

VICTORIA

My name is Victoria Kochick, and I am the coordinator of the exertion concussion program with the UPMC Concussion Clinic. And I'm going to be discussing our exertion therapy program, and some of the rationale between getting our patients active, and also what the meaning of exertion therapy is.

KOCHICK:

These are the objectives. We'll discuss the epidemiology of concussion, the definition of concussion, and pathophysiology surrounding concussion, just to give you a little bit of background as to where we're coming from, and how we developed our exertion therapy program. Then, I'll go into the definition of exertion therapy, some literature, or lack thereof, surrounding exercise after concussion. And then some of our return to play recommendations, and at least what our concussion program utilizes.

So as far as the epidemiology of concussion, it's a pretty significant injury. There's about 2 to 4 million sport related concussions each year in the United States. And in general, about the same number range in adolescents each year. Almost 200,000 of those are in children under the age of 10 years old, which is pretty significant because those are very young children.

Then, of course, a 1/4 million military service members in the years 2000 to 2014 sustained injuries. The next statistic I found pretty surprising. About 6% to 7% of the total injuries in sports are related to concussions. So that's a pretty significant number. And then, again almost a 1/4 million show long-term deficits each year from sustaining a concussion.

So what is the definition of a concussion? There's a couple ways that you can look at it. You can look at it from the perspective, that I would say is most common in family members, in athletes and coaches on the field, it's the whole-- I hit my head and I got knocked out, or I didn't get knocked out. I had this loss of consciousness, and it results in altered mental status.

Well, literature shows that you do not need to have a loss of consciousness to sustain a concussion. Some literature even supports it if you have that short-term loss of consciousness, it can be a good indicator for a shorter recovery. So loss of conscious may or may not be an indicator as to whether you've sustained a concussion or not.

The second definition of concussion is it's a type of brain injury. It's caused by a rapid acceleration and deceleration of the brain within the skull. It can be a straight forward and backward, but most commonly it involves some sort of rotation of the brain inside of the skull. And this causes the brain to stretch, deform a little bit, and it can impact individual neuron cells, blood vessels, et cetera. And then, this sets forth a cascade of neurochemical imbalances that can cause some of the deficits after concussion.

So the CDC also put out a definition of concussion. And their definition is, is it's a type of traumatic brain injury caused by a bump, blow, or a jolt to the head, by hit to the body, and this causes the brain to move rapidly back and forth, which is that acceleration and deceleration that the definition above lists. It's a sudden movement that can cause the brain to bounce around or twist inside of the skull, and it causes those chemical changes in the brain, sometimes stretching and damaging the cells.

So those are a few definitions, a few different perspectives, on how to define a concussion. Moving forward into some of the pathophysiology of concussion. It is a complex physiological and functional injury involving these neurochemical imbalances. Concussion is not, and does not always, involve anatomical changes, such as a skull fracture or an intracranial bleed. It is an imbalance from a complex cascade of events that happen at the chemical level. And it typically occurs with that injury, that jolt, that rotation, inside of the skull.

So what is this neurochemical imbalance I keep talking about, or more commonly known as this energy crisis after a concussion? So each of our individual cell membranes have a resting potential caused by potassium inside of the cell having a higher potential than the extracellular sodium and other neurochemicals. Post injury, with that stretching and the deformation of some of the cells, the potassium can leak outside of the cell as the resting potential sort of takes it outside of the cell because it wants it to be neutral, it wants it to be even, so the channels are open, the potassium leaks out.

Well, in order to bring the potassium back into the cell, it requires energy. It requires ATP, which is created in the mitochondria of the cell. In the mitochondria, from the injury itself, there is excess calcium and that can decrease the efficiency that the mitochondria can make energy, hence the energy crisis. You need more energy to regain this balance inside and outside of the cell to help pump the potassium back inside, but our body is less efficient at making the energy that's required.

Over time, our neurons will recover and we will get back to that normal resting potential inside and outside of the cell. But unfortunately, there's no time frame to determine how long that is going to take. And there's no way for us to measure that at this point in time-- no way to pull an athlete off of the field and measure this neurochemical imbalance, or measure the neurochemical imbalance to determine that they are ready to return to play.

So as I mentioned, it's both a physiological and functional injury. So what do these patients look like? Are concussion clinic typically profiles our patient into six different categories. It's not always just one particular category. It could be all six of them. It could be any combination of these six profiles. So I'm going to talk about each of the profiles separately. But as part of our UPMC concussion clinic team, we have primary care, sports medicine doctors, neuropsychologists, physical therapists, or neuro-ophthalmologists, psychiatry-- we have all of these team members so that we can best treat each of these clinical profiles after the concussion.

So the first one is cognitive fatigue after the concussion. So some of the management strategies for that include physical activity, getting the patient out and walking, instead of having them lay in a non-stimulating environment. Next, is structured rest. So not ultimate brain rest, not total isolation, but a structured exposure recovery type model, and structured rest strategies and recommendations, whether that includes school or work accommodations, which is typically dictated by the neuropsychologist that is managing that patient's case. And then, in some occasions, primary care sports medicine-- we bring them in to maybe discuss some medication to assist with some of the cognitive fatigue.

The next profile is vestibular. So for some of the vestibular patient's management includes usually a vestibular trained therapist, and they will initiate some vestibular exercises. In addition, they'll-- additionally, they will encourage the patient to get active again, whether it's a walking program or some sort of resistance training program, participation with their athletic team, whether it's watching practice or doing some conditioning with the team. They'll do some of that basic behavioral recommendation, but also they get into a lot of the vestibular specific exercises. They'll discuss environmental exposures with their patients, as far as getting back into the grocery stores, or being in the classroom, the lunchroom at school, different work environments that might be challenging for our patients. They're going to be the coach from that hypersensitivity perspective to busy environments.

Additionally, we may get primary care sports medicine involved if they need something a little bit extra on top of vestibular therapy, such as medication management for some of the vestibular hypersensitivities and dysfunction that can happen.

Next, are migraines-- so post-traumatic migraines are sometimes a challenging piece to concussion management. Exercise is one of the strategies that we'll utilize because it is well known that regular exercise can help decrease the frequency of migraine onset. However, migraines can be-- or exercise can be a trigger for migraines. So we have to find that balance between not doing too much that we're triggering migraines, but encouraging regular physical activity to decrease the frequency of onset of migraines.

We also educate on behavior regulation because we know that if you are an individual who has a lot of migraines, regular sleep and eating patterns, drinking lots of water, exercising regularly, living this very regulated lifestyle can help with some of the migrainous type triggers.

And then, of course, there's medication management. I would say that's one of the most common referrals that we'll make to physical medicine and rehabilitation for-- or primary care sports medicine-- for is migraine management. So whether it's in a board of medication or something, they might take a little bit more frequently to help manage some of those migraines. And of course, patient education on the importance of discovering any triggers they might have, and some of the regulation strategies that you can utilize with a migrainous trajectory.

Next, is mood dysregulation after concussion. Again, exercise can help manage mood. A lot of you who might be watching this presentation might utilize exercise to help with some of your stress and anxiety management daily. With depression, it can help improve mood. So exercise is absolutely something that we'll utilize to boost a patient's mood, and/or manage a patient's stress if it's dysregulated after concussion.

Or sometimes, we'll even find that in some of these very high level athletic populations, exercise was their stress management tool, and they further they get out from exercise, the more their stress and anxiety are dysregulated. So the sooner we can get them back to being physically active to help manage, probably, a pre-morbid stress and anxiety type tendencies, the better off that they're going to feel.

And then, of course, we have psychotherapy in psychiatry as members of our team. So they can manage this profile, and then medications, as well, are sometimes utilized to help manage mood after concussion.

The next is a cervical dysfunction trajectory. And this is where we will utilize physical therapy to do some mobilizations, some deep cervical strengthening, determine if the neck is a cause of some of their headaches and/or dizziness. They do prescribe exercises, but in some pretty severe cases, sometimes, they'll reach out to primary care sports medicine and/or neurosurgery for-- if we feel like medication or surgical consultation is necessary.

And the last one is ocular motor dysfunction. So ocular motor dysfunction is, sometimes, in the beginning stages, in the first four-ish weeks, managed by vestibular therapy. They'll utilize some very basic ocular motor interventions to see if in the early stages they can help retrain that system. However, if vestibular therapy is unsuccessful, or some of these ocular motor dysfunctions persist, that's make the referral to behavioral neuro-optometry or neuro-ophthalmology and through their testing, they'll determine if vision therapy is appropriate for certain patients.

One of the things that I want to point out, throughout our six trajectories after concussion, through all of them, except for ocular motor, which if vision therapy is important or determined necessary, they will give some ocular exercises. So you can maybe even throw exercise into that sixth category, as exercise is an important piece of management for every single one of the clinical profiles.

So this is where exertion therapy and/or exercise fits into the puzzle. As I described each of these profiles, I sort of skirted over the exercise piece, but exertion therapy can be utilized in a patient with cognitive fatigue, in the vestibular patient, in the post-traumatic migrainer, in the patient who's extra anxious or stressed, and even in the patient who's having some cervical dysfunction and they need some next level exercises to help manage that. So exercise is a pretty big piece.

So that answers the first question of why exertion therapy. So exertion therapy is a skilled and objective way to assist athletes towards return to play. And I will say, it's not always, and it's becoming more that way. It's not always athletes that we're exerting, it's patients who want to return to work, or an at-risk work environment, it's the weekend warrior, it's the marathoner. It doesn't have to be a college or high school athlete that we're always exerting. It can be anybody who had an active life that's a little bit apprehensive about returning to that, or they have activity-related goals.

So the other piece of why exertion therapy is in our concussion program. Exercise testing is a requirement for a return to play. We are exerting every single patient that is getting cleared and returning to an at-risk activity. We're putting them through an exercise test to determine that they are ready to return to that particular activity.

So what the heck is exertion therapy? It's a patient specific-- it's an individualized program to decrease exercise sensitivity post concussion. So patients report symptoms once they start getting active, and if we create an individualized program to them with the frequency, intensity, the type of exercise that's going both be valuable to that patient, but also help them achieve their goals, that's the target that we're looking for with exertion therapy.

We do closely monitor these patients. We monitor their vitals and we monitor their symptoms because we want to allow them to actively recover, and we want to eliminate the negative effects of rest. And as I'll touch on a little bit later, there can be some negative effects of too much activity and pushing things to too high of levels and into too much fatigue.

There are two additional components to consider with exertion therapy is do they have underlying or a vestibular overlay to their presentation and/or a migrainous overlay to their presentation where they might be sensitive to light and noise. Additionally, when we're seeing patients who are a year or so after concussion and they are finding our way to the concussion clinic, and they've been encouraged to brain rest until asymptomatic, they're going to be a little bit sensitive to busy environments, lights, noises just as a hypersensitivity or almost like a deconditioning to those types of things.

So those are other underlying things that we do consider with exertion therapy. As far as the vestibular impairments go, it's a two-sided coin. So if they're in the initial stages of exertion therapy, we'll maybe put them on a stationary bike versus the treadmill to assist with the vestibular stimulation from being on a treadmill.

We may be treating them in a particular treatment room than a busy gym because we don't want to exacerbate their symptoms just by the environment that they're in. We want it to be by the activities that we're asking them to do in exertion therapy. If we have a patient who has this hypersensitivity and/or this deconditioning to busy environments-- loud noises, bright lights-- we'll either have them come to the clinic at a slow time of the day. We'll treat them in a smaller, more quiet gym. We'll, maybe, have them-- again, just treat them in a room, turn down the lights. Because we don't want, again, just the environment to be provoking their symptoms. We want it to be the activity that we're prescribing.

The other side of the coin is if they're nearing discharge from vestibular therapy or they've been at some of our exposure recovery recommendations for a long period of time, we will sometimes push the envelope. So if they're about done with vestibular therapy, I'm not going to have them on something like a stationary bike. I'm going to have them on the treadmill. I'm going to have them on the elliptical-- something that has that added vestibular input.

I'm going to have them schedule at the busy times of the day. I'm going to have them in the busiest gym, busiest environment because those are more passive ways that I can up the level of stimulation for those particular patients. If you go to your gym near your house at a busy time of the day, it could be a very stimulating environment. So if I'm going to encourage my patient to get back into the gym or to go back to a professional or collegiate level sport, they need to be used to exercising in busy environments.

So that's our background as to what exertion therapy is, and why we exert our patients. But what are the current recommendations for exercise after concussion? So I pulled some of this from the International Conferences on Concussion and Sport. And the general guideline is and the recommendation for rest following concussion, and exercise following concussion, brain rest until you're asymptomatic, or rest from a physical activity perspective until asymptomatic still is the general guideline post concussion.

At our clinic, we're a little bit more aggressive with getting our patients active. We do have an initial period of rest after the injury-- three-ish, four days. There's no true time frame that it's automatically at three days we're making that patient walk-- at three days we have that athlete jogging. It's all individualized and patient specific, but that's why we follow-up with our patients so closely, and work as a team, so we can all be communicating and determine when these steps are appropriate.

So it's usually about three-four days that we'll start to get our patients active again, and take them out of that total rest period. And then, we also begin low-level exercise with a lot of our patients pretty early and progress them through some graded exposures and/or refer to exertion therapy. But we very, very regularly are recommending low-level exercise in those who aren't recovering as fast as we want them to.

And we just encourage them to work through their symptoms. Anybody who's beginning some low-level exercise-- work through their symptoms, especially as soon as they're out of that acute phase of concussion, which is again that three to four day range.

So to be a little bit more specific as to when we, maybe, begin exercise after concussion-- at any point in time, the neuropsychologist and the concussion team can refer to exertion therapy. But I'm just going to touch on exercise in general, at the beginning. So again, outside of that acute phase, which is an ish about three to four days-- there's no specific time frame-- and/or in athletes with minimal to no symptoms. So we may see a patient three days after an injury and they've got basically no symptoms, we might exert them at that point in time.

It may take an athlete five-six days to get that minimally symptomatic reporting that will begin exercise recommendations at that point in time. We do exercise all patients who have fallen into the chronic post concussive syndrome type grouping, particularly if they've been told and/or are afraid to become active. So if they're three-four, even six months out or longer, and they haven't been active, we're going to recommend that they get active at that point in time.

And then the third group is patients with just generally active lifestyles, they're generally asymptomatic, but they have some hesitation returning to exercise. I don't know how, or how much, or what to do. Neuropsychology may give them some guidelines or in any of these top three scenarios, neuropsychology might be recommending exertion therapy.

The referral to exertion therapy is a team decision, particularly in the highly symptomatic patients. So the team will sit down-- the management team of that particular patient will sit down and they'll discuss the patient's care and say, do we think they would benefit from a skilled and graded return to exercise or do we think we might want to go more of a medication or some other type of route?

So these are the three most common in, maybe, controversial times that exertion therapy is referred, is in a highly symptomatic patient, but they have a significant mood profile. So that very anxious athlete that their sport was their outlet, and they're still reporting dizziness, but we feel as though it's related more to their mood profile than actual sensitivity to exercise. And if we get them active again, that might help decrease some of the dizziness that they're reporting.

Same with the patient with some post-traumatic migraines. If they had been active prior to the injury, maybe that was helping to manage their migraines. And now, we've taken that management piece away, so it's no wonder that they are all of a sudden getting some of these migraines. So can we give them a graded exercise program to help with managing some of those post-traumatic migraines? If the answer is yes, then the exertion referral is made.

So then we have the person that's just not getting better. They've had limited progress otherwise, whether it's related to cognitive fatigue, fear, avoidance-type behaviors, any other psychological or personal factors that have hindered their ability to get active and/or their desire to get active again, the referral to exertion therapy might be made to give them something to work off of. So those are the most common ways we get patients active again, and the most common times is that exertion therapy is referred.

So is there literature to support exerting patients after a concussion? So in 2009, a study came out of children who were slow to recover following a sport-related concussion, and they had the athletes go through some aerobic conditioning. They had them go through some sports specific drills. And they gave them some home exercises, because at the high end in physical therapy, we will see our patients twice, maybe, three times a week. If you're a trainer, you might see them a little bit more often. But home exercise program is very valuable in this patient population, because there's a lot that they can be doing at home.

The result of this study in 2009 is that all patients had decreased symptoms scores, and they were all able to return to their prior pre-injury activities and sports after this exertion. Next was a 2010 study and it looked at sub-symptom threshold exercises for the patients in the refractory period post concussion. So these patients were greater than six weeks out. They followed a heart rate model on the treadmill.

And these particular patients, they demonstrated improved exercise time, so some conditioning. If you're performing cardiovascular activity, there's going to be an improvement there regardless of symptom provocation or not. And they all have decreased symptom reports by the end of the treatment. So definitely some improvements. And then, all of these athletes returned to their desired sport. And all of the non-athletes, because we talk a lot about athletes in concussion, but there's a lot of non-athletes that we're seeing as well, but all the non-athletes did return to work.

So those are two positive studies that reflected the importance of exercise. But as you can see, both of these were slow to recover or outside of that six week range post concussion. So there was a 2011 study done and they took a look at neurocognitive scores after patients were exerted. So they found that after you exert a patient, their neurocognitive scores are going to decrease.

And I don't look at this as a negative study towards exertion, I actually look at it as an indicator for exertion therapy, because if you're not exerting patients, and you're doing some of these neurocognitive testing or vestibular tests or even ocular motor assessments, and you're not exercising your patients at any point in time, you may clear a patient who is not 100%. So by exerting you can tease out some of those very tiny factors that may still indicate that there is an injury.

So, I say, that this study suggests that all athletes should be exerted prior to neurocognitive testing and formal clearance for a return to play. So that's how I would look at that particular study. So there was a study done in 2008 and it said that all athletes who engaged in high levels of physical activity in the weeks, initial weeks, following concussion, they had worse neurocognitive scores, their symptoms were higher, and they had a longer recovery time, which is not something that an athlete or an athletic team is really looking for in their sport.

So this suggests that there's an intensity element to activity post injury. So the first two studies, they said exercise is good, at least in the chronic or the patients who just aren't getting better. But this study says that too much is not great. So in our clinical experience, we know that ultimate rest cannot be great. We know that exercise is good, but we know that there is a point that there can be too much.

Otherwise, there's not a whole lot of literature to support or not support exercising your patients post-concussion - still a very new concept. So what do we look at when we get a patient into the office with a script for exertion therapy from the neuropsychologist?

So first I think it's valuable to point out that the neural psychologists are seeing these patients from many different referral sources. And then, they refer to all of the individuals that assist with patient management, exertion therapy being one of them. So we have to take a detailed history of these patients.

So they're on the field, they sustain an injury. The athletic trainer says you need to go see the concussion clinic. They go see neuropsychology. Psychology does their screening and their testing, and they determine that they would like exertion therapy to get on board.

We need to be taking the history of that particular patient. Are there co-morbidities that may get in the way of our treatments with exertion, whether it's an orthopedic concern or a cardiorespiratory issue, even something silly like asthma in a younger athlete. As the patients that we're seeing for exertion therapy are getting older, we are looking to get clearance from the primary care physician for physical activity. So that is another piece to this sort of history taking. Do they have that consent from their primary care physician or that clearance from their primary care physician?

We're obviously screening their cardiorespiratory system. We're taking heart rate, blood pressure-- just to determine are they able to be physically active in the capacity that we may ask them to be? If this patient has not been brought to us via the emergency room, likely their cervical spine has not been screened. So we're doing some ligamentous and range of motion testing of the cervical spine to determine is an additional referral warranted, whether it's to cervical or neck PT, neurosurgery, or even primary care sports medicine for some sort of medication management to help with some of that cervical function or pain.

We're also screening the vestibular and ocular motor system. My background is in the neurovestibular world. I'm a neuro-clinical specialist, so I use this exam very much so when I'm exerting patients to determine, are they having more horizontal sensitivities? Are they having more vertical sensitivities? Are there some central signs, meaning abnormal pursuits, abnormal saccades?

If I'm seeing some of this vestibular or ocular motor dysfunction, and they're not in vestibular therapy, they're not seeing neuro-ophthalmology I'm maybe going to make that referral that they get those systems assessed and/or treated. And I'm also using it as pieces of my treatment. So if they've got some more rotational sensitivity, I may stick with a Med ball rotation. Or if they've got vertical sensitivities, I may have them stick with squats and/or lunges.

So we are screening the vestibular and ocular motor system. And then we get to the exercise test. The exercise test is standardized for all of our UPMC concussion patients. It goes through some functional testing. There's a cardiovascular piece. Then there's more of a plyometrics circuit type piece to that test. And it helps us, again, are there directional preferences? Is it sort of exercise related, meaning the higher the heart rate or their working, the more symptomatic they get. It helps sort of tease through those types of questions.

We spend a lot of time educating our patients as to why the types of exercises, the frequency, intensity, the dosage of that exercise is important, so that they can then be compliant with the home exercise program. As I mentioned earlier, we rely a lot on home exercises because these patients should be exerting more frequently than they're coming into our office.

So a little bit more detail-- patient comes in. I want to know how they sustained their injury. Is it sport related? Is it a motor vehicle accident? I want to know the date that they sustained. So was this a year ago? Was this a week ago? I need to know what their goals are. So do they play a sport? What position do they play? Do they play more than one sport? Football season's over now. They're looking next towards baseball. So that might be-- I might change what I'm doing with them based on those types of questions.

Risk factors and prognostic indicators for both having a protracted recovery from concussion and/or risk factors for being physically active. What else are they managing from the concussion? Are they seeing vestibular therapy? Have they seen primary care sports medicine? Are they on any types of medications? And then, of course, I ask about the symptoms.

So how bad are your symptoms? How long do they last? One of the symptom pieces that I use all the time-- what's your recovery time like? So if I make you a three out of 10, a five out of 10 dizzy with my exercises, are you going to recover in two minutes, or are you going to take about 10 minutes to recover from that dizziness spell. I need to know that information before I exert them.

And then, of course, school or work demands-- so grades in school, how they're performing academically, work activities, meaning is it eight hours on the computer, or is it something on a production line where there's a ton of rotation setting things from one box to another box. Those are two very different types of environments, and I need to know about that.

Again, orthopedic concerns-- as our patient population in exertion therapy gets older and older, we need to know are there neck, shoulder, hip, back problems? A lot of these older individuals that sustain a concussion, it's a motor vehicle accident, it's a fall. So there usually are some other injuries from the accident that they're coming into therapy for.

And then, what have you been doing since the injury? Have you been vegging on the couch? Have you been going for daily walks, like the neuropsychology will typically recommend? So I'm going to ask about the FIT principle-- frequency, intensity, the duration that they're doing it, the type of activity, and then what happens when you exercise? Are you getting symptoms? Which ones? How long do they last? How long does it take you to recover?

The most important visit, in my opinion, is their first follow-up visit. You spend about an hour with them on their initial evaluation. You take them through our standardized exercise test. You spend about five-10 minutes with them after they're finished with the exercise test. But, at the subsequent visit, you can ask how did you feel for the rest of the day?

Did your symptoms recover by the end of the day? Or did you feel like your fuse was shorter-- you had less energy, ongoing? Were you able to do your exercises that I recommended? If so, how did they feel? Were they too easy? Were they too hard? Did you change them at all? Were you able to find a place to do them? I gave you a Med ball exercise, did you find something to do that with at home?

So I'm getting a lot of valuable information on the real-life application of the home exercise program that I gave them. So the subsequent visit is huge. I'm obviously asking ongoing treatments-- when they're follow-up with neuropsychology is? How's school going? How's work going-- et cetera. So the subsequent visit is, arguably, one of, if not the most, important information gathering. The first one's a lot of screening. The second visit is really giving me the information that I need moving forward.

So alluded to this a little bit earlier-- throughout exertion therapy, I'm considering these vestibular impairments. So is it more of a visual motion sensitivity-- the busier, the more wide open the environment is, the higher their symptoms are? Or do they have some ongoing gaze stability impairments? These are both vestibular considerations.

And again, it's that two sides of the coin. Are they early that I'm going to cater to these sensitivities, or is it later that I want to challenge them with these environments to habituate some of these hyper sensitivities? If they have gaze stability impairments and I'm catering to that, I may educate them on spotting techniques with squats or lunges to give them that stable visual piece. And I'm going to encourage them to limit head movements. So I may have them do squats with a head rotation later, but now I'm going to have them pick a spot on the wall, squat down, squat back up, no head rotation, and their eyes are fixated.

I'm going to have them, again, be on a stationary bike instead of the treadmill. Whereas later, I might have them do squat jumps with head rotations. I might have them do lunges with med ball rotations-- like some of these more rotational pieces as they're gaze stability and their visual motion sensitivity improve. It just depends on my goal at that particular time. These are absolutely considerations that are ongoing every single time I'm seeing this particular patient population.

So all of this is to assist our patients with returning to play, returning to work, getting back to whatever activities and environments they desire. So I look at discharge from exertion therapy and formal clearance as two separate things. As a vestibular therapist and exertion therapist, I'm discharging them. I'm not clearing them for a return to sport. So once the athlete has progressed through my entire therapy plan of care, which includes an exertion test that we make every single athlete that's looking for clearance go through, once they've progressed through that and they're asymptomatic with all elements of my testing in all activities, that's when I'm going to discharge.

There's no time frame for this. I can't say whether it's typically five days, five weeks. I can't specifically say that I'm going to progress a patient. This is what I'm going to do one day. This is what I'm going to do that next day. This is what I'm going to do the following day. It's just very patient specific. It's sports specific. I'm going to exert a patient who is on the diving team very differently than I'm going to exert a patient who's on the football field very differently than I'm going to exert a CrossFit mom. They are two-- they're totally different types of exertion therapy, so that's why there's no specifics surrounding these patients.

And one piece that I'd like to mention is, it's Pennsylvania law that there is no time frame for return to play. Other states, other governing bodies, such as school districts, and/or athletic groups may have some return-to-play time frames that they've mandated.

So I would say ask around, look at your state law, and/or discuss with your school district if there is a time frame that they need you to put a patient through a return-to-play protocol before they can get active again. So although, from a concussion perspective there is no time frames, there may be some mandated time frames in your governing bodies.

So formal clearance-- typically given by the neuropsychologist. They sign off and send it to work, send it to the athlete trainer, send it to the school, or coach. These patients are symptom free at rest. They're also asymptomatic with physical, cognitive, vestibular, and ocular-motor activities, and/or stressors that maybe were symptomatic at one time. They've got intact neurocognitive, vestibular, and ocular function. And they've returned to all of their activities that they've done prior in the way that they've done them.

And I emphasize that because they're back to track practice, but they haven't gone from being a distance runner to now they do high jump, and that's it. So they're back to all of the activities in the way that they did them. They're back to their normal speed of movement. They're back to all of their prior classes, et cetera. And the last piece is they've discontinued all medication management for their concussion symptoms.

Now, if they had a new medication for some sort of mood dysregulation or migraines, those medications might stay intact, and they will definitely still be managed by our primary care sports medicine team until they determine it's appropriate to discontinue those medications, if they determine that it's appropriate to discontinue those medications. But for the most part, we like that they've discontinued all medications that are for their concussion specific symptoms. So we want them back to being who they were and doing what they were doing before they sustained the injury.

In conclusion, exertion therapy, it's indicated it's just a necessary part of formal clearance after concussion, and it's a necessary part of managing a lot of the different clinical profiles that we as a concussion clinic recommend or recognize. And particularly-- and everybody seems to agree on this-- that it's OK to exercise and push your patients who are asymptomatic at rest to begin physical activity in those particular patients. So it's necessary for clearance, and it helps with management of a lot of their symptoms, but little literature exists on the value and validity and safety of exerting patients in symptomatic individuals. It's just a newer concept.

So we find that it's very effective, but we also find that there is a lot of scale in the exercise prescription with this patient population. So that's it. Thank you.