion centers of excellence and honestly you know we have Bill Beane in Boston in primary care doing this stuff. PM&R is phenomenally talented with this injury, neurology, etc., etc. But you know this is the model that I think we should be striving for in every community. Will we get there or not, I don’t know but I do think it takes, again it takes a village really to manage this injury.

When I see a patient in clinic, I’m going to be focusing on three very general things. I’m going to talk to the patient for a long period of time to start to understand what symptoms they’re having, what risk factors they have, what they bring to the table, how these symptoms fit together. I’m going to be, we’ve come up now with a new 2-3 minute vestibular/ocular screening examination that I’m going to show you here in a few minutes. Really looking at the vestibular/ocular system in a pretty rudimentary way and understanding if there’s turbulence coming from those systems and if there is we may follow up for a little while see if it gets better. And if it doesn’t get better, get them into vestibular treatment and rehab. We will also obviously look at computer based neurocognitive testing, we find that to be critical in terms of our evaluation and understanding of this injury. But it’s one piece of the information we gather. When we gather all this information in the office we’re going to, as you’ll see, we know who’s not going to do well prognostically we’ve had a lot of evidence now knowing the specific cut off scores of testing predicts a month or longer recover with a
higher grade of sensitivity. We understand that certain deficits in the testing can predict poor outcomes. We understand that certain symptoms predict poor outcomes. We’re going to discuss whether the patient needs to be referred for further treatment, what type of level of physical exertion can the patient do, what should be done in school academically, what kinds of accommodations may these kids need. And obviously for every patient we see we’re determining can they or can they not go back to play. And those are the questions that we’ll be, that we address in our evaluation.

Now I want to talk about these 3 different components and break them down a little bit. But let’s talk about the clinical interview. I can’t do it justice in the 7 minutes or so I’m going to present on this, it’s a lot of, this is a 3 hour lecture in terms of how we actually talk to the patient and ask about symptoms, etc. What I wanted to do first is show you some research that we’ve published, just came out, looking at a factor analysis of concussion. This is a study of nearly 1500 kids with concussion and we did a factor analysis looking at how this injury breaks down within the first week post trauma. Okay, and Dr. Kontos was the lead author on this and what we’re finding is that in the first week after concussion in a very large sample of kids, what we’re finding is that this injury really falls into 3 distinct, you know 3 categories; cognitive dysfunction, migraine dysfunction and vestibular symptomatology. And you can see we have a soup that sticks together very well when you look at how this breaks down in terms of factoring in analytic work. We also have some secondary factors of mood issues, sleep problems and somatic concerns, but the primary factor is here, the cognitive, migraine, vestibular stuff and it’s all this combination of symptoms. We’re doing follow up research right now and looking at these patients 2, 3, 4 weeks out from injury and
what we’re starting to see in our research is that all of the sudden you start seeing the cognitive stuff separate out; the migraine stuff separates, the vestibular stuff separates out, ocular stuff separating out. And as the injury evolves we start seeing these distinct sort of profiles of symptoms that stick together. But during the first week you really have to be mindful that this is the type of stuff we’re primarily seeing; concentration issues, slowed down, drowsy, fatigue, headache, light noise sensitivity, dizziness, feeling detached, feeling one step behind yourself and I’m going to show you how important this symptom is in predicting poor outcome and where it’s coming from, difficulty remembering. So that’s really the sort of the meat of the injury at least in that first week. In follow up we’re starting to see these different sort of trajectories for these patients.

We’ve also done a lot of research and I think everyone of you in this room has seen this slide. This is a prospective study we did a long time ago now, where we looked at 2,000 high school kids, we followed them all across 3 years of studying and we followed 17 high school football teams and everyone that was diagnosed with concussion was taken out of play and they didn’t go back to playing until they were symptom free at rest, symptom free with exertion and demonstrated in tact neurocognitive functioning relative to baseline. And this study showed that when you look at individual recovery from concussion in football players, high school kids, we get about you know 40% of our high school population is recovering within a week, about 60% by week two and about 80% by week three. And then 1 in 5 athletes take longer than 3 weeks to recover, so when I hear, I’m hearing a lot of people now talking about how and I even heard it this morning, that you know 90% of patients, you know 1out of 10, 1 out of 12, 1 out of 14 are taking longer than a week or ten
days to recover, I scratch my head when I hear that. Because that’s not what we’re seeing in clinic and it’s not what we’re seeing in the data, at least our data. We’re finding recovery is taking a little bit longer than what we initially thought and this study we started in 2003 if we added in some of this vestibular/ocular stuff we’re talking about in addition to the computer based neurocognitive testing, I don’t know. I think we’d need to do a follow up study really looking at this because I think all of you in this room that see patients daily would understand that when you ask the right questions and look at the right things, maybe there’s a little more going on. And I think we need to be very careful with it. But when you look at a good, control study, I think the bottom line is here is that at least 1 in 5 kids are taking more than 3 weeks to recover from this injury, at least 1 in 5. The next question we want to ask after we did this study is who are those kids. Who are these, this 20% of the population that’s taking more than 3 weeks to recover. And we’ve done a lot of research on that topic and here it is.

So I want to share with you in the next few minutes about what sings and symptoms within a few days of injury are predicting these kids again, that are taking you know the 20% that aren’t recovering in an expeditious manner. So let’s look at some of the studies we’ve done. First of all, what on field signs and symptoms predict poor outcome. Well this is a study that was published last year and what we did, is we looked a 176, these are male high school football players, low hanging fruit I know, we have to replicate this in females, but this is the first time anyone had done this, but we looked at 176 male high school football players that had a concussion. All underwent baseline neurocognitive testing, we followed them until they recovered and long story short, in this sample
32% of the sample actually got better within 7 days of injury. Okay and that’s about what we saw in that other study I just showed you. About 17% of the sample took more than 21 days again, what we’re seeing in prior research. On average the kids that took longer than 21 days to recover, which was 17% of the sample, they took about 33.2 days to recover from the injury. We had 39% of the sample that fell somewhere between the 1 and 3 week group and we lost all 12% to follow up. We then did a MANOVA multivariate analysis of variance looking at what signs and symptoms on the field best predicted those kids that took more than 3 weeks to recover. We looked at 14 different things. For terms of signs we looked at loss of consciousness, all of them lost consciousness for less than 30 seconds, retrograde amnesia, post traumatic amnesia, confusion. In terms of on field symptoms we looked at dizziness, headache, light sensitivity, noise sensitivity, nausea, personality change, balance problems, etc., etc., etc. And what we did, we found interestingly when we look at this data and we look at a pretty well controlled study here in terms of what signs or symptoms predicted poor outcome, low and behold there was only one on field sign or symptom that predicted someone to take more than 3 weeks to recover. And what we found was that on field dizziness was the only sign or symptom that predicted someone to take 3 or more weeks to recover. In fact if you’ve had on field subjective dizziness, you said you were dizzy, you were 6.4 times more likely to take that month or longer to recover, okay. And interestingly when you look at loss of consciousness that was actually protective, if you lost consciousness for less than 30 seconds you were more likely to fall in that 1 week recovery group. If you had on field vomiting you were more likely to fall in that 1 week recovery group. So interestingly the signs of injury, what you see outwardly in a person best predicted someone that took shorter time to recover. The on field symptoms, in other words
what the patient is feeling, primarily dizziness, predicted patients that took longer to recover. Very interesting stuff and this corroborates a lot of our prior research showing that at least brief loss of consciousness is not predicting outcomes very well when you look at a pretty well control research.

But what is it about the dizziness construct that where is that coming from and I want to continue you know stay tuned to this story. We’ve also done work looking at what symptoms in 3 days post injury predict poor outcome and we did the exact same methodology in a different cohort of kids, I’m going to save you the details but what we found if we look at symptoms at 3 days post injury, so dizziness on the field predicts poor outcome. When we look at, when we see the patient in the office in 3 days what signs and symptoms predict poor outcome we found that if you have in office fogginess at 3 days post injury that is the symptom that best predicts someone to take more than a month to recover from concussion. For many years I asked myself what is fogginess? You know when I’ve thought about it as sleep issue for awhile, we didn’t know exactly, what is fogginess anyway? You know it’s such a fuzzy construct no pun intended. Fogginess to me means like your high definition TV is like a standard definition TV, you feel one step behind yourself, you feel detached, you feel sort of disjointed, outside of yourself, you know you almost feel hung over. That’s, how many of you in this room have had a concussion? How many of you unequivocally felt that symptom? What we’re learning through our work with Ann Mucha and our vestibular folks is that symptom is coming from central vestibular dysfunction. It’s coming from inability of the vestibular system to coherently put that signal together when you’re walking down a busy hallway, when you’re in a busy room, when you’re surrounded by a bunch of people, when you have a lot of
space/motion/movement. And when that signal comes through aberrantly through the vestibular system it doesn’t come through cleanly and there’s this energy crisis that Bill talked about, it comes through in the sensation of feeling detached, feeling outside of yourself. And what we’re also learning is that when you have that symptom, we often see emotional changes as well, a lot of anxiety in these patients. We’re going to talk a lot, we’ll set the stage now and I’ll talk a lot more about this as we proceed. But fogginess to me is a very important symptom not only in our research but when I see these patients clinically. Interestingly that difficulty concentrating is the next symptom that best predicts poor outcome. If you vomit at 3 days you could have a worse outcome than if you vomited on the field, I think that makes sense to people. Dizziness still carries a lot of variance here at 3 days as well, nausea, headache. What’s interesting about this data is that every one of these symptoms are all either the physical, cognitive, migraine type symptoms as well. So when you have in office, these are all large effect sizes by the way- so any of these symptoms would predict at 3 days post injury, someone that’s going to probably have a more difficult time recovering.

We have a new paper coming out this month looking at the role of migraine symptoms in predicting poor outcome. For this study what we did is we looked at about 200 kids with concussion and then we looked at within 3 days of injury, 3 different groups: athletes that had a headache that met international headache society guidelines for migraines so within 3 days of concussion they’re having a headache with nausea and or light or noise sensitivity. We looked at that group versus a group of patients that had a concussion and had a headache without the migraine symptoms and then we looked at a group of patients that had no headache at all within 3 days of the concussion. And
what we did is we looked to see if patients who have a headache with the migraine symptoms differ in terms of their outcome versus those with headache alone, versus those with no headache at all. And what we found is that if within 3 days of a concussion you have the headache that you had, you fit the criteria for the post traumatic migraine symptom group, if you have that, that group when you compare them to patients with no headache at 3 days post injury you’re 7.2 times more likely to take more than 3 weeks to recover from concussion. Interestingly if you have a headache with the migraine symptoms compared to the headache only group you were 2.5 times more likely to take 3 or more weeks to recover. So in other words when you evaluate these patients in an office, if you have a patient that had on field dizziness, in office fogginess, and they had a headache with nausea and or light or noise sensitivity, I mean all of those variables in and of themselves predict with a high degree of likelihood that recovery is going to take longer. You put that all together, and you can rest assured that these patients are probably going to have a hard time recovering from the injury.

We also followed that up with a neurocognitive study where we looked at these different groups and the athletes with post traumatic migraine type symptoms, here is their ImPACT data at baseline, and what we find is the athletes with the migraine symptoms post injury here they are at baseline you can see at 14 days post injury they’re not even sniffing baseline. Whereas the groups that have headache only are back to baseline as well as the athletes with no headache at all. In other words, again, it’s more than just a headache. You have to understand that when you have these migrainous type symptoms the recovery is going to be a little longer and more complicated.
We’ve published a lot of other work looking at recovery and what constitutional risk factors predict poor outcome. And all of you are familiar with the work that’s been done looking at adolescent athletes and we’ve found that if you’re a teenager you’re going to take longer time to recover than you are at the college level versus professional level. Quite honestly I’m shocked when I work with professional athletes, most of the time, you know I had to adjust my thinking, I mean these guys do recover quicker. They just do, they’re different, they’re different animals literally, figuratively. And these guys there’s something different about them, you know, I just am shocked time and time again when I work with them how quickly a lot of these guys become symptom free whereas high school kids just don’t, they just take longer. They’re more complicated and I think there’s a lot of discussion topics on that. But again the migraine stuff predicts poor outcome for sure, we’ve published several studies on that. If you have a history of learning disability your outcomes are going to be more difficult. Repetitive concussion, I think the jury’s open on that. I think as Bill talked about a well managed concussion is the best form of prevention and I don’t think the literature is clear at all that if you have one prior concussion you’re more likely to have worse outcome. When you look at all the breadth of research that’s out there, there’s no research that’s done a good prospective study looking at how were these injuries managed, were they symptom free before they had a second injury. And I think it’s too complex to say, anytime I hear someone say we’ve had a long concussion here, 6.2 times more likely to get another, I think that’s, I really don’t really believe that. In poorly managed injuries perhaps but we really need to do a better study looking at this prospectively over time to see if we manage this effectively and get them totally symptom free, do we have better outcomes, I believe so. I don’t think you’re necessarily at more risk. And there’s an
evolving literature here looking at females and we’ve done research looking at soccer male vs. females and we found that females have a little more difficult time recovering perhaps you know the female gender may be a risk factor as well. We do know that migraine is a huge risk factor and girls are 4-6 more times likely to have a migraine than boys and for us at UPMC we think migraine’s the elephant in the room when we see these patients if you have any migraine proclivities these patients do take a little longer to recover and maybe that’s why girls are a little more complicated. Or maybe they’re just different right? I have 4 daughters and you know I can tell you that girls are different.

But the next component of our evaluation is our vestibular/ocular screening. And I wanted to talk about this a little bit and it’s something that’s really adding to my clinical abilities and understanding the vestibular/ocular systems. But let’s talk about why we care about these systems. Why we care about these systems is because when they’re not working well a lot of what you feel is a lot of what we’re seeing in terms of predicting poor outcome of recovery, quite interestingly. Vestibular therapists for a long time had known that the vestibular system goes way beyond balance, well beyond balance, and I think just focusing on balance in and of itself is a mistake. You know we see balance deficits early on with this population it’s been well studied by Kevin and others, but the real noise of this system may be coming in different aspects of the vestibular system and not necessarily through balance in and of itself. But when the vestibular system or the ocular system is not working properly patients will get dizzy, you’ll feel unattached, you’ll feel one step behind yourself, you’ll be sensitive to motion and movement, you’ll be sensitive to busy environments. What we’ve really found in a very powerful way is that patients will have, it’s like the anxiety genie comes out of the
bottle in patients who end up with vestibular dysfunction. They avoid busy places, they avoid going into that busy hallway at school, they’ll avoid the cafeteria. A lot of kids don’t even want to go to school and I don’t blame them in some respect because it doesn’t feel good. You get tired, you get foggy, you get headache you just don’t feel right, you feel off. And if you think about the ocular system as well, and we’re seeing a lot of problems with the ocular issues with ocular system with concussion, with that system injured we’ll often see a lot of tiredness and fatigue, difficulty focusing, blurred vision, and primarily problems math and reading. How many of you have seen patients in your office and they say you know what I feel better but the only thing I can’t really do is math really well? How many of you have ever heard that from your patients? Everyone in the room and that may be one of the last systems that gets better from this injury and if you know there’s problems there you may need to treat it and I’m going to talk about how we treat that tomorrow. And then you have impaired balance. So if you’re not focusing on this stuff, I think you’re missing a lot of the variance of this injury and these are the kinds of questions you should be asking of your patients. And if you do the right evaluation, you can start to uncover some of these problems. So let’s talk about our evaluation. Before doing that, I want to make sure everyone in this room understands that I am not talking about the inner ear necessarily when I’m talking about vestibular dysfunction. I’m talking about central projections in the brain that cover, it’s a labyrinth system, it’s a very complex system. But I think a lot of people mistake when they hear vestibular they think of your ear. That is a component of the vestibular system but as I talked with (inaudible) last night most of our dysfunction from this injury is more centrally mediated, it’s not coming from the ear, it’s coming more from the brain. And as we learn more and more about this, you’ll see that there are some
projections there that I think we need to study a little more carefully and we’re doing that within imaging and correlating our vestibular/ocular impairments with imaging and we’ll talk a little about that tomorrow.

Okay, I’m not smart enough to know how to do a detailed 45 minute vestibular evaluation or an ocular evaluation. But you know Ann Mucha and our vestibular team has allowed me to better understand how to examine this system with a pretty basic, cursory examination. When I sit down and talk to the patient and I start understanding these symptoms and hearing what they’re experiencing, I start to think to myself, okay if the patient is having a hard time with note taking in class, maybe there’s something going on with his vertigo gaze stability or maybe it’s an ocular issue. If they’re getting dizzy when they’re walking down a busy hallway maybe it’s more of a horizontal gaze stability issue, etc., etc. I’m going to talk about, we’ve created this exam, it’s being validated currently where we look at, this takes about 2 minutes to complete, we’re looking at smooth pursuits, we’re looking at saccadic eye movements in horizontal and vertical plains, we’re looking at VOR gaze stability in horizontal and vertical plains, and what we call a response optokinetic stimulation. We’re also looking at near point of convergence and we measure that 3 times as well as near point of accommodation. And let me show you that exam, so if you could play the video. Here’s a girl—before playing it actually sorry—this is a girl that we had seen, I just saw her this week. She had come to Pittsburgh about 2 months ago and she had a year or 2 years of problem with concussion, having significant issues, we got her into vestibular therapy and she improved almost immediately. She was still having some very subtle problems with vestibular system, very subtle. But I wanted to
show you our basic exam that we do with these patients, if you can play the video. So the first thing we’re going to look at there is just simple pursuits called the H test and what we’re looking for here is if there’s any signs of nystagmus, they’re not able to follow, everyone is normal. I mean most folks obviously are not going to have any problems with that. Now what we’re going to do is hold out our fingers a ways away from the patient out of the convergence area and have them do saccadic eye movements in horizontal direction for about 15 seconds. They should be able to land on the target with no hyper metric saccades and most importantly they shouldn’t get symptoms with this. And now we’re going to look at the vertical saccades. And again we’re looking not only whether they’re able to do the task but also how provocative it is in terms of symptoms. Now this is more vestibular stuff here, we’re going to be looking at this horizontal gaze stability that keeps her eye on the target, moves her head about 45 degrees each way. We want to see if there’s any, if this system doesn’t resolve immediately you’ve got to, there’s some abnormalities there. We are going to look at this in both horizontal and vertical plain again about 15 seconds and you’ll be amazed at how many patients that come in and say they’re symptom free and do this and it’s like they’re having all these problems. And if we figure out where that symptom is coming from we now ran an exertion plan on this patient to figure out how to exert them also academic accommodations, etc. This is optic kinetic sensitivity where we got our eyes on a target moving it about 180 degrees, she should be, and you should, you’ll see the eyes jump in the patients that don’t do well with this and they’ll also get stirred up very significantly with this.
And now we’re going to look at what’s called near point of convergence, it’s where we have a dot on a stick, I can thank Charles Shearer who’s in the audience for this stick, thank you Charlie. But here’s the dot that we look at, the patient looks at and what we’re looking at here is at what point does she get diplopia. And she should be no more than 6 centimeters from the tip of the nose to where she sees two. And we want to look at recovery of that as well. We actually measure that on the tape measure, that should be less than 6 centimeters in every patient that we see. Now we’re looking at near point accommodation which is more of a lens issue, but what we want to do here is just make sure that she can see a target clearly until about 15 centimeters or less for both eyes. Again that’s from the tip of the nose and you want to see equally distance points of where that target gets blurry. If you have a big difference between the left and right eye, there may be some post traumatic accommodation issues. We figure out where that signal is coming from and then we can create individualized academic accommodations, individualized exertion plans to get through a vestibular problem, the only way you recover from a vestibular problem is to expose and recover. I do not believe in putting kids in a dark room with this injury. I believe in actively treating it and when you look at the neurocognitive testing and you look at the vestibular/ocular screening and you understand the symptoms and how they all fit together with the information that you gathered, you can create a program that doesn’t over expose the patient because that will make them worse, but you also don’t want to under expose the patient. You want to expose, recover. Early on with concussion if I have a patient who comes in with these risk factors, you know, really bad ImPACT data, on field dizziness, foggy, migraine stuff, I am going to sort of let this settle down for a few
days. But there’s very, very few patients I am going to be telling to do nothing to after the first few days of the injury, much more active ways of doing it.

We are coming out with a study looking at prevalence of this vestibular ocular dysfunction in a sample of patients and here is a study, 78 consecutively screened patients with concussion, mean age of 14.93 years, the mean days from injury in these 78 patients was about a week and remember we are taking all comers here, these aren’t selected patients that are sick, these patients are coming to our triage program and being seem pretty quickly and when you look at whether these tasks produce symptoms in patients 90% of these kids are having symptoms when they are doing vertical or horizontal saccadic eye movements within 7 days of a concussion. The convergency insufficiency 53% of these patients are abnormal that are greater than 6 cm. Optokinetic sensitivity 58%, there is something going wrong with these systems if you really know how to look at it. And when you couple that with the rest of the data you start to understand this stuff a little better, this is not uncommon. And again that’s why I scratch my head when I hear oh everyone should get better within you know a week of injury, it’s just not what we are seeing.

When we talk about computer based neurocognitive testing I’m going to leave a lot of the psychometrics or all psychometrics to Phil Schatz, there is going to be a very good discussion on psychometric abilities and neurocognitive testing in the next half hour. What I want to do is present to you, because Phil doesn’t have enough time I’m going to steal his thunder and talk about a study
he just published looking at sensitivity specificity of computer based neurocognitive testing that just came out. And I also want to talk about how we could use this data prognostically.

So this is a study that was just published where a large – it’s probably the best study done where a very well controlled control sample was utilized. So here is a study, it came out of the American Journal of Sports Medicine where 162 athletes were examined, 81 of whom have had a concussion and were seen within 3 days of their injury. Phil then carefully matched 81 controls and they were matched very specifically on the basis of gender, sports concussion history and absence of learning disability or ADD. Neurocognitive testing was done within 3 days of injury and then Phil did an analysis looking at what the sensitivity specificity was, so how many of these you know – sensitivity obviously is defined as if you have a concussion you are abnormal and specificity is if you don’t have a concussion you are normal right?

And what Phil found in this research if you look at the sub scores on ImPACT is that 91.4% of the population that are concussed are abnormal on the testing and the specificity, so it means if you are a control you are not concussed 70% of the time your test is going to be normal. And so those numbers match you know 5 or 10 other studies out there looking at the sensitivity specificity not only of ImPACT but other neurocognitive tests as well is that there is a high degree of you know a pretty good – look we have no blood tests, we have no marker, there is no perfect tool to measure concussion. I would argue that if you are using ImPACT or neurocognitive testing in isolation you
are really making a mistake. It needs to be supplemented with a lot of other things. But when you just look at the neurocognitive testing it’s fairly sensitive and specific.

Now the most important part of this study done by Phil was that at the second part of the study is he looked at 74 athletes that were diagnosed with concussion, 37 were diagnosed with concussion but within 3 days they had a symptom score of 0. So they were all documented by athletic trainers and physicians to have had a concussion in the field, they come into the office or wherever they were seen within 3 days of concussion and in 3 days they had a symptom score of a big fat 0, so they were denying any problems. Phil then matched 37 controls to this group who were concussed but asymptomatic group versus athletes that don’t have a concussion and when you do a discriminate function analysis with that group what he found is that there was a 94.6% sensitivity. So even though these patients were denying symptoms they were abnormal in neurocognitive testing. And the specificity so if you are a control patient and you didn’t have a concussion the test was normal 97.3% of the time. So in other words even in patients that are not reporting symptoms the data is abnormal. And this is Phil’s statement in this discussion and he can share more with you on this issue in the next talk. Also importantly we’ve now established cutoff scores on neurocognitive testing that with a very high degree of sensitivity can determine who is going to take a month or longer to recover from concussion.

This is a study that just came out in 2012. To save you the boring details if on neurocognitive testing we’ve established that if you have a verbal memory score of less than 60.5 within a week of
IN OFFICE EVALUATION OF SPORTS CONCUSSION: CLINICAL INTERVIEW, COMPUTERIZED NEUROCOGNITIVE TESTING, VESTIBULAR-OCULAR SCREENING, MICHAEL COLLINS, PhD

injury or actually 5 days of injury, 2 days I’m sorry, 2 days of injury there is an 85% sensitivity that recovery is going to take on average 3 to 4 weeks or longer, so if you have a score of less than 44.5 on visual memory, less than 22.5 on processing speed, greater than .86 for reaction time. So if you have an athlete that comes into your office here, this is an NFL player that was seen this year, so he’s got a symptom score of 14, you see how he’s got a score of .84 in reaction time, well there’s an 80% sensitivity recovery taking more than a month even though this guy is telling you he’s got a symptoms score of 14. And in this athlete he ended up taking 6 months to recover from his injury.

So what I’m trying to paint a picture of is who are these kids that don’t do well after concussion? And what the research is showing is that there is pretty coherent understanding of that. Another study by Iverson showed that if you have 3 or more RCI changes on neurocognitive testing relative to baseline has a 94.6% change to recover that will require more than 10 days. And symptom score did not improve classification nor did it predict outcome either. So if you have 4 scores that are low on ImPACT there is again a 90 whatever it is, 94% chance that recovery is going to take more than 10 days. This is important information.

So if John Norwig sends me a patient with the Steelers and there is 4 scores that are involved and the patient had on field dizziness, 3 days later he’s having fogginess, he’s got a history of migraine, he’s got a light sensitivity, nose sensitivity, nausea and his data looked like that guess what I’m telling John there’s no way in hell this guy is going back to playing in a week. That’s important information to understand as a clinician trying to educate parents, trying to educate coaches, trying to educate the
kid with a very tacit hard to describe injury that there is a lot of problems going on. But what it also does is it starts to point to different systems in the brain that you need to look at carefully. And when you look at the found data here what we are finding is that outcomes from concussion are highly variable. The vestibular related symptoms of dizziness and fogginess does predict more protracted recoveries. Migraine test symptoms or a preexisting history of migraines seemingly place patients at increased risk of injury, we are finding anecdotally, we need to prove this in research but patients that have history of migraine less force is causing these injuries to happen. I’d love to see Kevin look at that and maybe he has – he can speak to it, but that’s an issue that we see. How many of you see that a lot in clinic, patients with migraine, you know a stiff breeze will take them down you know, something that we see commonly. We know that adolescents are different, girls may be different. I feel strongly that preventing poor outcomes is all dependent on clinical management and really because of this data that we showed you the mild injuries become severe, and the severe injuries become mild. And kids that look like you know like one takes a knee and loses consciousness you know these kids sometimes get better very quickly and the kids that have fogginess, whatever the hell that is, end up taking forever to recover. You know so it’s a very tacit hard to describe injury, you’ve got to ask the right questions, look at the right things in your evaluation.

What I want to talk about for the rest of the – for my section of this conference is really starting to talk about these different clinical trajectories. We find – I agree with Kevin that concussions are like snowflakes, everyone is different. But maybe there are 6 different types of snowflakes or more,
okay. But we are starting to see that there is different snowflakes and that there is different symptoms for each snowflake, there is different ways of looking at that snowflake, there is different assessment procedures you need to make with that snowflake, there is different treatment and rehab with that as well. And no wonder the research of this injury is a little confusing because concussion is not a homogeneous injury, it is heterogeneic and everyone is different that we see. But what we are starting to feel with this injury is that some patients fall into this category, some patients fall into this, some patients fall on this, some patients fall on that, that and that. Sometimes you have that and that and that going on, sometimes you’ve got all 6 going on, sometimes you just have that going on but nothing else.

When I have that going on I exert the heck out of these patients and they don’t have any problems, they don’t feel problems because their vestibular system isn’t affected. It’s an ocular thing, not a vestibular thing. If I have that going on I am very careful with rehabbing that system before I get patients active physically. If I have that going on without that and that going on, I am going to make sure they are exercising because if you are not exercising you are getting migraine, okay. So everyone is different in how we approach and what we feel strongly is this seems to be the money slide for our conference is that, and it really fits with Mark’s comments earlier that we have certain risk factors that people bring to the table. Ocular, you know history of strabismus, lazy eye, history of car sickness, age, sex, learning disability, migraine, previous concussions. You get a concussion you get these different permutations of the injury but we need to actively treat the rehabilitation, rehabilitate those different permutations of the injury. And you have to understand how to look at
these different areas. And what we are now doing is taking this information to David (inaudible) in Imaging and start to see different imaging findings with these different modalities and different trajectories. We are trying to put this all together.

So getting back to our major league baseball player, I saw him 3 ½ weeks after the injury, his symptoms were horrible, he was having you know gross headaches, fatigue, a lot of anxieties, sleep problems, he had a Near Point Conversion to 27 cm, no one had even looked at that. He had significant provocation the minute I had him move his head in a horizontal or vertical direction and look at his thumb it reproduced the symptoms he was experiencing. He became more emotional, very anxious with that information as well, a lot of optokinetic sensitivity. We did exert him with Kerry Troutman, our exertion specialist and she found that he couldn’t tolerate a stationary bike for more than 15 minutes and it wasn’t because of his heart rate, it was because there was a lot of people in the gym. So we had to put in a quiet gym, he got on a bike, he was fine. A lot of times this isn’t a heart rate issue guys, it’s more of a motion, movement issue and what’s around you. We then did neurocognitive testing and he had a really hard time. I’ll show you that data.

Long story short is on April 4th we recommended all these different therapies, none of which he had gone through. Targeted vestibular therapy, we started vision therapy with Dr. Steinhoff and you’ll hear about that tomorrow. We did exertional therapy with Cara. We get these patients active. We are going to start moving them. We prescribe medications. You are going to hear about that from
Dr. Anderson. We used Amantadine, he had huge sleep problems with Ambien. He had a lot of space and motion discomfort, a lot of anxiety so we put him on low dose Klonopin.

And then we followed him over time and long story short is this is where he was when I saw him on April 26th, 3 ½ weeks after his injury you can see the functioning is very severely down according to the neurocognitive testing. You know this score right here predicts a month or longer of recovery you know in patients, so from that point on we knew it was going to be a long ride. He goes through our treatments and we ended up clearing him September 6 of 2012 and the guy is completely symptom free and looks phenomenal on ImPACT. You see impulse control score is low, that’s why his reaction time is a little slow because he was very careful with the test. We ended up – you can see we exerted him heavily from here to here and there is no changes in the data and we cleared him. He’s back playing profession baseball and has had an incredibly good season, he’s hitting the cover off the ball and I talk to him periodically, he’s had no recurrence of symptoms and is doing wonderfully.

Concussion is a manageable injury, it’s something if you understand where the aberrant signal is coming from, you look at them in the right way, you understand this injury we have good treatments and therapies to treat it. We need to make that all evidence based, that’s what we need to do. I sat this conference for all 615 of them and I can tell you that we haven’t had one in a while and I’m very excited that our program is here to share with you some of these advances we’ve made in terms of
how we approach this injury. And for the next 2 days you are going to be hearing a lot more about this. And thank you very much for your time.