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Return to Play - When Is the Athlete Ready and How Do I Manage the End-Stage of Rehab?

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- [Calista] And today's course, once again, is titled Return To Play, When is the Athlete Ready and How Do I Manage the End-Stage of Rehab? And it is my pleasure to welcome Carol Mack. Carol is the owner of Cleveland Sports and Performance, in Cleveland, Ohio. Carol graduated from Duquesne University, the Doctor of Physical Therapy program, in 2006, after playing four years of varsity soccer. She is a board certified specialist in sports physical therapy, specializing in end-stage rehabilitation of soccer athletes, female athletes and runners. Carol recently finished her second term as chair of the Female Athlete Special Interest Group through the American Physical Therapy Association. And she is now vice chair of educational programming for the American Academy of Sports Physical Therapy, as well as a member of the US Olympic committee's volunteer medical staff. So thank you so much for presenting, once again, for us today, Dr. Mac. And at this time, I'm gonna turn the classroom over to you.

- [Carol] All right, thanks, Calista. Hopefully you guys can hear me. Thanks for joining me on this Friday afternoon. Just start, I'm in Cleveland, obviously as Calista mentioned and it started snowing about an hour ago, so I've got my computer here, looking out the window and watching it snow and I am not happy. I'm happy to be presenting to you guys, so at least I'm inside where it's warm and I've got coffee and everything, but I cannot believe it's May 8th and snowing. Although I can't believe we're in quarantine either, so the way that this year has gone, I guess. Anyway, I hope you guys are all doing well today and again, thank you for joining me. I like to take questions through the whole time, I feel like it's a good way to maybe break up my rambling on about different topics. So if you guys have any questions, please, by all means, throw them in the chat box and love to take a break and just get some kind of discussion about whatever you're wondering about. So we'll get started here. This is a disclosure slide just for you guys to understand disclosures that I have and it's just

content and sponsorship. And then in terms of learning outcomes, why you guys are here, so after this course, want you guys to be able to understand the multifactorial nature of return-to-play decisions, it's not as clear cut as just go back or not. Be able to state what the current literature says on functional testing, re-injury rates and just other things that have to do with the return-to-play decision making process.

Understand components of how to make that decision and also understand what we don't know yet, in terms of research and what we need to study. You'll be able to perform a sport-specific needs analysis.

And lastly, you'll be able to understand specific progressions for return-to-sprinting, running and just other sports. And I have a lot of slides, I've given this talk before with probably the same amount of slides and I probably will not get through all of them and I have them there more just for a reference for you all, so I have slides, at least, hoping to touch on soccer, return-to-soccer, return-to-football, skiing, volleyball, but like I mentioned, if I go through them quickly and I'll explain this at the end, too, again, it's more of a reference for you guys. So you may be more interested in skiing, you may not really care at all about football, or vice versa, or whatever, but they're there for you. So moving on, return-to-play, so how do we define return-to-play, which I have to be honest, I mean, I've played sports all my life, I've worked in sports since 2006, it's funny for me to be reading a paper on how to define return-to-play, but I think it's brilliant that this consensus statement, this is from the First World Congress in Sports Physical Therapy and it was a paper published shortly after word on consensus of return-to-sport, I actually think it's brilliant that they made that definition because it's the sport and it's the level of participation that that athlete aims to return to.

And that's different for different athletes and it's different per the goals and we're gonna go into all that. And I think whatever that definition is for that athlete, you need to know, at the beginning of your rehab, you need to know if they've accomplished that or not, so we're gonna talk about that. So it's a collaboration, so when you make this

decision and I always take some solace in this because it's not just on my shoulders, as a PT, or on your shoulders, as a PT, or an athletic trainer, it needs to be a consensus between the athlete, obviously, that's huge, the coaches and then whatever clinicians are involved. So the team doc, the athletic trainer, the PT, whoever is involved in that care. And you need well-defined roles and responsibilities for this. Obviously, you need to be consensus and you all need to be on the same page. I know I've encountered different times where I'm working with an athlete and maybe I said that they could go back and somebody else said that they couldn't and that's a miscommunication between me and that other person, or, this happened when we were actually in school and playing sports, where I had an athlete with concussion, had outlined very well to the head coach, at the weekend practice, I wasn't going to be there, I work at a high school, I coordinate all the sports medicine and then I do the sports performance at a high school.

One of our basketball kids had a concussion, had outlined what she could and could not do, she could basically just do some running and some light shooting. And then told the head coach, well, the assistant coach was the one that started practice for them and came to find out that she scrimmaged. So you need to really be on the same page and just make sure that you're all communicating, but then also you need to have those roles defined, like is it the team doctors that has final call, or is it consensus that you all need to sit down and talk about it?

And that seems like it's a simple thing, but, as I've mentioned, things fall through the cracks very easily if you're not careful and I can't emphasize that enough, that good communication is so important. So if we think about what is exactly a successful return? So as I mentioned a couple minutes ago, that needs to be defined, that's different for everybody and that needs to be defined as soon as possible after the injury. So it means different things to different people. So the consensus paper from 2016, actually does a great job of outlining this and I think, as I talk about each of

these, I think you can imagine an athlete that fits probably each one. So you may have an athlete that is very goal focused. They're trying to get back in the shortest possible time. If anybody's had ACL, athlete with an ACL injury and they're coming into you as soon as they find out that they're having to go in for surgery. They're telling you that they need to be back in five months, or something, like they saw on ESPN that somebody came back in five months and they're gonna beat that and they're gonna be back. So that's their goal. Or you may have a coach that, they're performance focused, so they want that athlete back at their best possible performance. Makes sense, right? They're coaching and they're trying to put their best people out there. They need that same athlete that tore their ACL to be able to be the same rebounder that they were before in basketball.

That they can box out the way that they could, that they won't get knocked around on the court. So that's another definition. Or to you or I, as a clinician, we may be very outcome driven, which makes sense, right? We're trying to make sure that there's no any other associated injury, that they're not compensating so much that they cause another overuse issue, or something else. We may be worried about re-injury because that, as we're gonna talk in a little bit, the data coming out on ACL re-injury rates is pretty staggering and a little almost, I find, a little depressing.

But that athlete's telling you five months and you know what the risks are associated with. So what is a successful return? We really need to talk about that and you need to talk about it with the athlete from day one because I think it's important for goal setting, but also I think it's important for consistency's sake and accountability's sake, but on my shoulders, as a clinician, making sure that I'm getting them back to what they need to be doing and then also for that athlete to know. Because otherwise, they're in this no man's land of, "Am I going back, am I not, how do I know? "I know I have a doctor's appointment "in a good a couple weeks, "maybe they'll clear me, maybe the PT." I think we've all been in situations like that. I don't know if anybody else

is in this situation, but I think in this quarantine, at least, I mean, I'm in Ohio, I'm pretty locked down, which is fine, I've no complaints about, do whatever we need to do, but I've thought a lot about different athletes that I've worked with that had an injury and they're out for a while and our gyms are closed, our schools are closed and we don't really have a definitive date. We just got one yesterday to reopen some restaurants, still no date for gyms or sports competitions. And I'm in this no man's land, I just want a date on the calendar for me to say, "Cool, we can start training, "we can go back to outdoor workouts, "we could do this or that." And obviously that's not possible for many reasons because the situation we're in is very unpredictable right now and I get that. But it's given me a really interesting perspective on some of our athletes when you don't have a goal on the calendar and how unmotivating that can be.

I know, even myself with some workouts, I thought to myself, "Well, what does it matter, "do I really need to push myself at this, "who knows when the heck I'm gonna get back "to be weightlifting again or that kinda thing?" And I think, for me, I've always known that with our athletes, but living through it is just something that, it's a good lesson, at least, for me. And hopefully, you all are, I don't know, I wouldn't say, "Hopefully you're all going through it," but hopefully we can take something from what we're going through right now.

So anyway, again, return-to-play, when we define it, after we've defined what success looks like, how do we get to that? So there's really a continuum, there's this return to participation where they're going back to something, so I'm gonna keep using a basketball example, that basketball player is going back to foul shooting and they're doing some running with the team, maybe they're walking through plays. They're active, they're with their team, they're not yet ready to go back to sport. Then there's the just return-to-sport, where they've returned to their sport that, but they're not at their desired performance level. So this might be the end, some athletes may just wanna get back, they're just happy to be back on the field. and that's their goal. And

that's that's fine, that's why we need to have these conversations with our athletes and what we need to get back to, then if that's their stopping point, cool. If not, you have return-to-performance, where they've exceeded that pre-injury level. So they wanna get back to being better than they ever were. So think about, you've got a high school soccer player who is trying to get recruited at a division one level and they tear their ACL, it's sophomore year, when they get back to playing, they're a junior, a year has gone by, maybe they want to be at that level that they would have been when they are a year older, barring any injury that had happened. So that's that return to performance.

Or their coach, again, talking about what their coach is trying to have them get back to, their coach wants them at a level where they can go back in in playoffs and make a game-winning shot, or goal, or score a point, or whatever it is. So just understanding where we're at in this return-to-play. And I think sometimes we can get caught up in different things, sometimes it's an insurance thing, sometimes it's a pressure from a coach, whatever it is and we may get them back to sport, but really they need to be back to performance.

Or yeah, they're back to going to the gym and shooting foul shots, but are they really back to practicing? And that's not really the time to be discharging them at that point. They're really not back to what they want, they wanted to get back to their sport, they wanted to get back to high performance. And again, I'm beating a dead horse here at this point, but we need to understand where we're working our athletes back to and making sure that they get there before we just let them loose with their team. So couple theoretical models, too, and I'm just gonna go over these, they're more of a reference and just understanding where these can be used to help guide the decision making process basically, so we'll start with this. This is the strategic assessment of risk and risk tolerance framework, that's a mouthful. Basically, this takes in different factors that you would take with return-to-play and I think we do this already, just it's

outlined in a nice stepwise decision-making. So you take tissue health into consideration. So how healed is that person's ankle fracture, or ankle sprain, or how healed is, whatever it is? Then you're looking at their medical history. Do they have a bunch of other things going on, in your physical exam, all the special tests, everything else, range of motion, strength, all of those things? So you're taking that into account, it's basically trying to understand all that information relevant to how much stress that tissue can absorb. Then step two, takes that information and you extrapolate that tissue stress even further into what sport are they going back to, what level are they going back to, are they going back to rec league soccer, or Sunday co-ed, more just hanging out than anything, or are they going back to college level?

It depends, then you're looking at functional tests and psychological readiness, too. Then the third step is taking all of those things and looking into risk tolerance. So it's the amount of risk that that athlete can assume, what's the timing of the season, are we going back preseason where they can gradually ramp up or are we throwing them back into a playoff game where it could go into overtime? I don't know if anybody is watching the Michael Jordan documentary where he broke his foot and he's missing most of the season and he's getting back right before trying to get the team in the playoffs. So what are you going back to?

And they limited his minutes for a little while, too, and he was trying to push the envelope. So those things, those risk tolerance, what is that risk, what's the external pressure, what's that coach doing, is that coach? I mean, I don't know if anybody, I've had this many times, I'm sure you have, too, where you've got a coach who, you know that your athlete, if you give that coach an inch, he's gonna take a mile. And again, this is where we all need to be on the same page, but sometimes you just need to make sure that you're careful because shooting foul shots could mean going to play in a scrimmage, but he's concussed, or whatever it is, sometimes coaches can push a little bit more in what that athletes not ready for, or do they have external pressures in the

professional level of having a contract be up? Do they have external pressures of trying to keep their spot on the field, that they feel like they have to go back because somebody else won their spot? There's so many things and then obviously conflict of interest, fear of litigation, those are all the more obvious risk modifiers there. So what this framework says is basically that athlete can go back if you take steps one and two, so that tissue health and then the amount of stress the tissue can take. There's a numerical, if you guys look up, there's a PDF framework that helps you grade some of these things, but if you take steps on one and two and the total for that are lower than the risk, so you add up their risk and if, obviously, the risk is higher than what steps one and two can be, they can go back to their sport.

And then, oppositely, they would not be cleared if that risk assessment is higher than the risk tolerance. So just thinking about that. So meaning if there's a huge level of risk and then the tissue can't take that, that tolerance is a little bit lower. So moving on, biopsychosocial model. This has been obviously very popular in all kinds of realms, not just sports, which is great because just understanding that there's biological, there's psychological and then there's social factors that might influence that treatment and that outcome. And just that, again, there's a couple references there for you, I have references at the end, but that's in all aspects of physical therapy and care right now. But obviously, it still needs to be applied to sports, too. Then when we think about loading and load management and that's such a buzzword right now, but I think it's very important, what's bio optimal loading?

So are we just throwing them from zero to, is that runner that had a stress fracture, I mean, obviously this is an example that I think we all know the answer to, are we gonna take a runner that just recovered from their stress fracture and let them run a marathon, next week? Probably not, it's the same for soccer, for football, for skiing, for any sport, lacrosse, whatever it is, you have to be gradual in the amount of load that they're absorbing. And that's different than, yes, their strength might be five out of five

in their quad or whatever muscle, but can they take load that is applicable to their sport? And we need to make sure that we progress that, we progress strengthening, we progress mobility, we progress all these other things, but we need to progress low tolerance. Sometimes we can't do that in a clinic and it needs to be done at the field, but just having an understanding of how that's going. And I'm gonna talk a lot more about that later, but if you think about this, there is a phrase in the consensus statement, I called it the Goldilocks approach, which I think is a nice little way of describing it. So what does the evidence say? So when we talk about return-to-play testing, I think we're all pretty well-versed in functional tests, hop testing, time testing, whatever it is. Those are closed tasks, so they know what they're doing, when you tell them, "You're going to hop "from one cone to another "and I'm gonna time you," they know what they're getting with that.

Sports are a matter of reacting, reaction time, reacting to a downhill ski course and reacting to a defender that is coming up to take the ball away from you. So what the evidence is now showing us is that relying on closed skill tasks just only, only using that, really isn't the way we should go when we make these return-to-play decisions. Now, that's hard because functional tasks are pretty objective and we can get some good objective data when we have this open reactive element, it's like, "How do we do that, we can't predict it?"

One way to do that is you can use a gradual introduction of sport specific training and you can use that as your progression and start to build in reactive decision-making, or game skills, or that kind of thing and that's different from every sport. We'll touch on that a little bit, I've had to do it, at least, for, well, when we talk about different sports at the end of this, but we, excuse me, we need to make sure that we're doing that and that it's a very thoughtful progression. The other thing we need to understand is that, in a fatigued state, too, and there's all kinds of debate now, if anybody has been on Twitter and looking at some of the sports PTs and researchers debating back and forth

about the role of fatigue in terms of injury, most notably ACL injury, and there's very conflicting evidence. However, I will say this, the role of fatigue in sport, that can't be ignored. I mean, when your legs feel like jello at the end of a soccer game, you're gonna perform differently than fresh-legged, coming off of halftime, that kinda thing. And that's true for any sport. So whether we can define what that has to do with injuries, I feel like that's a whole different conversation, but just understanding what fatigue can do to your performance is important. And when we're rehabbing our athletes, we need to take that into account because we can't just have them be totally fresh-legged and doing some drills in the gym and then throw them on a field, I mean, if anybody's took a break and then went back to working out for the first time and you know how that feels and your doing that on the leg that just had an ACL reconstructed, that kinda thing, it's inappropriate.

So just understanding that there's a fatigue element, there's a reactive element, that we just have to use the art of our clinical decision-making and our clinical skill to introduce in addition to functional tasks where you're being objective. So I love this quote, this is from that consensus statement and it's pretty much summarizing everything that I talked about, it does acknowledge that sometimes this is difficult, you may not have a ton of time with somebody, so if you're gonna fatigue them out in a half hour session and try to introduce, so you just have to be creative.

So maybe it's getting them to go for a run, or do some drills beforehand and then we start to ramp up whatever kind of introduction of, maybe we get them running and we get them tired a little bit and then we bring another player in and we have them do shielding drills for soccer or that kinda thing. Or maybe you really have that great relationship with your coach that you're working with and you can start to introduce elements into that. Maybe it's doing a video conference, in this past month, that has become a lot more feasible, I think, for people. So whatever it is, you just have to be creative and you have to work with that athlete and team and coaches and have that

network of people that can help with bringing that progression that that athlete needs to reality. So if we think about what do we have evidence on? We have evidence on physical testing, we have evidence on isokinetic testing, a lot of the tests, in general, are based on ACL injury, but we have that, we have literature on other strength testing, range of motion, all of those things. Psychological readiness is also important, if anybody has not heard of the ACL return-to-sport after injury scale, or the psychological readiness to return-to-sports scale, those are important and we've got references down there and then again at the bottom for you on that. And then in terms of specific injuries, there's limited evidence. We're gonna go through ACL because there's a ton of evidence on that.

We're gonna go through other injuries, too, like hamstring, groin, those things, just to know what's out there, just because I think that's important. So what do we need to learn? A lot, I mean, I think we always need to learn a lot, but I think, here, where we need to start is, in terms of injuries and return-to-play, we need a clear definition of what exactly is the injury and the hope is that we can use international consensus on that reporting, diagnosing, categorizing injuries from future studies moving forward so everybody's on the same page. Is it time lost from sport, what is that?

But then we also need to have a clear definition on what is a injury, is it, again, time lost re-injury, or is it they went back and their knee swelled up a little bit, but they're fine in another in another day or so? How do we classify that? We just need better definitions of that. And then we need clear answers on return-to-play, so example, maybe we had a tracking the number of athletes who went to a different sport than their pre-injury sport. So let's say they were a soccer player, but then they went back and are now, I don't know, golfing, just is that, did they return-to-sport? Well, they didn't really return to that sport, how do we define that? Or the people that returned to their pre-injury sport, but at a lower level, so they were in high-level basketball, but now they're in a lower level. There's a couple studies out there that do talk about that, I know in terms

of ACL injuries, the MOON Group, which is a big multi-center outcomes network that has been churning out great research and very well done research for probably past the 10 years, now. They did a study on high school football players and what they did was, it was interesting how they designed the study, they looked at high school football players after ACL injury and then they took out seniors because the thought was, seniors, you're either going to keep playing, or you're not gonna keep playing, one way or the other. So they looked at how many of them return to sport and then how many returned at the same level that they were playing at previously. And they were able to see that less than half of those football players return to sport at that level. So just having clear definitions of that, return-to-sport will help make sense of what the literature is out there and will help us make better research decisions in the future and be able to synthesize the evidence a little bit better.

The other thing we need to look at is performance metrics. So again, did they go back to sport at a high level? Yeah, what does that mean, how many yards did they gain per game or per season, how many goals did they score if they were forward in soccer, how many assists did they have in basketball? So those things really might be better in terms of performance outcomes and it makes sense, it's something that, that's the athlete and the coach's angle anyway, right? So maybe if we can base our research off of that, that would be a better way to go.

And a lot of things now, especially at the higher levels of sports, GPS and accelerometers are everywhere, so you have that data and you have those benchmarks and it's very exciting that we can actually use those moving forward. We also need sufficient follow-up. So we need to understand, what's that long-term participation? So a longer than two-year follow-up in sports. Obviously that's hard because sometimes people, depending on when they get injured, or what stage of their career, talking about high school seniors injuring their ACL, their career might have been over that senior year anyway, it's hard to tell, but as much as we can follow up with these

studies, it's very important. And the length of follow-up needs to be relevant to the injury that's studied. So an ACL injury follow-up is gonna be a lot longer than a hamstring strain, well, actually that might even be a little bit longer, but another just muscle injury follow-up. Then if we think about risk of re-injury, just as soon as we can identify these subgroups that are at risk for that and quantify that, that may give us more ability to target our interventions for those risk factors. And then if we think about other variables, that would include baseline tests, diagnostic tests, that can be done immediately after injury. If you think the impact testing with concussion is a good example of that, that we have baselines and then we can test, not immediately after injury, but pretty shortly after injury to see where they're at, or when they're going back to-return-sport, or if we have other tests that we can use as metrics throughout the whole course of rehab, that's important, too.

And then obviously after return-to-sport, to measure their continued performance and their re-injury risk. So just understanding all of those things further and we have studies on these things, but we need to just continue to build that. All right, I'm gonna talk a little bit about, as I mentioned, about injury specific evidence. So we're gonna start with knee, we're gonna start with what we know the most about and then we're gonna go to what we have the least amount about, but if we think about knee injuries here, start with ACL. So we're gonna go with the most depressing news first.

And you probably have seen this 'cause a lot of these studies have come out pretty recently, one in four athletes have two or more ACL injuries and the risk of ACL injury is 15 times higher in the first year. And now we're talking either re-injuring that leg, or injuring the opposite leg. So 88% of the athletes expect to return, so most people think that they're gonna go back and I think that's pretty consistent, I'm sure with the athletes who you work with, at least that is with mine, I mean, as soon as they get that surgery date on the calendar, they're circling a date when they can go back, when they're targeting to do that. Sadly, one in three fail to return to sport within two years.

So you think about the athletes that I work with, as I used the example earlier, try to go back in five months, which, I mean, but obviously is not something that is realistic for many reasons. And we're gonna talk about that, but like maybe they have that goal or whatever. It's not even two years before some of them are coming back, so that's pretty staggering. And then athletes with a history of ACL injury actually retire at a younger age, which I find sad and just a really eye-opening statistic from the literature here. So we have to have our conversation with our athletes about this and I honestly really struggle from it because I want to be that person that's like, "Yeah, five months, let's go for it, "you can do anything you put your mind to," but that's not, unfortunately, realistic from a literature standpoint at all. And I'm sure you probably have very few athletes that are going back at that point.

I'm exaggerating by saying five months, but they're really looking for whoever went back in the quickest amount of time, also plays their sport and that's the example they wanna follow because I think we all try to do that when we admire athletes and things that they've done and have similarities to them, so I get it. But in terms of defining, as I mentioned earlier, success, return-to-play all of those things, one athlete's timeframe might be different than their teammate's and there's so many reasons why and we have to be upfront with them about the long-term data because more and more studies are coming out that are supporting this.

So I get that mental toll that a one-year is gonna take on that athlete, I mean, imagine what 12 months, imagine, I mean, we've all been sitting out, or people we work with have been sitting out from their teams or training for how many weeks now where we're at, think about what a year is gonna do, or even longer, two years. So most athletes, the way I do it is, I lay out the long-term data and I talk about what we need to, I have to be realistic with them, but then we try to get metrics of where they should be. So at least they have something to shoot for in the short term, "So to be able to run," and we'll talk about this later, "you have to pass these things, "to be able to go

back and shoot, "you have to be able to do these things." And then try to keep them involved with their team as much as possible just from a mental and just an involvement perspective, I think, you really have to work as hard as you can to keep them engaged. So all of that, I think helps in the process and at least gives them something short-term to go at. Then they're not getting blindsided when they go back to their six-month follow-up with their surgeon and it's like, "Oh, why didn't I get cleared? "I don't understand." We have a question, a good question, "Is the number the same for all types of ACL, "hamstring, allo and autograft?"

And I'm glad you asked that, we're gonna talk about graft types in probably a couple slides here, it's a little bit different in the short term, so long term outcomes tend to be the same, but in terms of short-term, within that six months to a year mark, they are a little bit different. Quad tends to be, or sorry, patellar tendon tends to be a little slower in terms of getting short-term outcomes, but in terms of return-to-sport, it is similar and then in long-term outcomes. That's a good question and there was a really interesting paper I'm gonna talk about in a second, it came out, I think, in November of last year and it does look at graft types, so thanks, Gail.

If anybody else has any other questions, too, please, by all means, happy to talk about them. So factors that are associated with increased risk of graft rupture and these studies are based on all grafts. So we'll be talking in a second about just quad, versus cadaver, versus hamstring. But increased risk of graft rupture, what we know now is young age, so you're under 20, pivoting sports, so any soccer, lacrosse, basketball, football, allograft in younger age, so if you're under 18, there is a significant higher risk of an allograft rupture and then return-to-sport before nine months. So this paper just came out in February and again, one of those staggering, I wish the results would be different, but it is what it is and it's a very well done study and I'm glad that we have this data, at least to be able to inform our patients with. So return-to-sport, athletes who return to sport before nine months, have a sevenfold increase rate of an ACL, a

second injury. So again, if you go back to playing before nine months, you have seven times more likely to re-injure, that's huge and sad. And the interesting thing is that there is no association between return-to-sport criteria and second injury. So we think and I mean, I've done that where I have an athlete that looks pretty good, I'm pretty confident, they've passed all my progressions, all my tests and all that, well, sadly the literature does not show that their second injury has anything to do with getting symmetrical muscle function or quad strength, those were the specific things that they tested in the study, those were not associated with new ACL injury in young athletes and there are also studies on hop testing that show similar, so just, again, pretty staggering. Let's talk about something more positive in terms of what is a successful return-to-play.

This paper came out last year, talking about outside factors that drive a successful return. And it's interesting, we talk about all the objective things not having any basis, but some subjective things actually do have a really good positive effect. So the environment that an athlete is rehabbing in absolutely matters and so does a relationship between the athlete and the PT, or whoever's doing their rehab. So athletic trainer, PTA whoever it is, when that person is acting as a confidence booster, a motivator, a guide and when that athlete has access to rehab, or access to a clinic environment, or a good environment to rehab in, a very well-run training room, strength, weight room, that kinda thing and then when that care team can talk and communicate and coordinate everything, they do a heck of a lot better.

And I think that's awesome, I mean, I'm sure we all do those things anyway, but it's pretty crazy to see that that matters and we're looking at hop tests and things that still matter, but aren't the end all be all like we thought they were. So just if you weren't a positive person before, which I don't know why you would be in rehab and not be a positive, I'm sure you all are already, that goes without saying, but just please keep doing that because it makes a difference. You really are making more of a difference

than you think you are. So again, the psychosocial factors, when we address those and we treat those, those nonphysical factors, that really does make a difference in terms of successful return-to-play. So why don't screening tests work, why can't we be able to say that you have this percentage of injury risk, or that, or whatever it is? Now, it's because that cause of re-injury is multifactorial, there's just so many things going into why they're injured unfortunately. We really have a tough time figuring out, we do have a tough time figure out that perfect combination of tests to predict re-injury in everyone that has injured their ACL, between sports, between athlete, between all those other outside factors I've mentioned before, unfortunately, that's the way that it is. Return-to-sport testing though, I mean, we shouldn't just totally throw those out, by all means, please don't think that what I'm saying, I'm not bashing, I still use hop testing, I still use isokinetic, I still use all of those things, there is good literature for isokinetic testing.

Workload monitoring as well, they're not always going to tell us who's going to get injured again definitively, but they do give us a really good piece of the puzzle. And so they are still important and they all guide treatment, I mean, if somebody's doing badly and they can't stick a landing, I mean, that's something I'm going to work on. Like I said, does that definitively say, "Oh, that person can go back to sport if they do do well," maybe not, but like if they're not doing well, then I know what I need to work on for them. Or just helps to guide, if they are doing well with that, then maybe we need to up it a level and get them doing more. So just understand the limitations for everything. So here we go, here we go about graft choices. So in the long term, the data's shown that hamstring versus patellar graft have similar outcomes. Cadaver does have a high risk of failure in young active athletes, in people that are older, all of those are similar. In the short term, people with patellar grafts, athletes with patellar grafts, anyone with a patellar graft, they're about 1 1/2 to 2 1/2 months longer to get key rehab criteria. So just strength metrics, range of motion metrics, those kinds of things. And then they can take up to four months longer to get back to playing. Again, I think that return-to-play

is so different for everybody, so it trends that way that they are a little bit longer for patellar grafts, but obviously, as we've mentioned, there's a lot of things that go into those return-to-play. But the study that came out at the end of last year did talk about that, graft outcomes data. The reference is down there, JOSPT, November of 2019, the graft type really needs to be taken into consideration when you're setting goals for an athlete. So what kind of graft they have is a decision between the surgeon, the athlete, you may have some input in it, it depends on your rehab setting, surgical prep, there's so many other things with that, but you do have control of taking the time to set those goals with that athlete. So regardless of what it is, you guys need to be upfront, you set those goals together, but that's up to you to have that conversation with them. If we look at just some differences, again, in graft type.

Obviously the hamstring is a very large graft, you're sparing the patellar tendon, so you're not having as much anterior knee pain, but since that tendon doesn't have the bone plugs, there's a risk of issues with the fixation and then also, loss of hamstring strength. But then in terms of patellar, you have that anterior knee pain, especially with kneeling, sometimes there's the long-term abnormality, some long-term issue in the patellar tendon because of that just being a donor site, but it is a very stable graft. So those are the pros and cons to that.

Cadaver, with a high re-injury rate if you're young. So all of those things just have to be taken into consideration. All right, moving on. That was a lot on ACL, but we're gonna move on and there's not as much on the rest of these, so just bear with me as I get through some of these injuries. So yeah, if we look at MCL, it's the second most common injury, at least in soccer. And it's behind the ACL, so they're usually contact injuries, you're out for about a month, give or take some time. So in terms of meniscus then and articular cartilage, lateral meniscus injuries have been shown to be a longer recovery time and have a lower return-to-sport rate versus medial. So just understanding that, just by nature of that that those are the outcome studies and just

by nature of where that is and the mechanics of that. Hamstring injuries, these are any sport that has high speed running, it's the most frequent noncontact muscle injury. So you're running and I always have the visual of Jozy Altidore in the World Cup, gosh, when was that? 2016, no, anyway, the US, if you follow soccer, you know what I'm talking about. Sprinting down the field and pulling back with that hamstring injury, that's basically how you see these things happen. There is a huge risk of re-injury with these. And we're gonna talk about it a little bit, it's beyond the scope of this talk, but just understanding that there's a high re-injury rate. The time to return-to-sport varies, so you could have 11 days for a hamstring, you could have 50 weeks, when you're surgical repair, it's six to nine months. And that's what the data is showing right now, in return-to-sport. The MRI results actually are not able to predict return-to-sport.

Most of these athletes do go back, I mean, so it's not a matter of if they go back or not, it's just more of a matter of when, so the rate of getting back as close to 100% is just a matter of, like I said, when, or what level, or that kinda thing. Criteria for going back, just based on a heck of a lotta literature about it, because obviously if we're having trouble with that high re-injury rate, then we're trying to develop some guidelines for it.

So criteria, pain-free, obviously, these are ones, the obvious minimal issues with strength, range of motion, hopping performance, successfully getting through a rehab program, that's important, can they progress through? And then no apprehension with any field testing, that's important. And then pre-injury sprint speed, so we shouldn't be sending somebody back if they can't sprint to the level, and again talking about feasibility of doing that in the clinic, where you just have to get creative with what they're doing at the field, or communicating with the coach, or doing what you can at the clinic and just understanding that. And then there is a hamstring test, Asking ballistic hamstring test, that has also been cited in the literature. So talking about, then, other muscular injuries, we've got groin injuries, the return-to-sport rates are, again, pretty high, about 85% of these athletes have returned to some form of sport

somewhere on that continuum. And this is after both groin injury and groin surgery, but a lot of these studies aren't the greatest of evidence, so take that with a grain of salt. Most athletes get back within four weeks, but again just like hamstring, there's a high recurrence rate here. If you have a re-injury that occurs, or if you have an adductor and abdominal injury along with it, so that sports hernia muddy area of those, if anybody's ever treated somebody with that, that's a tough one 'cause it's a pretty nebulous, there's a lot going on there. But if that does happen, then you're gonna have to expect a longer absence from the sport. If you're talking about after surgery, surgery in terms of groin muscle injury and also long-standing just groin pain, those return-to-sport times are actually similar, with the exception of full adductor ruptures, obviously not having surgery gets you back faster than having surgery. If we, whoops, I almost lost my place there.

So if we look at return-to-sport rates, factors associated with a prolonged, strength is a major issue with having trouble getting back to sports. So strength should be addressed with your rehab program and with your testing. And that's been shown in terms of football and ice hockey, which makes sense, especially in hockey, in skating and being able to push off. Tim Tyler has published a fair amount of literature about groin injuries in athletes in the recent, well, in the 2000s, so just another reference if you're interested in that.

So this quote, "Given the association "between reduced strength and adductor injury, "we suggest that hip adduction strength "should be measured to help with that decision-making." So just there is enough evidence to at least make that recommendation, so. All right, moving onto, we're on the home stretch, we're gonna look at Achilles and shoulder and then move on to how to do these return-to-sport programs. So in terms of the Achilles, if we look at tendinopathy, but then we also look at rupture, tendinopathy, there's a wide range, 10% to 86%, depending on the study, go back to sport in 12 weeks. I think we all have probably worked with athletes that it's

either a quick fix or they're struggling for a while with it, too. Obviously, there's more data that is coming out on tendon issues, there is also more that has come out in recent years about where in the Achilles that issue is. Is it at the insertion, or is it at midsubstance? And then in terms of rupture, again, wide range, between about 30% and 90% go back to pre-injury level. I'm gonna shift over to a question that we've got. "What are your thoughts on using IT band, autograft or ACL reconstruction? "I've seen one research article on using it "in skeletally immature prepubescent children, but." I'm having trouble with my screen, hold on one second, Nicole. I'm trying to expand the text box a little bit. So my thoughts on IT band, I've heard of it happening, I've honestly not seen a patient that has had it. I know that, a long time ago, too, in early years of ACL reconstruction, that was something that had also been used. And it makes sense with skeletally immature children.

I think that the thought process on it, it makes sense, that's a whole different procedure in itself in skeletally immature kids. I think my thoughts are, it's hard to know in terms of outcomes, right now, what the long-term outcomes are, so I'm not really anti using it, but I think we just don't know. Before I do what I do now where I'm out on my own, I used to work for Cleveland Clinic and there was a fair amount of ACL research that has come through there, they're part of the MOON outcome study, but even before then.

And every year we had a presentation called 40 Years with the ACL, actually, now, we're probably up to like 55 years, based on when I started having that. And they basically go through how we've evolved the ACL surgical process and the grand theme of all of everything that they've tried, you've synthetic grafts, IT band, whatever it is, is just that we don't really know until we have long-term outcomes of at least two years, if not five years, longer. And with kids, it's really important to track. So for me, it is hard to say, one way or another, what is good and not, but I think, in that population, it's interesting and it's really cool that there are different innovative techniques coming out just to try to manage that. Because it is happening in younger and younger kids and it

used to be, I've even seen some kids that have been recommended, managed non-operatively for a little while and I just don't know that in a young child, you can really shut them down for that long. So Nicole, thank you, that's good food for thought with your comment, keep them coming guys. We can definitely talk about what is more on your mind than what is on my sides. I would be happy to do that, just to know we can have more of a better discussion that way. So in terms of, again, Achilles, let me see if I can get this to advance, okay.

All right, in terms of return-to-sport with Achilles issues, tendinopathy, the standardized load progression, I think, we're learning this with tendon issues, that there's less of a chance of recurrence and we're having better outcomes that way, but also, at the same time, monitoring their pain, too, is important. With a rupture, there's a huge fear of re-injury. I don't blame those athletes one bit for having the fear of re-injury. So you have to address that and you have to address those fears and your graded progression needs to help build confidence, too, that's just really important. As for a criteria, there's really no milestone-based criteria, right now, but what the evidence says, at this point, is that you should get your athlete through a full progression of loading.

They shouldn't have pain during activity, they should have pain subsiding by the next morning. Pain and stiffness, you can't have issues week to week. And again, with a rupture, you have to make sure that they've gone through that, that load progression and that they can sprint and run and jump and all of those things, so. There is an association with after rupture. And repair, there is association with permanent strength deficits and tendon elongation, unfortunately. All right, last one, shoulder. So injuries in the shoulder leading to time lost from sport, there's not a huge prevalence. So 10% to 15%, I mean, some of that is sport-specific, there's not a ton of evidence of return-to-sports rates or time for return-to-sports, I think, just because every sport's load on the shoulder is different. I mean, a baseball pitcher is gonna be different than a volleyball and there's load, it's just a different type of load. And I think it's hard to draw

evidence, we need more evidence on sport-specific, or position-specific rates. So in predictors for return-to-sport, we don't know, again because it's pretty sport-specific, in general, there are some studies on isokinetic data looking at 10% deficit, the dominant side versus nondominant side. And obviously, there's some baseline strength differences between those sides, too, but then also looking at external rotation, internal rotation. Now, that's a pretty wide range, 65% to a 100%, but there are some references down there if you want to go further with that. We talk about, in terms of scapular upward rotation and scapular stabilizing strength and we've all probably used that in our progressions, they're hypothesized to be a key factor in sports performance.

And there are some functional performance tests that have been gaining interest, but there's just not a ton of normative data, right now, for that and cutoff values really for injury prevention, return-to-sport, we just don't have that, right now, so trying to build that. In terms of just a clinical pearl because that's what we've got, when do you start that throwing program and then load management? Just understanding that. All right, return-to-support program. We're about halfway through, if you guys want to just stand up and stretch, take a break while I'm talking, while I shift gears, go for it, I'm gonna keep going, but by all means, stand up, move around. I've been on a lot more webinars and conferences and meetings than I'm used to, in this whole time, so I think sometimes, I've found that it's nice to get up and move and stretch and just take a breath and take a walk away from your computer for a second, or I mean, yeah, don't go too far.

But I'm gonna talk about return-to-sport programming. So there's really four things and these are on a continuum, too, and these can be put into your program at any time, too. I mean, we're working on movement quality, in different aspects, early on, there's different aspects of that throughout the whole time. Physical conditioning, all of those aspects, I don't want you to think that it's once we get the clearance to return to sport, then they start any kinda cardio, when maybe that person could have been on a bike,

even from early on, just doing range of motion and then starting to up that to keep their heart rate up. Whatever it is, just understand that there's a continuum. But first, we're trying to get through that movement quality and conditioning, as I mentioned. And then sport-specific skills and then that chronic training load. Again, those things can be on a continuum, too, there's very often that the school I work with, we have had a couple of ACL injuries recently and very early on, they can be sitting in a chair on the sideline of practice and dribbling a ball back and forth and just sitting with a ball, that's fine, they're sitting with their leg propped, the ball rolls away from them, a teammate can get it, they're still having that sport-specific skill and we just ramp up or down with whatever we need to. So just understanding that continuum. All right, we're gonna talk about a needs analysis.

I love me a needs analysis, if anybody's been to any talks with me in the past, I really talk about this a lot, but it's so important and it's just something that we have to do for each athlete in each sport. And it's sometimes the bare bones of it, when once you work with a soccer player and you understand their needs analysis, that's great. And then you could tweak it for that athlete and their position in whatever, in football, but just you have to do this, it's so important, I don't say you have to do anything, but it's important, we'll leave it at that.

So we're looking at the physiological and the biomechanical requirements of a sport. So what do we start with? We start with the athlete goals, we talked about this earlier so hopefully you've done that part with your athlete and your coaches and the rest of the staff. And then we take that and start to work it into this needs analysis. So there's gonna be a lot of strength and conditioning principles at work here, that will help get that athlete back to the specific sport, so that's important, too, and just understanding that. I think it's that blend of PT or rehab, athletic training, physical therapy, use that rehab component and getting back to that strength and conditioning. So what do we have to look at? So I mentioned earlier, biomechanics, we also need to look at the

energy sources that are utilized. So we're gonna go into that in a few minutes. Common injury sites, common patterns, so if it's a sport that's heavy in hamstring injuries, that maybe needs to be taken into consideration. Whatever it is, just understanding what's specific to that sport and that athlete. What do they have a history of, let's say, I just worked with somebody, yesterday, that history of chronic hip bursitis, she's a runner, marathon runner, and fractured her ankle, in December, while obviously being in the boot irritated the hip and now going back to running and starting to have the hip pain, too. So what's that athlete's history? What's flaring up, in addition to the other injury? Then there's all the things that we work on as PTs, strength, range of motion, flexibility, power, endurance, speed, all those things. So energy systems, I'm gonna go through this pretty quickly.

And we will talk about, again, very quickly, but it's important to just have a review of this. So ATP, body's energy currency. So we remember this from biology class, we've got the three pathways. Phosphagenic, glycolytic, oxidative, phosphorylative, I've never been able to say that, even from undergrad, but anyway, moving on. Quickly, in the first 10 seconds of a sport, that the phosphagen system is kicking in, you're using creatine, creatinine kinase, then as you move through, so thinking about that is like Olympic weightlifting, 100-meter sprint, you have a finite supply of that, the capacity is pretty limited, so once you burn through that, your body is not able to make more right away.

And then we move on to glycolytic pathway, glycolysis. So this is when the 400-meter sprint. So six to 30 seconds, or, yeah, six to 30 seconds of any activity, I'm laughing 'cause my 400-meter sprint is not 30 seconds, it's a lot longer than that. This is where you have that breaking down stored muscle glycogen and the blood glucose. So just understanding that there's that pathway and you have that acid buildup in the muscles, that causes the body to slow down and then you have the aerobic system taking over. So lastly, I'm sure you all remember the Krebs cycle. I'm not gonna go through it, you

all don't need that on a Friday afternoon, but just that's that aerobic system. So the reason I bring all of this up is because it depends on what you're rehabbing them for. And we need to think of it on this continuum here. So are we rehabbing a marathon runner, or are we rehabbing an Olympic weightlifter, or are we somewhere in the middle? So just understanding what you're getting that athlete back to, you have to build that energy system. Your Olympic marathoner is not going to love you prescribing a workout where you're doing quick short bursts when they need to be able to run 26 miles. Conversely, your CrossFitter may not love and I know running is part of those workouts, I just did one the other day with a lot of running and lifting combined, but your CrossFitter's not gonna love you putting them on an elliptical for an hour and just saying, like, "Build endurance."

Just understand what you need to get them back to. It's a matter of if they love it or not, I mean, I'd say, it's what's best for them. So just make sure that you're setting goals and your building their energy, you're not just getting their heart rate up to get it up, you're getting it up with a purpose and towards what you need to build. That being said, on that continuum here, a lot of team sports aren't really easy to classify, you have all three energy systems.

So basketball, lacrosse is like this, soccer is very much like this. So it's this thing called repeated sprint-ability and it's been said that this is a key characteristic of team sports. And anybody who's played a team sport knows that it is different, you're not just good at running a 100-meter dash, you're not just good at running for distance, you gotta have this strange combination of both of them. So a large part of your soccer match is spent doing a lower intensity activity and then you've got this brief bout of, so you're you're jogging to get in position and then you're sprinting to go chase down a ball and then you're recovering a little bit. So we used to call this, when I was growing up, four speeds of soccer. So it's all out sprinting, close to all out sprinting, running and then recovery, where you're maybe pausing and walking a couple steps and then going to

run again. So basically, you're never at the extremes of your energy. So you're not hitting a speed that you would for one single 100-meter sprint, you're not going all, all out, but you're running faster than what you would run for a 10-mile jog, it's just at different times. So you have to train this and that's just important, I'm just making sure that we understand that that's important. Really the bottom line is you just have to know your athlete and you have to know your sport. And that's why this needs analysis is very important, so that once you've done one for a certain sport, you don't spend as much time on it, you just tweak per athlete, per position and we'll get into more detail later on in this talk. In terms of end stage rehab, you need to be objective. We've talked about some subjective things, but in terms of that documenting the workload, it is a piece of the puzzle, but you do need to be objective and quantify it and constantly reassess it, constantly reassess how that athlete is doing.

So that has been called a key focus area, so just important. And we'll go into details maybe more in a little bit about soccer and basketball and how I would do that with some of that repeated sprint-ability and building the energy systems. So moving onto training load. Like I said, load management, very popular right now. And it's basically because if you're doing too much too soon, you have that increased risk of injury, but then if you're doing too little, you're not building up their performance either.

So you have to find that balance of really loading them up and giving them what they need to succeed in building up that low tolerance, but then not doing it to the point that you're doing damage. So you have to look at two factors. One is the load and then just how you ramp it up. Acute load, so we can look at two things and Tim Gabbett has done a ton of research, which I find fascinating, on it. I think, there's a lot coming out all the time from him and his group and it's a great insight and great data, I think, on how to manage these things. So acute load, so think about, it's Friday, so if anybody who has been working out all week, think about what you did, or what your athlete did, in the past week, that's acute load. Then we think about what we've done in the past

month and that's your chronic load. So you can take those if you quantify, it's the easiest, we're gonna work through a couple of examples in a second, but the acute to chronic load, just being the athlete's current status. So there's a sweet spot that we're aiming to hit and we'll talk about how to calculate this with running and weightlifting and those are the two easiest. So there's a sweet spot that Gabbett's research has shown us that .8 to 1.3 and this is in healthy athletes, this not people that are injured, so just understand how to most accurately extrapolate this, that's the sweet spot. If you're going over 1.5, then you have a two to four times increased risk of injury in the following week.

And if you're going up even higher, then there's a higher risk and it's a following week, so I think if anybody has had a patient or themselves that has been in this situation, where you feel great on a particular week, like, "I feel good, I'm just ramping up," and then you feel amazing and then literally the wheels fall off. And how many times have I had people tell me, like, "God, I felt so good, "I don't know what happened, "now, my Achilles is so flared up "to the point that I can't walk, "what the heck happened?" The data does show that this happens. It's the following week that you really have an issue there.

And that's where it's scary because you can be feeling good and just pushing and pushing and pushing beyond what your body's capacity is. So how do we monitor this? We can look at things like heart rate. We can look at oxygen consumption. We can look at rate of perceived exertion, so for somebody that doesn't have a Fitbit, or a garment, or something like that, RPE is perfectly fine to look at. Then we can look at speed acceleration if they are lucky enough to have GPS. Whatever that is, that's that's important, too. So internal and external load. Whatever you're monitoring, just make sure that it is specific to their sport. Otherwise, again, why bother? So I'll have regular conversations with my athletes to, like, "What did you do at practice, "what specific drills?" They may just be like, "Oh, it was hard," or "I was fun, it was fine." "No, what

drills, did you do a post up drill, "did you do a box out drill, "were you just running through plays and just walking, "what exactly did you feel? "How tired did you feel on a scale of zero to 10?" And then you could take other factors in, is it July and you're in a hot gym with no air conditioning, like we have at our high school. "How hot was it, was it pretty hot? "Okay, that's gonna affect you, too. "How'd your leg feel, was it swollen?" Make sure that your detailed when you ask that. And then you also need to gauge mental preparation for how prepared are they to expose into another progression? So once you make that clinical decision that they've done well with that work out based on objective, subjective factors, then also take that mental aspect into consideration, too.

All right, let's work out a couple examples here. So marathon runner, if there were any marathons, right now, Cleveland Marathon was supposed to be next week, there's the virtual option that some people are doing, but I work with a running group, this is what we would have normally been doing in our peak weeks, which was a few weeks ago. So as you can see, every week, you build up their total mileage. So for a runner, this particular runner, I'm gonna take their last week where they ran 30 miles and then I take the average of the four weeks prior and it's $24 \frac{3}{4}$ and then we take a ratio. So there at 1.21, so that's right within that ratio that we're looking for, where .8 to 1.3 is what we're looking for.

So they're right within that and that's okay. Then if anybody has run a marathon or 1/2, you understand that there's taper weeks, which I think is interesting because our athletes always are freaking out, like, "I'm not running my long runs to the extreme, "am I still gonna be okay?" I enjoy the taper magic, this study puts that in perspective here. So we see here, we're starting to decrease and then our acute load, so that person going into race week is running a lot less per week than they were earlier. But if you look at their chronic load, still pretty high and that their ratio is still within that, that ratio's still right where you want it to be, about a .8 to 1.3. So they're gonna be pretty

well rested, but they still have a decent amount of load in there, that it's going to be okay for them for race day. Now, if we look at a weightlifter, then you would just take the total pounds lifted per week and you would calculate that times reps. So here, lot higher numbers here, but so let's say they had, that's their weekly volume of squat and that's their weekly volume of bench press, about 4,800 and 7,200 for the squat. Now, we take that acute load and then we look at their chronic load, same thing, we can just make that ratio, which is 1.09 for that athlete and start to track that. Now, the reality of these, these numbers are great, but I just wanna warn you that we can't just rely on that load, as we mentioned, all these things are multifactorial.

There's so many things, so this is a piece of the puzzle, but even with training load we have to understand that we need to take into account age, physical qualities, training history, injury, stress, health history, sleep. Maybe they're sleeping, maybe they're stressed, especially right now, I don't know, a lot of us, maybe our sleep is a little off. Diet, again, might be a little off, nowadays. So take all of these things into effect when you're working with your athlete and understanding that it's not the whole picture. I'm gonna leave this quote here for a second.

This is Dawn Scott, was with the US women's soccer, she just went back home to England to work with the Women's national team in England, but she was a fantastic coach and credited with a lot of the success that the US had in the World Cup this summer. Gosh, that seems like eons ago. And she is somebody that, they had a lot of monitoring with those athletes, down to the fact that they even monitor their menstrual cycle and having diet recommendations based on that. Now, what she's saying is there's a lot of data, but sometimes it's more than that. So just understanding that, yeah, that's great, but it's really the relationship with the players and understands what they need in that given time. Numbers are great, but there's a bigger picture there, too. And another quote that I love that just talks about the training load. Again, we could just hang our hat on, they got hurt because they train too much and here's your load,

that injuries are complex, we keep talking about that for a reason. It's not just based on numbers and load and that kinda thing. So again, important, need to be objective, need to quantify it, but take that and put it with the bigger picture and in your clinical reasoning skills that encompass a lot of other things. That whole person, that whole athlete that's in front of you. So other considerations, I like this paper that came out, I think last fall or last summer, again, another Tim Gabbett paper, when you think about from the floor to the ceiling, it's just a nice way of describing how we work with athletes, I think. So the floor is where they're at and you need to get them up to the ceiling, to their optimal.

And it's really time you need to get them there. So if you do it too quickly, if you ramp them up too quickly, we've all been in time crunches where we need to get somebody ready to get back to playing, or, let's say, they were going to run a marathon next week, but they were hurt and we don't have as many weeks as we thought to get them up to the mileage they need, so there's a risk there of having them have an injury, but just understanding that.

So things that we can do to make that a little bit easier and this, is in terms of injuries, trying to maintain adequate fitness, doing what you can so what nonimpacts can that runner do, or whatever it is? But same also goes for off-season, so people that, if you're a fall-sport athlete, you can't take the summer off and attempt to come back in preseason. I think we all know this anyway, but you can't just expect to come back at preseason and just ramp up and not have an issue. So there's a big challenge of trying to keep athletes in shape, injured, or trying to reduce that risk of injury by keeping healthy athletes in the game. So also, be realistic about what's needed. So again, that's where that needs assessment comes into play and that's where an honest conversation with that athlete comes into play, too. And then just understanding that there's a difference in training tolerance between athletes. So for all of those other reasons I talked about a few minutes ago, it's important to understand that difference

and plan for it. So somebody may not respond the same way as somebody else for whatever reason and just planning for it and being understanding of it. All right, moving on to sport-specific considerations, if anybody has any questions about what I talked about earlier, feel free to throw it up there and I'll jump over to that. And then we're gonna go through return-to-running, now, return-to-sprinting and then getting into other sports factors. So return-to-running, in terms of ACL, it's usually around three months for running after ACL surgery. Other's injuries, we don't really have a ton of data on that.

Complicating factors, we used to think that meniscal repair would prolong returning to running, there's actually some anecdotal evidence that that's not the case. But really, I think that's a conversation you need have with your surgeon, or physician, or with your whole care team, depending whatever injury it is, on when you can get them back to running, again, needs assessment. But then when we talk about whatever injured tissue it was and what stress is going to be going through it with running, we needed to think about all these things.

And we need to be criterion-based with that. With ACL, I have that on there, criterion-based versus time-based, but it goes with any with any sport, I think, when I started practicing it was pretty commonplace to have three months as being that timeframe, like, "Oh, three months, you can start running today," and that really should never have been the case and even more so, now, years later. So criteria, what we know in terms of the literature, after ACL injuries, like I said, that's pretty much what data we have on this, it's about 12 weeks post-op for return-to-running, but that's based on a study where less than 20% of the clinicians used performance-based criteria and they did what I just talked about. So kinda sad, think we can do better. Just understanding, what are we getting them back to? So running, there's a high overuse injury rate in just healthy athletes and that depends on your mileage. I mean, again, that's a load thing, but we need to make sure that if you have somebody with one

injury and you're throwing them back to running, then they have a risk of another injury. What are your risk factors for running injury? Biomechanical, muscle weakness, or an issue with load progression. So what is ideal? And we'll talk about what's ideal and again, I want you to take this with a grain of salt, as I mentioned, I work with a running group, we have adult runners, we had 130 of them, we were really excited that we started this training cycle with a record number. We had had just under 100 earlier, we were so proud of ourselves and now laughing because sadly, of the year that we had record numbers, of course, there's a ban on gatherings with people.

So all that hard work to grow our group has been, don't know why we picked this year to do that. But anyway, and I had this conversation with our runners all the time because we give a lot of talks, once every training cycle, on what running form is and we do clinics and we do gait analysis and that kinda thing. And what I think we continue to learn is that there's this ideal, but everybody does have some variability in between. And in a healthy runner, I'm not going to tweak things unless I know that it's contributing to their injury.

So again, like I said, what's ideal is this, but I always had those runners coming back to me, like, "You said that my foot needs to be pointed forward, "but my toe goes out a little bit more "and do I need to fix that?" There's nothing, that person is crushing it, their paces and their runs, so why would I tweak something? So just understand that. But foot strike, under the knee, not in front, so you don't want that over-striding in terms of distance running, where they're over-striding, they're almost causing a braking action. Feet and knees should technically be pointed forward, you want a short, quick stride, so it's that quicker, shorter steps because that's been shown, especially lately, to decrease the amount of force going through the legs. Again, like I said, everybody is different. I have people that really get wiggled out about their cadence and they don't necessarily need to, if they're not over-striding, those are just just guidelines for people to follow. So if we look at foot strike, I just have this on here because it's a hot topic,

but a lotta runners do use heel strike, some are more on the midfoot and some are on the forefoot, heel striking has been said to be a horrible thing, but it's really an issue of not over-striding and not having that braking action. So you just want the foot under the knee, not in front, where they're really overcompensating with that heavy strike. So when you are working with an athlete and getting them back to running and we're gonna talk about some running drills in a second, the biggest thing is just understand that retraining their form can take some time.

So whether that's an injury and we're trying to retrain a habit that they had picked up because of the injury, all of these things, it's gonna take some time. So think about whatever cues and I've got a couple listed there, that you would wanna use throughout that run, or sorry, you want throughout that athlete's workout. You want it to be as easy for them to follow as possible. So one thing that they can think of, like squeeze your butt muscles, or an externally focused cue where they have a target. So run on the track, have a line, you run and try to step equally on either side of the line. So have that you straddle both lanes and just make sure that you're not crossing your foot over that line. Just certain things like that, that can help.

And then use intervals when you do it because if you tell somebody to go out for 30 minutes and try to run and focus on how they run, first of all, they're going to be really annoyed. I would be really annoyed. They're gonna be way too in their own head with it, so just use intervals, like one song on, two songs off, let them continue to have that enjoyment of the run and that helps with motor learning, too. So form running drills that I use with athletes when I'm trying to get back to sport, high knee to lunge, I like this where I make them pause, this is a slow, they're marching up slowly on that leg, so bringing one knee up slowly, pause for a second and then going into that lunge, so they're finding that balance point and the stability there, but still working on that knee drive to start out that start of the stride. A-skips where you're trying to come up to 90 degrees and just skipping and working on more of that ballistic power and timing. High

knees, that's more of a quick feet, quick reaction thing, I try to get them to listen for that, whatever injured leg it is and whatever injury it is, making sure that it even sounds the same, that that foot strike is whatever rhythm that they're going and just being really symmetrical with their movement. And sometimes that's easier than others to do, but that we have to really focus on that and get that right before we let them progress distance. And then statement butt kicks.

Butt kicks, just with that active knee flexion, that is very important. Running mechanics after ACL injury. There's a little bit of data on that, altered mechanics with it, but is that due to quad weakness? It would make sense, but we can't definitively say that. Moving on to return-to-sprinting though. So what happens between jogging and sprinting? The biggest thing is that your stance phase decreases. And then you have this rate of force development, you have to put more force to the ground to be able to propel you, that ground reaction force should be able to propel your leg and your body for it.

So you have that, that time and stance phase decreases, it's quicker, but it's a harder drive through the ground. Whoops, I hit that too hard, where am I at? Wow, I went pretty far. Okay, strength and power. So criteria for return-to-sprinting, just in general, there's not a ton in the literature about this, but as a general rule, you should be jogging or running for at least about four weeks without any injury. So you do wanna build a little bit of a base, regardless of what it is. Do you have to spend a ton of time developing distance? No, we just talked about energy systems. If you have somebody that is a track sprinter, you don't need to have them running miles, but they need to have at least a base of being able to take impact before we increase that impact through their leg. And then just good control, being able to jump and land on one leg so that you know that they can drive through the ground and have that ground reaction force. You need a little bit more mobility with returning-to-sprinting than running. You need full hip flexion, you need full hip extension to be able to go through that whole runner stride and then you need more knee flexion. But just try it being able to get, I'm

gonna go back so you can see, sorry for going back, but just so you can see. Right here, you need to get that heel to butt, that's that first part of that, that sprinting phase of swing phase, there. So what do we do, how do we get them back to this straight line sprinting? And we start at about 50%. There's a paper, I'm gonna go to the next slide here, Dan Lorenz just came out with a paper, last month, in the International Journal Sports Physical Therapy, so good timing for this, that had a good progression. So stage one is you're building a capacity for that higher intensity running in fitness. So that cue is about 50%.

And the paper, for time's sake, I'll have you guys, if you're interested, it's a great download, it's a great reference, go ahead and look it up online. But he has a little more detail about work-rest ratios and how to do this with distance. Basically, you're starting with 20 yards, then 20s, 40s, 60s, 80s, 100s, you're progressing and you're doing quicker workouts that way and then just tracking the total yardage. Stage two, then you're going up to 75% of your max effort. Basically saying, like, "Don't reach top gear, "but just go a little harder in stage one."

And then you're still focusing on techniques, so just understanding that, no matter what, their speed is increasing, but they have to keep that same form. And our job is to make sure that that is happening. Then we start to go into the last stage, where you're at 90% to 100%. So you should be very close to your max effort and we're working on that. And recovery and between sets is important, too. And that paper does go into more detail on that and I really recommend you reading it because I think it's a great reference and just some details that you wouldn't think about, instead of just saying, like, "Go run a couple sprints," it really lays it out of "This is what your work-rest ratio should be." So return-to-cutting. Last part before we go into specific drills of perfect work. Good for our last half hour here, time-wise, like I said, we'll go through this and then I'm gonna go fast through the sport-specific drills, but that's all of your cues, too, if you have any specific questions per sport, please chime in and I'll know to spend a

little more time on one versus the other. But anyway, moving onto cutting. So for cutting sports, this is important. And just understanding that, I always find it funny where we used to really be big on hop tests and obviously, they're still important, but if my athlete can jump and land on their leg, that's great, but what if they're a soccer player, I need to make sure that they can cut and plant on their leg. Sticking a landing's great, but you need to assess that differently than can they turn and pivot and check to a spot on the field and then completely pivot on that leg and get open in another area? So knee valgus angles, when we look at that during drop jumps, or jumping, landing, really doesn't predict anything during sidestep cutting, there's not a good correlation there. So when we work on cutting, how do we do it?

There's different angles of the cut and I think we have to progress all of them. So as you can see, there's a progression there and then looking at movement quality between everything. So couple examples, I'm gonna show a couple of videos here of, this is a lateral cut and just watching the drill and what we're doing for movement here. We're gonna play this video. And this will load up. So cutting and motor learning and techniques is a whole other topic for another talk, but just understand that, first, what we're doing is we're training sidestep cutting.

And what I'm having her do is work on planting through her leg. And what I'm cueing her to do, well, we'll see this is video one and if you can tell which leg is injured, I'll let you watch and see. I'll play this video twice, but if you can kinda tell which leg she's not really getting a full knee flexion, I'll give you a hint, or really getting all the way to the cone. So I'll play this twice here. So it's, wait to the next rep and you'll be able to see. So compare one side to the other. Do you see that left leg back there? So she's not, it's the same degree of knee flexion on one side versus the other and she's holding it out to the side and not really putting full weight through that leg. So what I did in the next and we can go to the next video and then had her take a water break during the reset and then my instructions for her were to come back and think about

getting her belly button over that cone on the left side. So really getting all the way to that cone and focusing. So I mean, obviously, it's not as quick of a stop and land, stop and plant, on the other side, but just trying to work on loading that to the same degree. So just working that angle first, in this lateral side to side movement before we go on. And we can go back to the slides and then we'll talk about going on from that. So another way of doing lateral cutting is just to challenge their, we'll go on, we've got one more video here, to challenge their angles a little bit more, just sidestep cutting. I'll play this video here.

So sometimes I'll throw down some hurdles here and I'll have a little agility drill and then stopping, so it's lateral movement, quick feet and then stopping here. And I always love this video because of the girl in the background here, that I'm not sure what she was doing. I've worked with these two girls, I actually coached one of them in soccer for many years, but we'll play this video. Just understanding, focus on the girl in the front, not the girl in the back, but coming down quickly and then stopping and planting and landing on her leg. So once they can get the side to side movements down and then we start to work 45 degree, 90 degree, 180 degree, we're thinking about drills like, we'll go back to the slides here, other drills that we can do that will bring some of those other angles back into play.

And so T-test, this is another drill, or a test, that you can use for functional testing on change of direction, where they're running forward to the cone, side shuffling, side shuffling, side shuffling and then backpedaling. So you're getting a little more change of direction there, then I love this figure eight hop because it gives you more of pivoting motions, starting to change directions a little bit more. So they're jumping on one leg in this figure eight around for two laps and then we compare one side of the other, but you can use it as a training tool, that kinda thing. Then other drills that we'll use are a pro-agility drill, I'm just gonna use my cursor on the screen so you can see. So pro-agility, you'll really be starting in the middle here, sprint to one cone, touch it, turn

around 180 degree, cut the other way, turn around and then run through the center. So we're moving on to other sports, so once you get the basics of running, sprinting, cutting and this is just building on that more, like I said, this is a continuum and people are starting that at different times, different ways, but we're gonna go through, I'm gonna use soccer, when we talk about needs analysis and a task breakdown, I'm gonna fly through these slides, so feel free to tell me to slow down if you want, but I just wanna give an example of what I do for a needs analysis and then we'll go from there. So a soccer player, they sprint every 90 seconds and they have 150 to 250, a lot of brief intense bursts of speed, change of direction at high speed in every match.

So just understanding, it's that repeated spreadability and just cutting sport, change of direction. 111 on the ball activities per match and I love the stat, 726 cuts per match. So we just talked about how important it is to have different cuts, being able to have them cut and plant on their leg at different angles, here's, case in point, why it's important. Different positions have different responsibilities, or different energy profiles even, so just understanding that your center midfield, fullback, forwards, they may have a higher intensity running, people that are center defenders, or sweepers, as you call, less distance.

Wide midfielders are doing a lot of sprinting back and forth, one of my teammates in college used to say that she thought of herself as a dog chasing a tennis ball, just literally going back and forth up that wing for 90 minutes. So just understanding what position that athlete, this could be what basketball position, what football position, we're gonna about that in a second, all of those are even important, too. So different types of fitness that you want to emphasize, very important in terms of, like I said, forwards, midfielders and then goalies aren't really doing a whole lot, in terms of running, but they need a lot of explosive strength and power. So that's more of that phosphagenic system, just something that's different and that's what you wanna train. I'm not gonna send my goalkeeper out on a 10-mile run, but I might send my center

midfielder out on a long run, yeah, 10 miles, but just understanding that difference. Again, goalkeeper, you're emphasizing high reaction drills with them, in terms of shots, breakaways, corner kicks. It's that explosion, reaction training and just, example, like a thud on the ball as it's leaving that attacker's foot and being able to react that way. Power, being able to jump in different directions. There's a paper on the biomechanics of shooting and just understanding what they need to go back to. Again, you should do this probably for whatever sport, what if they're swinging a baseball bat, if they're swinging a golf club, they're pitching, what are the biomechanics that you need to get them back to?

And you really need to dive deep into that when you're working with an athlete. If you haven't addressed everything that they need to be doing, then they're not ready to go back to sport yet and you're not ready to discharge them. So just understanding that reference there for you from JOSPT, from 2007, I feel like that article just came out, but I guess not. So anyway, return-to-play progression. Time flies and especially with this talk, too, when you get through another 20 minutes of working through some of these sports.

So return-to-play for soccer, for example, you would get their fitness, like I mentioned, that energy system back. Then going back to noncontact drills and then you start to bring in some controlled contact. So we can start to work on working off a defender, bodying for a ball, those kinds of things and then returning to competition. Things that are noncontact for a soccer player, you have passing, shooting, foot skills, fitness, all of those things. Those are things that they can do pretty early on, literally, as soon as that's safe, sometimes passing and shooting are very early on, sometimes I can have people juggling and sitting and doing that, like, just six to eight, you're not juggling, sitting on their butt, instep, just tapping a ball up in the air, like a six week mark if we're thinking like an ACL. So in terms of noncontact drills, things like foot skills, you can progress their technique, you can increase the speed of it. We're gonna play a video of

just some examples of things that they can do and I'll talk while you're watching this. So just different drills here, working on pulling the ball back, different change of direction, inside, outside of the foot, different angles to just help build, you need all of these, but just to start to work on that change of direction there. You can increase the speed, you can make them do this move and then turn and run or sprint to another place in your area that your rehabbing. Receive a ball, you can pass them a ball, then have the receive it and then dribble. Whatever variation you wanna do is important. And it makes them happy because their touch on the ball is so important and that's what they're so worried about getting back to, so just understanding that.

All right, we'll move on to the next, I like to have people do this for a minute each and just go through a couple of rounds, so one minute per drill and just set a timer and then up their rounds, go from one round to even five rounds of it. So then that's what I've just mentioned, things like passing, you're gonna progress how far they're passing, same can be done for any other sport, lacrosse passing, basketball shooting, all of those things, just be very gradual and be very thoughtful about how they're doing that. Shooting, soccer players, you can have them just start by holding the ball in their hands and then progress to the ball on the ground 'cause obviously different load goes through that.

And then when we work on controlled contact, so what that is is just working on first defensive positioning and then just starting to gradually work through reaction drills. If you have an athlete that slide tackles a lot, you can start to just do it slowly with a stationary ball and then just gradually building that distance of how they're sliding. That's something if you're not as familiar with soccer, you could bring a coach in, too, and just talk to the coach about what's involved with that and use your clinical judgment of how to progress them. Try to maintain a low center of gravity, when they're doing that and have them work on that. Then you bring a teammate in and you work on shielding a ball or getting a pass while their shielding a teammate. And you just start to

progress through, competing for a ball in the air, that's also important. And then gradually returning to competition. So basically, I'm gonna go through some of this, but you would have them playing as an all-time offense and having them wear a penny that nobody can touch them. They could just work on checking and receiving a ball, same thing, we've done this at basketball with athletes that I've worked with, too, and then you start to let them have some contact and have their teammates start to contact in with them. So you just do that and then building up, so small-sided games to full-sided scrimmages and then playing and gradually increasing their minutes and monitoring their load through that.

Now, football is a bit of a different animal, just in terms of the positions on the field are all, I mean, each one or each group of positions do really have those specific demands and just understanding what the fitness of an offensive lineman versus a fitness of a wide receiver or tight end would be and what movement pattern they're going through. So I think it's fascinating and I love that about football, but I think you really need to understand that you're not just getting somebody back to tackling, I think there's a lot more involved with that. Obviously, there's a huge demand on the lower extremity for force and power and contact from other players and being able to provide, either to produce that contact, or to hold off that contact. There is an article, 2012, I think it was very well done.

That whole JOSPT, in 2012 issue, I wanna say it's February, don't hold me to that, but references, you can download those, talk about return to skiing, football, soccer, bunch of different articles. And the football one is a well-written article. What they suggest is not a ton of literature. If you look at motor learning and just start to have discrete movements and then just start to make them more random, working on reaction, as we talked about. So working on a 10-yard acceleration and then, from there, starting to add other elements that are more variable into it. Then you're just linking together, you can change the order of different things for your athlete, adding in different change of

directions and then starting to introduce reaction drills. And also, progressing movement, linear to multi-directional, obviously things that we use all the time, double to single leg, all of those things. Criteria for returning, thinking about position-specific, really you want to, again, those random movements are really important and positional-specific movements, again, very important and just looking at both sides for comparison. And then, interesting statistic, the majority of NFL injuries have been late in games, so you could use a fatigue protocol, just to have them start to work through that and understand how to fight through some of that fatigue. And then using a similar work-to-rest interval to simulate what they're gonna be going back to.

Moving on to basketball, a lot of basketball injuries are noncontact and it's a lot of off-balanced landing, you're going up for a rebound, or getting pushed in the air and your landing off-kilter there, so just the risk in that and what you're sending them back to, we can't change those, I can't take away the fact that my player's gonna get knocked when they go up to rebound the ball, but we need better prepare them for it, obviously. Repetitive high-intensity actions if we look at the task breakdown and there's a lot more anaerobic type of energy systems, there is still that repeated sprint-ability, but with timeouts and different things like that, there's that play, sprint up and back down the court and then a stop, that kinda thing. You change movement patterns every two seconds.

Again, I find these biomechanical stats quite interesting and very helpful when you're guiding what you need to get back to doing. A lot of jumps in a game, your sprint length is a little different than somebody who's playing soccer, but there is still hefty amount of sprinting in there. They're running about 4 1/2, five miles a game. And just understanding what's different in that position of a point guard, versus a shooting guard, versus a power forward and center, that kinda thing. And in knowing what you need to get them back to. What do your big players do? What's your center doing versus what a point guard is doing? And that varies with different agility drills, different

things you need to have them do, things you can have them do, like a low post drill where you have a coach, or a player, or PT start to gradually build up that resistance to the back, like a low post player, having them start to work on boxing out there. Again, 2012, JOSPT Waters article is the same issue that was the football article. And it's a great article with a lot of good pictures and ideas for drills if you're interested in that. I really like how he had all of that laid out. I wanna say he was a PT for the Bulls. So just things, and leap contact, just gradually progressing the amount when they have to leap and land and take contact. All right, two more I'm gonna fly through in the next maybe five minutes or so here and then give you guys a chance for questions.

Return-to-skiing, there's so many variables with skiing, but when they're turning, just understand that there's a little different stress between the inner leg and the outer leg and that varies, obviously, from how tight of a turn you're gonna have. Is it like a slalom racer, is it somebody trying to get back to navigate a black diamond, on a weekend ski trip, whatever it is? The outer leg is the main weight-bearing leg, but I mean, it's not like you can just favor on a ski slope, you gotta turn onto one, you gotta turn on the other, at some point, down a hill, but just understanding that. Giant slalom turns versus parallel turns.

Especially if you're racing and you're in a tuck position, there's a significant amount of muscular effort that is needed to maintain that deep flexion and control and deep flexion in that muscular strength. So just understanding what you're training for that. And a lot of times, I've seen that the literature is advocating that, as soon as you can build up that squat tolerance and having them train in that squat and that tuck position and doing weight shifting and different things, it's very, very, very important. And that as soon as, whatever phase of rehab, if they can squat on that leg, introduce that as quickly as they can for whatever injury. Oops, other considerations, sorry for skipping back and forth there for a second, visibility, weather, grooming, time of days, in the last run where everything's really icy, or is it fresh powder, just all of those things need to be

taken into consideration when you're talking to an athlete and what you phase them back into doing. Wind, fatigue, how they times it's the last run of the day is when they got hurt, or, well, it became their last run, sadly, of the day? So again, early rehab recommendations. Early on, this article is from that same JOSPT issue that I keep talking about, start to use the quad as soon as possible, that's from in terms of ACL, but I think there's so much quad recruitment required in this sport anyway, that as soon as you can do it safely, for whatever injury, it's important. And then just working that tuck position is really what you wanna be able to do, according to the guidelines of healing. Adding things in, like perturbation training, very important, weight shifting, sports cord, plyos, whatever it is, again, important. Important in many sports, but important in skiing and in just trying to be able to take that unpredictability that a hill can throw at them.

In terms of getting back to sport, if they're with a team, you can send them back to dry land training, if they're not with the team, you probably need to help develop a progression for that and that's something that you can develop, along with the skier, with different resources you may have. Then working back from groom terrain, lower intensity hills, to speed intensity, all of those things and then just adding things like gates, moguls, pipe, skate park, whatever you need to do. Interestingly enough, from this paper, they recommend to not leave the ground during skiing for the first year of rehab.

So thinking about ski jumps, and this paper is a little bit older, I have not seen any new literature on it, if anybody has, please chime in and I'll share it with the group, for that, but just thinking about other terms of skiing, aerial skiing, ski jumping, all of that. All right, return-to-volleyball, you guys are in the home stretch here. So injury incidence for volleyball's a little bit less, but most are during jump landing. So spikes, blocks, 70% of injuries are linked with that. And unilateral landing is the most common mechanism of knee injury, which makes sense, in most sports it is, but volleyball, I mean, you're doing

it so frequently that it can lend itself to increasing that injury risk. So in terms of task breakdown, you've got your jump serve, your spike, they're jumping in the air and they're at the highest point of that jump, striking the ball, that's a max effort. And then on the opposite end of the net, you've got players that are trying to block that ball, jumping in the air and that's not a maximal effort, but it's a reactionary effort, so it's that reaction. So just different things that can be affected with that and we've talked about that in terms of how you're getting your athlete back and in preparing them for reaction time. The jump height is less important than, we're making sure, in terms of ACL injuries, knee angle. I mean, you can extrapolate that to other injuries, too, using clinical judgment. Just in terms of landing force and knee extension, that kinda thing. And just some stats are there on blocking.

Again, these slides are for your reference, so if you have an interest in that, references are there, you can go back to these slides and go into more detail about what I'm saying. Majority of these landings occur on two legs, but the frequency of landing on one leg is sometimes related to how quick a set is going. So if they're spiking a faster set, you may just end up coming up and down on one leg, or just off asymmetrical landing there. And then, again, this is just a little more statistics on one leg versus two leg, skip through this, average play's about six seconds, average rest is about 14 seconds.

You have rallies per game. I mean, some of them last a little bit longer than others and just understanding that they need to work them back to that. So what you really wanna do, in terms of conditioning, is training for a lot of repeats that last five to 10 seconds. So gradually building up that tolerance of those repeats, up to 50 is a lot, but if that's what they're going back to in a match, you need to understand that that's what they're working towards and use your progression of load management appropriately for that. Obviously, plyometric progressions, we do this, I think, with most athletes, double to single leg, very important in volleyball, for reasons that I just talked about. Then

increasing that height of jump landing, reaction drills, spike blocks, skill work, some of that skill work can be very early on, where they don't have to jump and land for and they could work on standing, hitting the ball. Perturbation training, important, too. If they're going up at the net against somebody else, or if they're going jockeying for position, just trying to get around a teammate, or that kinda thing, they need to be prepared for that. And then, again, whoops, back line players, just thinking about that that's gonna be different than what a setter needs to do, in terms of their sprinting to the net, or a back line player, maybe a little more lateral movement. And that is about it, just some other volleyball specific return-to-sports and just other considerations with tendinopathy being important, but that's it.

So I'll take questions in the last couple of minutes, especially with those slides that I flew through. Thank you guys for bearing with me with that. "In my experience, any specific external stabilizers "that help in knee-related injuries "during the return-to-sport phase "and also training and strengthening "that includes more eccentric strengthening." That's a great question, it depends, I do a lot of, in terms of like external stability work, a lot of plyometric work, but a lot of reactions, like sport-specific, so being able to sprint to a spot, plant, stabilize on their knee, like I'm just using soccer, for an example.

So having them sprint to a random spot, stabilize on their knee, get a pass, pass it back, turn, sprint to another spot and just having random game-like situations there. I guess it would, just really has sport-specific, with skiing things that are like perturbation training, where they're working on sport cord perturbations, or being on an unstable surface perturbations, or basketball, with like a box out drill, where they're having to work on holding stable with their knee, or even just balancing on one leg in an athletic position where the knee is a little bent and having to hold stable that way and then having somebody, you can do some light perturbation training that way. And then in terms of training and strengthening that involves more eccentric strengthening. Even

things like, that's a great question 'cause I think that's so important, you need that eccentric control in almost every sport, even done running, for force absorption. I love single-leg squats and any variation of those, I think, is really important. I love working on holding a landing and sticking a landing when they're doing single-leg jumps in various directions. I still think tap downs, like single-leg tap downs off a step, where they're just doing that, lowering down is important, split squats, or Bulgarian split squats with weight, that you can load them up and working on that, that depth, making sure that they're hitting the same depth of one leg to the other, those are all important, too, in terms of eccentrics. I just had somebody, yesterday, with an Achilles issue working on eccentrics for Achilles, but really controlling that load without letting them hold onto anything and just prolonging that one count on the way up for a heel raise and two on the way back down. So good question, any other questions? All right, well, thank you, guys, for, like I said, bearing with me. That was a lot of information in a long, well, kind of a long time, so appreciate that. Thank you, guys, all of your questions, I really enjoyed those, so thank you. It's nice to have a interaction with people, I always enjoy it, but especially more these days, these weeks, so much appreciated. All right, well, I think, if anybody has anything else, just go ahead and ask it. If not, can probably let you guys enjoy the start of your weekend. Aw, thanks Shannon, thanks for listening.

- [Calista] Well, thank you everyone and thank you, Dr. Mac, for sharing your expertise with us today.

- Anytime.

- And I'm gonna go ahead and close out today's course. And thank you, everyone, for attending. Have a great day everyone.