Principles of Strength and Conditioning Applied to Rehabilitation

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- [Calista] The title for today's course is Principles of Strength and Conditioning Applied to Rehabilitation. And I would like to welcome Dr. Carol Mack to physicaltherapy.com. Once again, Carol is the owner of Cleveland Sports PT and Performance in Cleveland, Ohio. She graduated with her doctorate degree 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 Interests group, through the APTA. And she is now vice chair of educational program for American Academy of Sports Physical Therapy, as well as a member of the US Olympic Committee's volunteer medical staff. So, thank you for presenting for us, once again, today, Carol. And at this time, I'm gonna turn the microphone over to you.

- [Carol] All right, thanks, Clalissa, I appreciate the introduction. I appreciate the chance to be back here presenting again. I always love doing these webinars. And it's a nice thing on Friday afternoon, at least, for me to do this. So, thank you all for joining me. We're gonna go through the outcomes, just so you all know, clearly, what you're gonna be learning about for the next two hours. So, after this course, my goal is for all of you to be able to list at least three concepts of exercise physiology and understand their application to strength and conditioning. So, a good review from a lot of our couch coursework. Then, describe at least five concepts of strength and conditioning programs, things that you can use to modify movements for the rehab setting, and then outline at least one concept of program design, just to be able to apply these concepts and appropriately progress our patients and athletes toward our plan-of-care goals. So, we will get started. Before I start, I don't know if anybody's ever heard of something called the Daily Stoic. It's basically a bunch of quotes from stoic ancient philosophers, Marcus Aurelius, Seneca. Anyway, basically this book is, every day there's this little reading and you read and you can journal about it if you want. It's something I started this year for January 1, I've been reading these every morning. I

had a laugh because today's, it's quick, I'll just read it to you all. It talks about pushing for deep understanding. So, the quote is "I learned to read carefully "and not be satisfied with a rough understanding "of the whole, "and to not agree too quickly with those "who have a lot to say about something." So, I read this morning and I thought oh, that's really cool, because webinar, and basically the concept is just to be present and to really take in a deep understanding of what you're learning. And I thought that was very fitting. I also had to laugh, then, the more I thought about the second line, about not to agree too quickly with people who have a lot to say about something.

And you're all here to listen to me talk for two hours. So, take that with a grain of salt. I think they're getting at people that just go on rants about things. And I promise that these slides were thoughtfully put together, and I'm gonna try not to rant too much. So, anyway, moving on. So, what I wanna talk about is a lot of the traditional thinking. Us, in the rehab setting, we get an injured athlete. And in the strength and conditioning setting, everybody kinda thinks about that as training the healthy athletes. So, the traditional continuum has been you get injured, go to PT, then you're done with your PT, or maybe at the end stage of PT, we turn things over to the strength and conditioning coach.

And the strength and conditioning coach gets that person back to return to sport. The way that I see it is that it's more of a continuum. So, initial stages. Athlete gets injured. Our job as physical therapists is to correct impairments, but it's also to maintain fitness. And I think a lot of us do this, but I just wanna talk about it because it's kinda central to this whole presentation. As soon as we can get that athlete to maintain whatever type of fitness is specific to their sport, whether it's a soccer player that had ACL surgery, we use the bike a lot for range of motion, but maybe we need to keep them on that bike for a little bit longer and try to develop a basic cardio fitness before they can start running. Or examples like that. I think that needs to be a central part of our plan of care. Whether that's something that we can do during our visit with the

athlete, or whether that's something we can educate them, or getting other strength coaches involved from the beginning, I think that's really important. To use that ACL example again, to, an athlete that, I have to do this quite a bit in my role, as I work in a high school. I'm a strength and conditioning coach and I work in the training room. So I get to bridge both of those things. But we did just have this with an athlete that tore her ACL, basketball player. Trying to keep her involved as much as possible, with every time the basketball team's in the weight room, she's in there doing upper body and core. Might have been pretty early after surgery. We can get a bench for her, we can get her sitting so that she doesn't have to be standing on that surgery-repaired leg. But, keeping her involved as much as possible. Maybe doing seated dribbling drills while the team is playing.

And then, in addition to her ACL rehab exercises. All of those things could be started, obviously, very early on, and they're so important, I think, to, one for the mental health of the athlete. And it makes the rehab go quicker. Two, it makes your job in the end stage, when you're trying to restore, get them back to sport, we've already laid that foundation and had a good baseline of whatever is necessary for their sport. Whether it's conditioning, skills work, fitness, all of those things. So, we're gonna move on to exercise physiology.

Start to talk about different types of fitness and again, this should probably be a review for all of you, but probably a good one. 'Cause I know it's not something that I think we apply on a daily basis, but maybe going back to the principles of it is important too. So, if we remember ATP, that wonderful ATP. It's the body's energy currency. So, you really need it for every movement, every exercise, every function that we do, whether it's working out or not, just daily living. ATP gets to the muscles via three pathways. And all those three pathways are important in terms of sport. So, we're gonna go into each of these for a good review. So, first one is the phosphagen system. This is the first system to kick in in the short term, so, less than 10 seconds. And the way, at least,

I remember, this is, you always hear about athletes or baseball players or people that lift weights taking creatinine supplements, and if you think about, that's basically to improve muscle performance for short-term things, weightlifting, like I said, baseball. Hitting, throwing all of those things. Well, the more creatinine in the muscles, the more the system available for high-intensity, short-burst contractions. And the more force would be that exerted with lifting weights or hitting that baseball or just better performance. So, that is, obviously, the first system to kick in. It's that power, just a quick burst of energy. Think about it that way.

Again, as I mentioned, Olympic weightlifting, 100-meter sprint. The only issues, we only have a certain amount of ATP, creatinine stored in our bodies, so, there's only a certain amount of the system we can use. That's why it runs out after about 10 seconds. Then, at that point, glycolysis takes over. And as we all remember, glycolytic pathway takes over between six to 30 seconds. It actually starts at the same time as the phosphagenic pathway, but it makes ATP and it makes it more slowly. So, it kicks in once those initial stores run out. What happens in this pathway, is it breaks down the immediately-available blood glucose, and then the glycogen that's stored in our muscles, and the glycerol back bone, if anybody remembers that, that's from triglycerides or fatty acids that are also stored.

Just wanting to review that from a physiology standpoint, and also a nutrition standpoint. We end up making, y'all remember that wonderful cycle? I can't tell you how many headaches this gave me in college, but we make four ATPs with it, then it costs two, so we really only get two ATPS for every one glucose. Did anybody else have that for their very first college exam? 'Cause I did. And as we remember, as a byproduct of this, it also creates two pyruvate and two NADH's as a byproduct of this. And we'll touch on that a little bit when we talk about lactic acid, which we're covering from some of these exercises. So, as I mentioned, this is from a recovery of fatigue standpoint. This is important. What ends up happening with the glycolytic pathway, is

we release hydrogen ions. And the hydrogen ions is actually what fatigues muscles. You have this NAD that picks up hydrogen and pyruvate and that creates lactic acid. We always hear or we felt, all of us, the burn in our muscles as we're working out, just talking about lactic acid buildup. Lactic acid actually buffers the hydrogen and carries them out of the cells. It itself does not cause the fatigue and muscle burning. After about 90 seconds of intense exercise, the acid buildup in our muscles causes the bodies to slow down, and that's when the aerobic system takes over, that we're gonna talk about in another slide or so.

So, I think we all fall into, as I just said, we hear about the trap of lactic acid buildup and that's kind of ingrained in all of us to say. Or hear about talking about after exercise or for recovery, we need to flush out the lactic acid. Well, it actually kind of buffers out right away. It's kind of your body's internal checkpoint for that high-intensity exercise, not allowing it to continue. So, just understanding that that's a little bit incorrect in terms of just from everybody that thinks that lactic acid is what causes that. We need to flush that out.

For all of the recovery things that are so trendy right now with the door-ma-teck boots or muscle stimulation, all those things. They're pumping out other metabolites, but they're not pumping out lactic acid. Anyway, moving on to the aerobic, the oxidative phosphorylative pathway. This is what keeps up our endurance. So this is what, if we're running a marathon or long distance biking, walking, those kinds of things. This is the system that we're using. Two processes for it, the Krebs cycle and electronic transport. I'm not going to read the last two bullets for this, just, they're here for anyone who's a glutton for punishment and relearning all this stuff. Just wants a little review, I'll leave it up here for a second before I switch slides. So, putting all this together, the energy system, it's on a continuum. So, we talked about that zero to six second, maximum intensity, so going to do a heavy power clean, going to, like I said, try to hit a home run, throwing a shot put, all of those things, that's what the ATP-Pcr system is

starting out. Then, from six to 30 seconds, glycolysis kicks in. You're still able to run, thinking about a 400-meter sprint. That's kinda where we're in that window of that. If anybody's run that, you can kinda feel how that feels on your legs. That anaerobic fitness. Then, after about 30 seconds or so, it's really all just glycolysis from that to 120 seconds. And then, after a couple minutes, the aerobic system starts to kick in, it kinda blends with glycolysis, and then after, we're just straight aerobic fitness. So, just understanding that, when you're working with an athlete, no matter what, understanding, we're gonna talk in a lot of detail later about a needs analysis of sports and understanding, but understanding what energy system they use in their sport is very, very important.

So, are you working with a track and field athlete that is a sprinter? So, that's an aerobic athlete. Are you working with a weightlifter? Are you working with somebody in team sports, which is a little more complicated and we're gonna get to that in the next slide. Are you working with a marathon runner? So, everything that you do with them, in terms of sets and reps of exercises or like I said, fitness from the get-go, really should be geared towards maximizing those energy systems, or preserving what you can of them while they're rehabbing.

And then ramping up as they're able to. So, as I mentioned, team sports get a little more complicated. And I don't know that you all got this info in exercise physiology. I know that I did not because it's a little muddy. Like I said, it's easy to classify certain sports. Straight aerobics, straight anaerobic, but team sports, if you think about soccer, basketball, or lacrosse, or any of those sports, there's this constant cycle of repeated sprints, what we call repeated sprintability. So, basically, you're sprinting, then you're kinda jogging back to a spot. Then you're sprinting again, and you're doing that for soccer, 45 minutes and then another 45 minutes. Basketball for a full game. All of those things. So the fitness needed for those sports spans all three energy systems, and just understanding that you need to train that. So, it's that combination of aerobic and

anaerobic fitness. In those sports, what I tend to do for an athlete, is you need to keep that base of aerobic fitness and that's usually the easiest one to keep early in rehab. And then, you start to layer in this anaerobic training on top of that. So, you have, again, this ability to repeatedly sprint, repeatedly go into that anaerobic state. So, as I mentioned, it's been said that this repeated sprintability reflects a key characteristic of team sport. It really is. I mean, how much fitness, if you see how an athlete can play, I'm gonna pick soccer, just 'cause I played soccer, and it's an easy go-to for me, but 45 minutes of a half of a match, first half of a match, how that athlete can make a run to get down the field in the first 10 minutes, really, the goal is in the last 10 minutes of that half that it's the same or the last 10 minutes of the match, that it's the same. And that can separate ability and success from failure in a match. So, it's very important. That being said, they're making a sprint pretty fast, but they're probably not making a sprint to the degree of, if you think of a track and field athlete that's lining up for a 100-meter dash, and that's their all-out one shot, 10 seconds, and that's all they have to do.

So, everything they've got for that. Versus, like I said, 90 minutes of a match. So, there's this, with repeated sprintability, the athlete is not usually utilizing the extreme ends of the spectrum. So they're not going all out and sprinting, they're not going all out on the aerobic end of the spectrum too. So, just understanding that you need that good, well-rounded blend of everything. And just understanding that fatigue accumulates over a longer-term time period versus somebody who's running 100-meter dash or even a 400-meter dash might be a better example if anybody's felt what that feels like in their legs or their body towards the end, where you're kinda just done. There's no way you could probably run anymore after a 400. So, just understanding that. And I really think that's a key concept in rehabbing the end stage of any athlete that plays a team sport. So, knowing your athlete and your sport and really, this is the first, or probably the third already, of a thousand times I'm gonna say this during this talk, but just knowing that is crucial. And just knowing it from day one

and knowing what you need to get them back to doing. So, when you're in the end stage of rehab, and I really, as I mentioned, this should be thought of from the beginning, but start at the end and work your way back when you're setting those goals, initially, in rehab. Be objective and really know what you're working towards. And then when you get to that point that you can quantify and document that work load and just reassess, just understand that writing those down, as you're writing down sets of reps, that this athlete did two sets of 20 squats and verus, this athlete ran for this long at this heart rate and this thing. So. And I apologize if anybody heard that beeping. I have my iPad that's sitting next to me on mute, but for some reason a text just came through. So, I very much apologize for that. Anyway, moving on. So, we've done physiology of fitness. Now, let's just touch base on physiology of strength training.

So, if anybody remembers this, how any movement is produced in our nervous system and our muscles, the brain signals the involved muscles by recruiting those wonderful things called motor units. And the motor unit is a neuron in the muscle fibers associated with that. And if we also remember, the motor unit recruitment depends on the nature of the movement. So, how you're gonna do a find motor task, like picking up a pencil, versus picking up a 50-pound barbell, things are going to be different and the amount of motor units recruited is going to change to reflect that.

That brings us to something we call a neuromuscular adaptation, which has always been something fascinating ever since I learned about this in school. Just, when you think about strength training, we always think about our muscles getting bigger, stronger, that hypertrophy or that increased cross-sectional area of those muscles. But really, there's this neural change that actually takes place. And neuromuscular adaptation, ends up being that improved efficiency, that coordination of that movement. And at the beginning of a strength training program, that's what's responsible for a majority of the strength gain. So, I find this fascinating and pretty

amazing that our bodies do this, is that our brain and our nervous system teaches those muscles to function more efficiently before they increase their size. It's kind of like when we talk about people learning a skill and proper form's essential before we move up. In weightlifting, proper form's essential before we move up and load you up with more weight. Our brain is essentially doing that to our bodies and we're trying to tap into that coordination. So, if you think about true strength gains come about six to eight weeks into a strength training program, but people tend to notice that they're doing better in the first couple weeks of that program and that is due to the neuromuscular adaptation. So, I'm gonna go into some training concepts, so just talking about mobility, stability, strength, all of these things. So, training concepts, mobility. This is, you guys know this. This is kind of our bread and butter, the general range of motion that we all restore as PTs, that's what we do. Just understanding that the athlete may have to do specific drills prior to lifting weights, doing their sport, other things.

So, if we have somebody coming in for a shoulder injury, we're restoring that range of motion for external rotation. Well, let's say that person's a baseball pitcher and they need a little bit extra external rotation, excuse me. So, restoring that specific to what is needed for their sport. Or we restore it to a certain area, and then at the end stage of rehab, we're working them through warmup drills that they may have always done before they throw. So, it's maybe a little different than the drills that we're giving them, but just tapping into that, same with weightlifting. Or, these are a couple drills that I've put here. The first picture is squatting. Or the first picture on the, I guess, top right you would say, is just an assisted drill with a band to support the body, and just kinda lowering into a squat position and just seeing, from there, you can kinda see, does one knee or does one hip feel tighter? Do I have trouble keeping my balance? Is my ankle a little bit tight on one side? And just being able to shift towards that side and stretch that out, it'd be a little bit more mobile. Picture directly below it is what people call a bunch of different terms, but Spiderman lunge, world's greatest stretch, which it is a

pretty good stretch. I can see where that name has come from. Just doing that kind of deep, low lunge, then adding an upward kind of rotation through it and just kinda working through that mobility. This is something that been used before. Soccer matches, I used this before. I had a lot of my athletes come into the weight room and do any kind of lunging, squatting movements 'cause they need a lot of hip or shoulder mobility, something that's more of a dynamic movement, feels kinda good for people to do. Getting a little bit of upper body, thoracic rotation, or shoulder, shoulder external rotation there, too, with that top arm.

Then, the next two pictures are something that are pretty commonly used with people that are about to life weights. You do a lot of overhead movement. The middle, kinda smaller picture is a stretch for the front rack position. So, when you think about front squats, where you have to kinda keep your elbows up and you're holding that barbell between the two elevated elbows, just helping to stretch that out. It's also good for anybody who's doing any cleans, power cleans, squat cleans, that kinda thing where you have to really get under the bar and shoot your elbows out front through.

This can help stretch that out. It's something that I've recently been using with some of the softball players that I work with that are high school, just noticing that they have a lot of trouble with some of that shoulder mobility after they pitch or play any of their, right now, they're playing winter ball games and doing a lot of extra pitching training, and throwing a lot. So, we found that, especially on Mondays, after they've gone to be training all weekend, down with our coaches and with our team. The winter ball games, they all tend to be a little tighter in that position. And just helping to stretch out from that overhead. Overhead movement just helps getting that shoulder movement. And it just seems to be a good recovery thing. And then, the picture on the left is just an overhead stretch, getting some shoulder elevation and also getting a little bit of a lat stretch in there too, which is good for anybody doing any overhead work that is tight in that position. So, when we, then, think about stability, again, this is something that we

do a lot. Same concept for PTs, we're able to assess this. But just assessing it specifically to the athlete, their injury, what's needed for their sport, and like I said, we do this all the time. So, I'm just kind of repeating it to just drive the point home that we have to know exactly what we're sending our athlete back to. For example, I had an athlete, this was, gosh, maybe 10 years ago at this point, come in to see me, and they were a CrossFitter. This was kind of at the beginning of CrossFit. And I did not do it myself. And I kind of wasn't a big fan of the sport. Now, I actually do CrossFit pretty regularly. So, changed my thinking on it. But just not understanding what they're getting back to. This was an example of it. Athlete came in, she had shoulder pain. She said she had shoulder pain doing a workout where they had to do 100 burpees. And my first thought was why the heck would anybody do 100 burpees? And that's weird, and okay.

So, my advice to her was okay, that's fine, just when you go back to the gym tomorrow, maybe we can scale that back a little bit. Maybe you don't need 100 burpees. Can we do another movement? Or can we, I don't know, 50 of them? Or what's your threshold for pain? And she looked at me like I was nuts. And then, once I actually started doing the sport myself, I understood that it's constantly varied movement. So, that workout, that person's probably never gonna see again. What I would have been better served to tell her is when you're either, maybe you're having pain with high reps of any movement, so we can dive into that. Or maybe it's that pushup position that's causing your shoulder, you know, the getting down, getting back up. So next time that you have to do any pushups or any bench press, or anything involving that, we can modify it. Any of those things. So, just an example of really understand, and it doesn't mean that you ave to do the sport, the athlete does. But just try to research it a little bit. Or ask them questions and let them explain to you that the advice you're giving them may not be feasible. That particular patient never came back to see me after the first visit. I can imagine why, because I really wasn't giving her any advice she could use that was practical. So, another example is an

athlete who, we're talking about stability, who needs to build stability over a long term. So, let's say you're working with a distance runner, so a marathoner, but a trained marathoner. So, this is somebody who's run multiple marathons, knows how to train, follows a very well-written training plan, this isn't somebody who you're thinking about overuse. And all of the sudden, they're having pain every time they hit the 15-mile mark of their training. They're ramping up to the 20-mile mark.

That's usually, most marathoners, when you're training the long runs, for the most part, kinda get up in the 20-mile range, and then they kind of taper back down and they run their race. So, let's say you're working with an athlete that all the sudden, this one year, has issues at mile 15. Nothing has really changed in their training from year to year, it's about the same. So you think about what may have been unstable in their gate pattern, that, by mile 15 is causing something to overwork and hit failure at that point.

So, sometimes we're really quick to blame things like training, like oh, you're probably just running too much. Well, it's easy to dismiss an injury like this but maybe we have to really get in the weeds of what could have caused that. And sometimes we do gate analysis or trying to video a runner, maybe at the beginning, we're not going to see that, that error or that issue in their stride. And maybe it's a fatigue factor later on, and that's what's compounding. Or maybe an overuse issue has gotten them to overload fatigue that one leg causing the injury. So just things that we need to not only recognized, as PTs, from an assessment standpoint, but things that we need to train the right way in specific cases. Is it a high-repetition thing? You simulate that. Is it something we need to fatigue them out and have them do some kind of exercise that their leg is going to be tired, and then make them do a stabilization exercise on top of that. Moving on the strength. Strength, basically, the ability to produce force. Something we do a lot. But, true strength, we measure that with what we call a one-rep max. Now, we don't always do this in the rehab setting, 'cause it's not safe. But just understanding that when we talk about true strength, it's really measured with that

traditionally. It's maybe not trained like that. We don't often have people do a maximal one rep, especially early on in rehab. An alternate method, sometimes, is a percentage of a rep max. So you can calculate via a table or any kind of, online, if you just Google 10 rep max converter or something. Just understanding if you're working with somebody and they do a set of 12 or a set of 15, which is a little more realistic early in rehab, and they're pretty tired after that, the 15th rep is pretty difficult, say they wouldn't be able to do a whole lot more after that, you can kind of plug that into a table and just get a base of their one rep max and just kind of track that in your notes over time, just to see if they're making strength gains. When we're training strength, this is a really clear cut. It's been debated. But generally evidence supports this optimal dosage needing multiple sets. So, there is a greater strength gain versus a single set. So, we're talking like two to three sets of 15. Or even four to six sets of a certain number of repetitions.

And these studies were done in trained and untrained, but healthy individuals. So just understanding that application for that versus the rehab population. But, there aren't really a whole lot of studies on strength gains in the rehab population in terms of that breakdown of sets of reps. Three to four sets per exercise with, and this is again in healthy individuals, but then with eight total sets per muscle group. So if you think about working the quad, eight total sets. So, might be two different exercises of four sets. So maybe four sets of the eight of step ups and then four sets of the eight of split squats. That tends to elicit the greatest effect sizes in strength. Maybe multiple sets aren't possible, for whatever, there could be a million reasons, probably, I know I have had certain, either time wise, or fatigue wise or ability wise, or whatever it is, if you do take one set to failure, and I determine failure in the rehab setting as failure, my muscle's cramping and I'm laying on the floor totally burnt out, as failure, I'm pretty tired, it would be very difficult for me to do another one with keeping proper form, that is still okay. And research has shown that doing that is a good enough stimulus to have changes in strength and hypertrophy. So, just something else to keep in mind. Now, if

we think about the intensity, so we talked about sets and reps and number of times to do things, but if we think about the intensity, we think about, we don't often use 80 to 100% of a one rep max in the rehab setting at all. But understanding that towards the end range of rehab, if you're really sending somebody back to a sport, or shortly after they return to sport, they should be able to produce something of maximal power for a set of rep. Being said, if it is deemed safe to do so, in terms of the surgical repair I know I just had a girl, high school athlete, who has had her second ACL surgery. Tore right leg, then tore left leg. It's not on the same, wasn't a revision.

But just one on the other side. In the end stage of her rehab. And she was working out with her father who is a very active person who really likes to strength train. And they were testing their one rep max just because that's what her dad did. I wasn't around for this, it was on a weekend. And she was really excited that she did a one rep max of a pretty heavy weight for squatting, and then went in to see her surgeon, this is somebody who was about eight months out of her ACL rehab, and was so proud that, you know, I squatted a one rep max of, it was like 100 and some pounds and it was pretty awesome. But the surgeon actually came back with I don't wanna stress the graft that much with a maximal force, so let's stay in the six to eight rep range.

So, like I said, when we talk about one rep max, just having a, if it's post-surgical, or just understanding tissue healing if it's not post-op, and just ramping up intensity enough that it's still safe for tissue. And where we do a pretty good job of rehab professionals, of understanding how to do that. I think what ends up happening, a lot of times, myself included in this, is that I think we don't load our patients enough. So, there's the extreme that I'm telling you not to do, but then there's that fine line of maybe we do need to understand, that had we loaded them enough that they feel like they have worked out. That they're tired afterward. We've elicited the change that we need to and the stimulus that we need to to build the strength that we need to. So, as I mentioned, here's determining load. This is what textbooks say, and then other

methods that you can use, just a bunch of different things that are here for your reference. I'm not going to go through all of these here. But as I mentioned, just other methods that have been researched and studied in the strength and conditioning literature. You know something else that you could also do is a simple, watching your athlete, asking them after, obviously watching for form, and if they look like they're straining or having difficulty with the movement, or watching for any form breakdown, but then also just having the simple, can you rate how difficult that was one a scale of one to 10 or can you tell me how many extra reps could you've done? Was that so easy that you could have done 20 more of those if you could just keep going forever? Or was that so difficult that maybe you could squeeze one more out? That depends on the athlete, if you have a good enough relationship that they could give you an honest assessment of it.

But, sometimes that can help gear towards what you're going for, if you need to add on weight or if you need to add on reps or whatever. Whatever it is. We're gonna move on to talk about power. So, we build a good strength base in our patients, or athletes, and the next step is power development. And this is the component, when you hear people go back to their sport, and you may hear them say things like oh I'm back, I'm playing, but my shot just isn't there like it used to be. I'm just not hitting the power on the shot. Or my three-pointer, I just can't get it, beyond the three-pointer, I just can't get that ball to arc the way it did. Or I went back to soccer and I just don't have that quick first step, I just can't get around a defender, I can't make that run and be there as quick as possible. And really, power's the last phase of rehab that needs to be built. I think sometimes we leave that to be built on the field, like oh, you'll work your way back. But, really, it needs to be built in the weight room. It needs to be built, or on the field doing specific drills that isolate this out. Versus just thinking yeah, they'll go back and they'll play their way back into that quickness or that power or that kinda thing. I think that's setting them up for injury if they're not quick enough or if they don't have that power, we're putting them at risk when we put them back on the field or court. So,

power, back to physics class, force times velocity is power. Called the critical aspect of success in many sports, and it really is. I mean, if you think about these examples I just talked about, those make the difference between success or, I don't ever wanna call anything failure because I don't think things are in life. They're just not being as successful as you want to be. You didn't make that run. You didn't get to that spot on the field where you could be in the right position for a shot.

Or you don't have that power and you tried to launch that shot and your team needed you at the end of the game and you're not making it. Or somebody beats you out for a position. All of those things really can be linked back to power. It's very, very important. So, components of power. We can divide this into three things that we can train. One is strength. I already talked about that. I'm gonna talk about it a little bit more then. We talk about rate of force development. And then, maximal force at a high velocity. So, how much force can you apply quickly? So, again, muscular strength, the literature shows that stronger individuals generate forces significantly faster than people that are weaker, that are matched for other things, but just are not matched in strength.

So, basically, if you do get an athlete stronger, and I mean truly stronger, if you're really loading them safely and appropriately and effectively, you can improve their power and their overall performance capacity. So, power is very important to train specifically, but in some people, getting them stronger will improve it as well. A couple studies to talk about. One was an athlete had 24 weeks of intense strength training and we're talking about loads between 70 and 120% of one rep max. Obviously these are healthy individuals, not injured individuals. But when we talk about strength training, I mean really loading them. Again, 70 to 120% of the one rep max. Improved vertical jump by an average increase of 7% in the athletes. So, also, development, another study by Kormey, development of maximal strength has been shown to be more effective for increasing power during jumps versus matched controls that were not strength-trained to the same degree. So, that is very important. However, once you have an athlete that

really does have an adequate strength level, so, somebody that is close to their baseline strength, you really do need to maximize the benefits of specific power activities. So, it has been shown that athletes with a good strength base, so stronger athletes, are more responsive to power-based training. So, we're talking about plyometrics or explosive training exercises. They do make a big difference in people that already do have that strength base. Moving on to rate of force development. This is something, a concept near and dear to my heart because it's that explosive muscle strength. It's that rate of which that force is expressed during that movement, that explosion. It's jumping, sprinting, that change of direction. So, it's a short muscle contraction time. It's not an all-out maximal force.

So, we think about that one rep max. It's not to that extreme of that, but it's a short, powerful contraction. So, again, Olympic lifts, football, shot put, longer, those are longer, more force. So, some researchers and coaches will recommend that to train this, you need to lift lighter loads in kind of a ballistic fashion, others don't. So lifters kinda split on that, one way or another. But just understanding that that short contraction time, it can really take even less than 300 milliseconds to generate that maximal force, which I think is kind of a fascinating statistic. But again, it's how fast and forceful a muscle can contract and produce force. Something that absolutely can be trained in athletes.

And very beneficial to them. So, how do we train it? Again, you develop that baseline strength. And then, we think about sport-specific things. So, this is where we come into Olympic lifting, do we really need that to train? Well yeah, we actually do, if we're working on training power. And I'll touch on that in a little bit, later on in the talk. But then, just things like jump squats and medicine ball throws, box jumps, all of those things can train power. And if you just think of movements that are specific to the sport, that is very important to do. When we think about load, so, velocity, so speed is a primary component of power. So, how fast can you move? But how fast can you

move a load? How fast can you move some weight? How fast can a football player block a heavy weight? How fast can you throw a shot put, all those things. So, velocity is that primary component, but it's inversely proportional to the amount of load lifted. So, I mean, something that's heavier, you're going to need to be a little bit slower with your movements. When you're training power, that being said, that load is gonna be a little bit lighter than what's utilized in strength training. So, when we talk about those Olympic lifts, so clean squats, I'm sorry, cleans and snatches. Those are going to be, obviously, a lighter weight than somebody would be doing a squat, which is more of a strength move.

So, squat, controlled descent down, controlled push back up into the standing position. Versus a clean, where you are literally using physics to lift a weight up in the air and then drop really quickly underneath it. So, there is going to be a little bit less strength used with that. But, as you train, you can improve both of those. You can improve the amount of weight that you can put in the air for clean, you can also improve the amount of strength that you can use for the squat. So, moving on to speed. There's two components with speed. So, there's acceleration and then there's your max velocity. So, the goal is to accelerate as quickly as possible to try to get to that max speed.

Try to keep that max speed for as long as possible. So, when we think about that and we break that down a little bit more, acceleration. Acceleration is done due to ground reaction force. And maximal speed is also due to ground reaction force, and just a little bit different. So just understanding this here. When you're accelerating, that ground reaction force, so that runner is driving their leg into the ground and using that resulting force or bounce from the ground to propel the body forward. When you're accelerating, those acceleration forces are applied horizontally. If you think about, this is why sprinters start from a track block, so just starting from that block, how that's oriented horizontally, is to give them that starting boost to get that horizontal speed. And that's

important because we need to train the horizontal component. We'll talk about, in a little bit, we also need to train the vertical component. But when we're talking about acceleration, when you're teaching an athlete, whether it's a track and field athlete or whether it's an athlete in another sport that needs to be quick, you need to train it with horizontal force. So things you could train. Broad jump and power skips for distance. So, asking them, jump as far as you can. Skip and make that one step or stride as far forward as you can. Alternate bounding, prowler, so that's like the sled, the prowler sled where you put the weights on it. Prowler pushes, marches, trying to work on as fast as you can, driving that sled across the field in the horizontal plane. So that athlete's getting low and pushing forward. Sled sprints, same thing. Kettlebell swings. So, working from that bent position to the straight position. Trying to, that horizontal force. Hip thrusts, good ol' bridges, but loading those up with weight. All of those things are important. Now, when we think about, so that's acceleration. That's one component of speed. Velocity's the other component of speed. So, you accelerate as quickly as you can, hit that max speed.

Once you hit that max speed, studies show that ground reaction force is applied vertically. So, if you think about it, 100-meter dash is the best example of this. You're starting from the blocks. It's that acceleration phase, horizontally, directing force horizontally to accelerate, and then you can see it in a race, once they're running, and then once they hit that max speed, they're kind of a lot more upright. And at that point, you're applying that vertical, the ground reaction force vertically, right? Into the ground to get that bounce and keep you going at that. So, we need to train that component then. So, we train the horizontal for acceleration, we train the vertical for maximal speed. Things we can do for that, clean pulls, high pulls, back squats, dead lifts, regular trap bar, trap bar's a little more horizontal, sorry, go up and down. Box jumps, vertical jumps, single leg squats, single leg jumps just for height versus distance forward. Things that you can very easily apply into the rehab setting. I think all of those you can probably apply and I think a lot you probably already do that. When we think

about team sports, so, team sports require, you have to be quick in a bunch of different directions. So, it's not just a straight playing for sprint to the end, you need to be able to change directions and have that agility component. So, when that's the case, added some deceleration training is also important too. And then, track and field events are obviously more linear speed, just focusing on that vertical and horizontal force. I will say, I work with a group of distance runners, adult distance runners, half and full marathoners, and training that vertical force is also important in distance. So, even when we're not hitting maximum speed, these are people that do need to apply ground reaction force over the long haul.

So, it may not be for maximal power, they're going a little bit slower running, but at the same time, they're using that ground reaction force. So, training that, in these ways, training that vertical component is very, very important for them. And there's a lot of literature coming out right now about distance running, in terms of strength training and heavy strength training needed for distance runners. We always thought that long, endurance base, but they don't really need a lot of weight. We don't wanna make them bulky for running, and that's actually not being shown in the literature. If anybody's interested in references for that, Rich Willy and the Montana Running Lab have put out a good amount of research, really interesting research very recently about that. So, just direct you there for more resources, if that's something you're interested in. Moving on to agility.

So, as I just mentioned, that sport-specific agility. So, trying to get that multi-direction, getting to a certain spot on the field or court relative to what you need to do in your position or in your sport. So, if you think about tennis, so that side-to-side agility, versus basketball, where you need to turn, you're pivoting a lot more. You're trying to face one part of the court. You may be turning and literally facing the back. Tennis is facing one way for most of the time, but it's side to side, forward back pedal, that kind of thing. So, just understanding that, you can change around the agility drills that you

do to reflect that. When we talk about the need analysis and knowing your sport, it's always a great thing to go back to, strength and conditioning journals are a great reference. Or just any reference that you can find. Looking at a breakdown of what drills does that sport primarily utilize in conditioning? What are some classic drills? What are things that a lot of coaches use? Or even asking coaches, asking your athlete's coaches, or asking that athlete, what are drills that they get back to doing? Just prepping them and training them using those is very important. T-drill, this is a pretty common drill, soccer, basketball, football can all use that, that forward, back pedal, lateral shuffle, I actually use this with my tennis athletes a lot at the high school I work at. Pro-agility drill, this is football. It's also been used in soccer. I know this was actually one of my fitness tests for soccer in college. Basketball as well, it's that suicide. That quick change of direction. You can vary them, usually it's a five, 10, five. I've done it, when I have athletes that I need to get their first touch, or their steps even quicker, I've even shortened the distance to make them do a lot of cuts in a small space quickly.

Or you can lengthen it out. Whatever you need to do to tailor something like this to your athletes. Other drills I've used, is I've taken mini hurdles, so we're thinking six inch, agility training hurdles, and I've had some of our volleyball players do a weave in and out, so they're, let's say we have five hurdles set up in a row, and they're kind of weaving in and out, and then adding where they're bending, so they may weave into one hurdle, through one hurdle, and then reach down to the ground and touch an object next to them so they can get low and then get back up. Weave to the other side, so let's say weave to the right side, touch the ground with your right arm, then weave to the left side, touch the ground with your left arm. Just to simulate being able to get to a spot and get under a ball very quickly, is important. We've had some of our softball athletes that I work with actually do this themselves. Now, I use it a lot because I think it's a great drill that they taught me, going through the agility ladder and pretending like they're fielding a ground ball. So, maybe running through one square of agility, then

getting low and pretending that they're picking up a grounder and getting back up, doing the next thing at the next square and so on from there. So, again, just applying things to the sport that you're working with. All right, so now, getting into weightlifting. This is a topic that is a special interest of mine too. In terms of Olympic weightlifting, a significant breakdown of these moves and sets and reps and all of those things, it's kind of outside of the realm of this talk. I'm going to kinda get an overview. I am happy to take any specific questions that you guys have about Olympic lifting or power lifting. Again, this is a very special interest of mine, and over the past two, three years has been something that, just from applying it to athletes to extra study on it, I could talk about it for a really long time.

So, if you do have any questions, feel free to post them now. I can either take them now, or I can take them at the end. Again, happy to do whatever the audience wants or is interested in. But, right now, just understanding that power lifting is squatting, bench press, deadlift. It's strength, it's acceleration through part of the movement. So, there is a small acceleration phase through most of those movements. But when you have something like Olympic weightlifting, which is a snatch and the clean and jerk, there's power, there's a strength component, but it's a power, it's an acceleration through that entire movement at varying levels.

Olympic lifting is something that needs to be done with significant precision. You can kind of think of it as a golf swing. There's always something to kind of learn. There's always something very technical about it. The basic concept is you're generating enough force to pull that bar off the ground. So, that athlete is lining up, that bar is on the ground, they're lining up in a squat position. Right underneath that. They're pulling the bar up, accelerating really quickly. So you think, get tall, and then they get really small and they drop right under that bar. So, you need the strength and the precision and the acceleration to pull that bar up, and then you need that quickness and agility to get under it which is why things like, that's why our head basketball coach really

wants his girls doing power cleans because it's an explosive movement and it teaches you a lot. And that's really why I wanna talk about this. Even if your athlete isn't a weightlifter, if you've got a basketball player coming in for a knee injury, or if you've got a soccer player that's coming from knee injury, you may not think that you're going to need to rehab them to do power cleans, but you very well might be. If they're working in a high school or with a strength coach or with anybody, there's a good chance that they have to do those things. And our job as rehab professionals is to understand that they need to do that, and to safely get them back to doing that. Or to do that with them, and slowly build them back to the sport, if you know how to do that. If you don't understand how to do those lifts, that's fine, but then you need to be in close consultation with your strength coach. And just understanding what level was that athlete at before?

Because there is varying degrees, like I mentioned, I've got, right now, we have anywhere from, at our weight room at the high school I work at, and we have athletes that are great, very well-versed in cleans and maybe they knew how to do it before they got to my school, or maybe they've just picked up the technique in things that I've worked on with them and they can do a good amount of weight. We have other people that are doing it with the bar or with a PVC pipe that has no weight. Just learning that form and that technique. And it's awesome. And all of those have a benefit for the athlete, but if you were somebody, one of my athletes, that was coming to you for rehab, understanding what their baseline level was, what they get back to. They could clean 100 pounds, maybe they were just cleaning the bar, but that's okay, and scaling your rehab appropriately to that. So, moving on to program design. Again, happy to field any questions about Olympic weightlifting or power lifting, and how to build that in to your program. So, program design. Lots of different concepts with this. So, the key principle is that it's progressive overload. And I've mentioned this. We have to stress this system. We have to load the system appropriately. So, just, we have to do that. The art and science of rehab is to do that appropriately to facilitate healing or to restore

that baseline function no matter what, if it's an athlete or if it's not an athlete, doesn't matter, these same principles apply and we just need to appropriately stress the system in a way that is appropriate to the injury and to the type of rehab, the goals of the patient. The wonderful principle of specificity. This is important. I think we've all heard this before, just bears repeating. The body makes gains according to the manner in which it trains. So, a tennis player's not gonna train the same way a baseball player does. I'll never forget when I was, I don't know why, I always remember this, but I just feel like it's such a good summary of this principle. When I was in school, it was the winter, and soccer team was doing conditioning and the baseball team was also doing conditioning. We were all indoors in the field house. And we had practice after the baseball team.

So, we're all there, stretching and warming up, waiting to get our time on the field. And the baseball coach was making them run. And the baseball team, a couple of the guys looked at us, and they're like we're not that, swear word, soccer team, why are we running like this? And I remember us laughing because welcome to our world. This is what we do. We would run double what you're running right now. But just understanding that yeah, the baseball players were right. Why were they running that much? Who knows, maybe they were in trouble. I honestly don't remember. But, they don't need to run that much. It's a power sport.

They need to run, they need to sprint. There's things that they need to do, but do they need to be running for 20 minutes straight? No, they really don't. Soccer players probably need to be doing that and more. So, just understanding that we make gains in order to which it trains. You know when I used that example about an athlete that maybe is a basketball player that had ACL surgery early on in their rehab and yeah, I need to put them on a bike in the beginning to get some form of aerobic fitness. If they're at the end stage, and they're cleared to run, they're perfectly safe and fine, strength-wise, loading-wise, biomechanics-wise to run, and I'm still having them

condition on a bike, I am 100% doing them a disservice. If they need a recovery day and they need to flush their legs out, we need to maybe not have them do impact for a day because they ran hard the day before, yeah that's fine. But if their primary goal of training is coming from a bike, that is so wrong, because specificity principle really is something that's important. I was actually just at the gym this morning, just working out myself and we were laughing 'cause I'm from Cleveland. And if any of you follow football, the Browns, yeah, the disaster of this year. Like most years. But this year, pretty disappointing.

And there's all these videos right now, Baker Mayfield, our quarterback on the Peloton. He keeps posting that he's on the Peloton, and it's like oh, I'm getting in shape. I know you all thought that I was not in shape for this season. We were all laughing among ourselves this morning at the gym because of the same principle, specificity. Why is he on a bike? He's a quarterback. Why is he not running springs? Why is he not doing power movement? Why is he not doing agility? What is the Peloton helping him for next season? So, again, another example of that. Four types of specificity. So, I've already touched on all these. I've rambled enough about it. I don't need to do more.

The energy system, the muscle action, the muscle group, and the velocity. So, understanding the specificity of all those if very important in your training. The way you train is the way you play. Again, other principles of program design. Volume is the total amount of weight lifted in a session. So, if somebody's doing, we talked about, four sets of eight reps of an exercise, so that's 32 reps, and then another four sets of another exercise, working their quad, so it's another 32. So, 64 repetitions, times however many pounds they were doing for those exercises, that's a number of volume and that's important to track. If we are having somebody lift heavy, we need to be recording that amount of volume and just making sure that that does not increase too quickly. And I'll go over, in a short while, how to be a little more exact about that and understanding what is too quickly or what's not too quickly. The intensity, again, that

load, the amount of weight assigned, how many reps of that one. Is it a 15% or 15 rep max? Is it a one rep max? What are you assigning? 'Cause that is a big difference once way or another. Again, as I mentioned, inversely proportional. So, a really heavy weight lifted one time versus a lighter weight. Either that volume is going to be high with a weight a little bit lower, or that intensity is going to be high with the weight a little bit higher. So just understanding that. That being said, rest periods. So, how much recovery time are we giving? If we're having somebody to strength training, do we have them rush from one exercise to the next exercise? Or do we give them a break in between?

Well, the answer is it depends. It depends on the sport. It depends on their goals. It depends on the athlete's training status. Maybe we're just getting them right back into doing some of these things and they need a little bit longer of a rest because we need to be safe about how we're loading them or that recovery. Is it based on how much experience they have doing these things? Is it based on life stresses or how much energy they have that day?

All of those things need to be taken into consideration, and we can plan them out on paper for an athlete, but then we need to adjust accordingly, based on their response. So, and we'll go into a little bit, just different kind of rest periods or time in a little bit. So, again, when we think about program design, taking all those concepts I just mentioned and putting them into an athlete's goals, this needs analysis that I keep droning on, and a task breakdown, which I also keep droning on and on about. But, again, really important. So, when we think of a program design, we can do it in two ways. Periodization concepts and then just other things involved with planning. The needs analysis. As I mentioned, it's kind of important. Comprehensive analysis of physiological and biomechanical requirements of a sport. So, really, and I'm going to give you an example in a second of how detailed this needs to be. And, you know, once you do it for a soccer player, you start to have an idea. Or once you do it for a

basketball player, you have an idea. It's not like you have to take that much time, I know we're all crunched for time and we're probably seeing a ton of patients or doing a ton of paperwork or doing whatever. So, I mean, these are things that you need to individualize, but once you have the basic, general concepts of understanding a certain sport, it gets a lot easier for working with other athletes from that sport. So, again, general biomechanical analysis. So, what kinds of things, from a biomechanical standpoint, is it just a constant repetitive movement like running? Is it a varied repetitive movement like soccer? Is it baseball pitching, throwing? Is it, whatever it is.

Again, the energy sources. What are the common injury sites, patterns. Is ACL injury a big deal in your sport? Is rotator cuff or labral issues a big deal in your sport? Understanding all that. Then, we strength, range of motion, flexibility, all those requirements that we have to take into understanding from PT, from an impairment perspective, but also then, from a sport goal perspective. Then, also, the athlete's individual factors. Like how many times have they been injured before this? What's their training status? What's their mental status, and their whole world involving this injury, but outside of this musculoskeletal or neuromuscular concept, there's a lot of other things that are involved in what that athlete does for their sport. So, I am going to, very quickly, go through these slides.

If anybody went to my soccer webinar, this is similar. I did this at the top of that talk just to understand what the match profile of a soccer player is. For the sake of this talk, you guys don't need to know those details, I just need you to understand what to do in a needs analysis. And you can get this for whatever sport. Strength and Conditioning Journal is my first go-to when I'm not sure. But there's other resources out there, and again, you talk to the athlete, you talk to the coach, and just be able to wrap your head around what they are getting back to very well. So, again, soccer match profile. We're looking at how often they're sprinting, or how many of these brief, intense actions. So, that's that repeated aerobic, anaerobic sprint. There's a lot of them in a soccer match.

Obviously that varies per level of play. If I've got a middle school kid, is gonna be a lot different than a division one soccer college athlete. Again, these are things. What are they doing on the ball? What speed are they doing it at? I love the stat, there's a lot of time that they need to cut and plant. If I've got an ACL injury, athlete with an ACL injury, that's important. That's really important. That's what I'm getting them back to. If they can plant and cut on their leg once, that doesn't do me any good. What are they gonna do for 90 minutes? They have to do it hundreds of times. Level of play. So just understanding, what's the difference, what's you're level of play of your athlete. Again, what's their position? Maybe they're a goalie. Maybe they don't need to do all that cutting and planting.

Maybe we need to train them more of an explosive power. Or maybe they're a midfielder that's gonna run all game long and not really get much of a break. All of these things are important. Again, is there a strength difference? Is there a difference between field positions? There is between a goalie and a field athlete. But in other sports, there's differences between positions on the field as well. Think about a catcher in baseball versus a pitcher. Those are different strength demands.

Or an outfielder. Again, goalie, so if there's a whole different issue there. Maybe they need more reaction training. Whatever it is, just understand it and note it and just put it in your goals from day one that this is what they have to get back to and we work backwards from that. What are the biomechanics of shooting? Maybe we need to look that up and understand what they're getting to. So, just all of those things, very, very, very important. From that, we go into periodization. And what that is, is kind of the plan manipulation of all of these training variables I've talked about. We put them all together in a nice, organized plan and kind of ramp it up or ramp it down as we need to for our athlete, to make sure that we're getting the gains that we need to, and to prevent over-training. We don't just throw a million things at them and be like hey, good luck with that. It's training, it's supposed to be hard. It needs to be a very well thought

out plan. Periodization, if anybody cares about the history of it, it's developed from the theory of General Adaptation Syndrome. Meaning that your system is gonna try to adapt to any stressor that you might experience. And the goal is to meet the demands of those stressors. So, what's a stressor? What does that athlete need to get back to doing? Soccer? Should we just use that example? What are the stressors of soccer? We just outlined them all. How do we get that athlete's body to meet those demands of what's being asked of them. So, there's three phases of periodization, of classical periodization. The first one is this kind of alarm, reaction phase. If anybody started a workout training program, I mean you know what that phase is like. It feels like you've just started a really hard training program. It's funny when you read about it in scientific journals, where it's like the athlete may, this is a quote from a paper. "The athlete may experience stiffness, soreness, "or a small drop in performance from fatigue." It's like yeah, yeah, you kinda know where that is. And our job is to mitigate that so it's not so much fatigue that they can't walk the next day.

Phase two is a resistance phase, where the body starts to adapt to that stressor. So, things become easier. So that training program, then, your first week, you feel like death, you can start to, second week is not as bad. It's like oh, I could keep going. I can do more. The tolerance gets better. The performance gets better, those neuromuscular gains are starting to take hold. This is where they just start, again, to adapt. Then, the final phase, if the stressor goes on longer than an athlete can adapt, exhaustion results. So, this is where you may get the staleness in training, symptoms of over training, we want to mitigate this as much as possible. And I think us, as rehab professionals, do a very good ob of looking out for these things and making sure that they don't happen because it's very necessary for what we do as a profession and with our patients. There's something called the fitness-fatigue model. This is also something that periodization is based on and it's this balancing act between building fitness, where you have to load them, you have to make them tired, you have to have some training gains, but then, that balance between that and fatigue and what is too much

fatigue. So, true preparedness, how prepared are you between, again, that level of fitness? And for the neuromuscular system to really make the most gains from a training mode or a stress, you have to kinda play around with the volume and intensity. That's why we spent so much time going over that earlier. You increase the demands and it makes that neuromuscular adaptation happen. Even though we talked about the most gains are at the beginning of a training program, it's because that's where that stress is the newest, if you can continually ramp up that stress, you can continually allow those neuromuscular adaptations to approve as you're increasing strength.

So, you have to continuously overload. However, take that with a grain of salt, because if you overload too much, those physiological cost will be too great and that readiness that you're prepping the athlete back for, kinda goes out the window. So you can't make them too tired before a competition that they can't compete. A good thought, so if you've ever been a swimmer or a runner and you think about taper weeks, or if you lift weights, and you think about a D-load week, that's the reason for all of those. So, we make that training base, where they're trying to kinda fight through some of that fatigue, and make those gains. But then we ramp down a little bit and let that base kinda take hold and let the body recover a little bit, those training gains are still there if that taper week or D-load is a short enough or an adequate enough period of time, where the body can recover.

But then, make use of all the work they put in. So, if you really do a good job of periodization or any planning, because I'm talking about these concepts of periodization, and there's variations on this. Or there's people that may not use periodization, but use a similar concept of planning. The reason for that is to avoid all of those issues where it's overload or they're too fatigued out and we're causing more injury or more risk. So, I guess just kinda touch base on those. There are a couple types of periodization. And I'm gonna go over these, just to understand you can kinda apply any of these to different types of, again, periodization and planning. So, if we talk

about linear periodization, what linear is, obviously very planned out, linear, organized, ramping up kind of thing. So, what it does, in the early stages, you have lower-intensity so you're not lifting as much, running as intense, it's not as hard, but there's high volume. So you're training for longer each exercise or whatever you're doing, he's done for a longer amount of time. And then, that volume decreases and the intensity increases. So, thinking about, we talk about, let's call it, they're doing, you know, two sets of 15 squats. So that's a lot more squats, 30 reps total. And then they're ramping down by the end of the program to doing sets of four squats, four sets of four squats.

So that's 16, but it's a higher intensity, so they're doing less reps but they're doing more. If we think about, there's certain terms used in periodization, and you may or may not have heard of them. You know, feel free to use your own terms. You don't have to stick with these, with whatever you're planning with your athlete, but the macrocycle, that's the whole training program. A lot of times, that's a 12-month, so, a whole year, including one season and off season. Mesocycles are that intermediate, two to four month time period. So, maybe an in-season, off-season, immediately off-season, whatever chunks make sense with that sport or that athlete. Microcycle is the short term, one to four weeks.

So, the advantages of this, excuse me. The advantage of this is it's predictable. It's nice for an athlete because they know what they're getting into, like okay, it's gonna increase. Next week, it's gonna get a little tougher. I'm gonna not have to do as many reps, but we're gonna ramp up on weight, and I need to wrap my head around the fact that I'm gonna be able, I'm gonna need to squat a little bit more. So, that's kind of nice. The coach knows what's coming. The athlete knows what's coming. You're focusing on one parameter with this. So you build strength. And you build power. Then you build speed or whatever it is, it's a very step-wise, very logical progression. The disadvantage is if you have an athlete that's playing multiple sports or competitions, per season, it's not optimal. So, it doesn't work. If you're in the speed-building phase

and you play another sport that maybe doesn't need that, it's not really doing you much of service. Sometimes, specific training parameters are different. So, if you're only focusing on one thing, if this is your strength block, and then you move on to a power block and you're not doing as much of strength, there's something lost in that. So, that's the disadvantages of it. If you, so a couple other, so this is why, that's kind of the classical periodization. And then we've got other variations of this and I'm gonna go over that. So, non-linear is where you take those volume and load variables, and you change them a little more frequently. So, the theory on it is that the neuromuscular system can get a little bit more recovery, and it can alter that too.

So, the phases are a little shorter, and you get this change in stimuli that happens more frequently. And, sometimes the thought is that that might be more conducive to actually gaining strength or making gains in whatever you're trying to train. So, the advantages to this, you get this weekly fluctuation in load. And that might be better when we're trying to have continued neuromuscular gains, because that load is unpredictable and I mentioned earlier how we can do that by constantly having a stimulus.

The other thing is that it can be modified based on an athlete recovery. And you can work on power and strength and you can work on different things at the same time, which sometimes is a little bit more realistic. It's not as black and white. The disadvantages, like in the rehab setting, the power and speed training may not be appropriate in certain phases. When we think about the rehab setting, it's a lot more of a linear, like if you think of ACL surgery, so it's a linear. So, we've got this phase, we're building range of motion and decreasing inflammation. Then we've got this strength-building phase. And we've got this plyometric power building phase. So, that does work really well for us in the rehab setting. But, there's other times that we may be able to use some of these other kind of things. At the end stage, or as we're getting an athlete back to their sport. The other thing is scattered focus. And this always

reminds me of the phrase, what is it? Jack of all trades, master of none? So you may not be able to really optimally develop every single phase, so sometimes you have to focus a little more on one thing than another. So, what does the research say on this? A couple studies. One was that there was no difference in linear versus the non-linear, on, this was upper and lower body strength was the metric they measured, and this was in healthy and trained and untrained subjects.

So, these are even people that, sometimes if they're untrained, any training makes a benefit. If you are already healthy, or already trained, I'm sorry. If you're already healthy, if you're already trained, things may be a little bit harder to achieve gains with. There is a clinical commentary that Scott Morrison, who's the head of the, if anybody's in the American Academy of Sports Physical Therapy, he's the new chair of the sports performance special interest group. But he had a paper that came out, I believe in International Journal Sports PT, but anyway, if you search Morrison 2017, it's in my references anyway, at the end of the talk.

You guys can download that. He had this to say, after appraising basically all the studies that look at these two things, there's really minimal differences in strength and power between these two types of programming, and you really can't make a definitive conclusion about what's better. So, really, you just need to base it on the athlete and the sport. Another version of this is block. So, block periodization. It's where you have a high concentration of specialized workouts. So, the rationale is that these traditional models really only give you one peak per year. So, you're peaking at a certain time. But some athletes have a lot of competitions throughout it. So, maybe it's a basketball player, and they've got their high school season, and they wanna peak for playoffs, versus that. And then they've got their AAU season, that a couple college coaches are coming to scout them at a couple tournaments, so they need to ramp up for that. The block system allows for whatever training gains that you made to be maintained throughout the year. And then, there's something that we would call this long-lasting

delayed training effect. And basically, you keep these changes even after training is done. And this was actually studied. It's also been proposed that power and strength could be maintained for up to 30 days. Peak performance is a lot shorter, five to eight days. We're talking like a week and that's it. Very, very peak performance, if you think of something with a lot of technical precision that they need to train to be able to do, like an Olympic lift or a baseball pitch or something that is a little more skill technical. So, these are two to four week blocks, and then you have this accumulation phase, where you just build up the work capacity. And then this transmutation phase, where you have a little more sport-specific exercises. So, the accumulation phase is a little more general. Something, kind of, we're gonna actually go, I'm gonna go to the next slide, 'cause it'll show you. Like week one of the accumulation phase, a little more general, squats, step ups. Let's say this is in, just like a basketball player. Step ups, squats, lunges, okay.

And then you increase it a little bit more, week-to-week during this block here. Then you go into this transmutation phase, where the load gets greater and the exercises get a little more specific. So, we're looking at 75 to 90% of a one-rep max. You can use different things like elastic bands, chains, those kind of things to just give them another boost or make them have to work a little bit harder with what they're doing. And then, you get this realization phase, which is the last block and your loads are a lot heavier. So, 90% of a one rep max or greater. And then just even more specific. So, this is where we're doing hang cleats and we're doing squats and all those things. And then, week six or the last week of this block is more of a restoration phase or a D-load or a recovery week, or that kind of thing for safety there. So, the research says that this kind of periodization is superior in cyclists, cross-country skiers, alpine skiers, so just interesting when you think about what those sports all have in common, just a little bit more aerobic. Although alpine skiing, depending on the event, is not. But just interesting that there were gains in VO2max or max oxygen uptake, power output in cyclists, cross country skiers, there. So, another paper by Scott Morrison, and then

also my friend, Dan Lorens, who's the former chair of that special interests group. They had a clinical commentary that came out a couple years ago, and what they had to say about it was that this block periodization is showing some promise compared to some of the other traditional approaches. But, a lot of these studies are short in duration and the intensity was very high. And the intensity did seem to be a direct correlation to performance. So, again, they were shorter duration studies. So, if we look at these more long-term, comparing that to something like linear periodization that is based on the long-term, the macrocycle of a year, then, just understanding that there may be some differences when you look at it that way. Also, appearing that these athletes have multiple events per year, so cycling, skiing, track, again a little bit more aerobic of those exercises. So, we just do need more research before we can say oh, this is a better thing. Last kind of periodization. This is reverse. This is where you do highest-intensity, initially, in volume.

The lowest, obviously not, you would have to have a really specialized situation where you would be using that. So, that's moving on the planning. I apologize for the sniffles here. It's finally freezing here, in Cleveland, which, it's January and I think sinuses are feeling that this week. So, anyway. So, where do we start? We talk about periodization. We talk about planning. We've talked about this needs analysis. We talk about the athlete goals. In a perfect world, we'd have these huge blocks of time where our athlete comes in, they have an injury, and we need to get them ready. They've got 18 weeks and that's great. We can get them ready for competition that way. That rarely happens, at least from my setting. If that happens with anybody else, that's awesome and I'm jealous of you. But, we're often seeing people that are hurt and they're in a time crunch. Like they were training, and maybe they're halfway through their training, or maybe they have four weeks out from a race, and they're coming in and they have some training under their belt, but they've had to take two weeks off for this injury because they thought maybe I would just take some time off and heal. So, you're trying to fix the injury and then trying to get them back to the goal of their training program.

And that's their goal and that's why they're coming to see you. So, we need to do the best possible job we can at getting them at or as close to that as we can. So, I mean, we have to get creative. I mean, I can give you all these great planning tools and things like that, but a lot of times, I'm sitting there with my computer and my calendar and the patient, athlete, and we're sitting there, literally just entering important dates. Like okay, your race is on this day, and your training, your long-distance run is on this day. And your pre-season starts, whatever it is, and then we're playing the game of counting backwards in weeks and filling in things on calendar in between the non-negotiables that they have already set on their calendar as much as possible.

So, we're gonna talk about that at the end when we talk about some case studies. But, training frequency, like how often do you have these people come in? Well, it depends on everything I talked about earlier. How much volume, how much load. If you're having a really tough session, or workout, you probably shouldn't have that two days in a row. Or maybe you do two days in a row, and then you drop off on a third day. It very much depends on what you built them up to, what that athlete's capacity is, what they need to get back to doing. Their health, their training status, their goals, just there is a great assessment too in there. I mean, I could write out a training plan and I could get a call, I just did this morning before this webinar, where I've got a high school athlete, soccer player, she's got something she needed to do this week, because her club's season starts again on Monday.

And we had some conditioning things that she needed to do this weekend. Well I got a call last night, or a text last night, and then made a phone call this morning back to the parents, because she went to a foot skill session and her back really tightened up in the middle of the session. So, maybe we're gonna, what I had on paper is now a recovery weekend because I'm not going to push her for that. If training starts on Monday, we're not gonna make any gains by doing extra training or conditioning. On paper, that was a good idea, but right now, that's not the reality. So, you really need to

have that relationship with the athlete, where you're constantly reassessing them and programming days off and changing days and modifying days, or if they're hurt or maybe they're just burnt out or they're stressed or they're sick or their family, they've had a family issue come up. Or all those things. We have to modify around those things. Within session, so we've talked about planning, general, the big picture. But, within a session, this is generally, if applicable, obviously a good warm up, whatever mobility they need if they need that. If you have a hypermobile person, maybe we're not spending a ton of time on this. Maybe they just need enough to get warmed up and whatever range of motions needed for their activity.

Olympic list, if applicable, if you're doing these with somebody, these require the most precision. This neuromuscular control, you want to be fresh when you're doing this, so do it first, get it out of the way. Don't do it at the end of a session. Other things, like afterward, then you do squats, dead lifts, these are multi-joint exercises, but they're not in that technical precision in neuromuscular control and power. So, you can do those a little bit later. Then, cardio, there's an asterisk by this because I put it fourth, but really, depending on the sport, you might wanna do this earlier.

So, in my runners and my distance runners that I work with, if I would have them do a strength session before a run, before a decent run. So, something longer than a mile or so. This is very distance runners. I would not have them do a strength session directly before a run. And if you think about in adults, like lets say they only have three days a week to work out, and I need to build runs into their week and I need to build strength training into their week. So, some of those days are gonna have to be doubled up because they work full time, and again, they have families or whatever it is. I am not going to have them do a strength training session and burn out those muscles, those stabilizing muscles, those hip muscles, stability, balance, quads, glutes, hamstrings, ankle musculature. If I burn those out and then have them run on those same muscles, that's a plyometric activity, running. It's a series of single-leg hops. That would be

completely counterproductive. Maybe, if I'm trying to train fatigue. Maybe I could do some manipulation of that. But, in general, I'm not going to do that. I'm going to have them do it afterward and kind of do the run, fatigue the muscles that way, and then we work on the strength training of those. So, again, that's just kinda the theory with that. Just manipulate this outline as you need to. And then lastly would be accessory exercises. This is those isolation exercises. So, we're thinking front raises, rotator cuff strengthening, scap strengthening, core, hip stability.

We do these in rehab all the time. These are usually single-joint, single-plane exercises. It's also, these are things that we do, again, this could be manipulated in the front if I'm going to have somebody do a really heavy, upper body session of a lot of heavy upper body lifts, maybe I will start with some light rotator cuff, scap strength, kind of more of a muscle activation thing to prep those muscles and be an appropriate warmup. So, again, manipulation of what are your goals for that exercise? Or what that session and what you need to do. We talk about single versus double-limb training. There's a role for both. And I think we, in the rehab world, do a really good job of this. Because we recognize the importance of single-limb stability, upper or lower body.

So, there is a role for both. When you're doing double-limb, so squats, on two legs. We need those to build more strength. Maybe more power, box jumps, all those things. But then, there's a role for single-limb stability, isolation work. So just understanding and making sure that you train both. It's always funny, to me, when I go to workout, as I mentioned, I do some CrossFit or some weightlifting myself, and the running joke among everybody is occasionally, the gym will program in single work, and it's something that a lot of people aren't used to because they just don't do it because it's a lot cooler to squat 200 pounds with both legs than try a one leg squat to a bench. Like, what's that gonna do? Just not that exciting. But the big joke is, I'm personally not the strongest individual, the one thing I can do is a one-leg deadlift or a one-leg squat because in PT world, you demonstrate that all day long with the patients or

athletes you're working at, so you get a lot of extra reps in by default with that and it is very important. So, anyway. Moving on. A little bit more on rest periods. I mentioned I'd get to this. Again, dependent on a lot of other variables. And this can be a huge thing on overall workout intensity. If you don't give them a lot of rest, the workout's gonna be hard. They're gonna fatigue out quicker. Maybe that's what you want. Or maybe that's not what you want. And there's a strong relation to that load lifted. So, the heavier they're lifting, the more intense that sprint is or that run is, they need more, you can't sustain that over a long period of time. So you need to build in a rest that's appropriate to the recovery you need to elicit. So, the primary goal, so if you think about power, a rest period could be up to five to eight minutes. Maximum strength, three to five minutes.

Endurance is on the other side of the spectrum, 30 to 60 seconds. So, not a lot there. Then, when you think about reps and sets, and these are just here for your reference like the slide before, so power, your rep range is one to five and your rest period is long, so you're doing short bursts of things. Your system fatigues out very quickly. If we think about that ATP-Pcr system, there's a finite amount of ATP there. You're gonna need longer time to recover and regenerate some of that. And then, on the endurance, that rep range is 15 to 20, and that rest period is the shortest. So, if we think about, that's our goal for endurance, then we're working the shorter rest periods and that quicker ability to recover.

As I mentioned earlier, though, when we think about endurance and we think about if we're trying to apply this to endurance running, there is more data coming out that's saying that a higher load is more important for runners. So, just understanding what some of the research is saying with that. I think there's a role for endurance training. With anything, especially when we're early in rehab and we're trying to lay the foundation for really, most sports or most movement. But then, even with some of our endurance athletes, getting them into that max strength or power phase is important.

Couple other things we can do with reps and sets just to make it more exciting is supersets. These are a personal favorite of mine because I feel like, it's somebody that I don't need as much rest period time. It maximizes my time with that athlete. So, alternating that agonist antagonist minimal rest, so a bench press followed by a row. So, they're just going back and forth between those two things for three to five sets. Compound sets is where you're alternating two different exercises of the same muscle group. You don't have as much rest. So, lunges followed by squats, which is a good way to burn out somebody's quads and glutes. Which, maybe that's what you want. Maybe not totally burn it out, but work them and elicit that load that you want and just being able to kinda switch it up a little bit for the athlete, versus having them do 30 squats in a row. Maybe we'll have you do 10 squats and 10 lunges and go back and forth. Other methods, kinda touch on this. Alternating, push pull, a row and a bench. That's a good favorite combination of mine.

Or alternating upper body lower body, all of those things. So, training load. Load management. I feel like this is the new buzz word. I was watching a Cavs game a couple weeks ago and they were talking about one of the players resting because of load management. And I was like oh wow, this is the new trendy thing. But, it is important. It is important for a reason because if you do too much too soon, you have that increased risk of injury, so we are trying to manage that load on the athlete. But then, if you're doing too little, you have the suboptimal. We haven't does the right stimulus to elicit any gains with training. So, doing too much too soon, increased risk of injury. As I said. We usually think about these overuse injuries with training, but research does show that gradually ramping up this work load, actually does reduce the risk of injury in the long term. So, all the more reason to apply some of these concepts with the people you're working with. So, we have to look at two factors. One is the load. We've talked enough about that. And then, this is next, is that rate that it ramps up. Couple general concepts. These came out a few years ago. Tim Gabbett has put out a ton of very, very cool papers on it. At least I kind of love reading this research

about training load and acute to chronic ratio. I'm going to explain this in detail, but then I'm going to tell you why this isn't the end all be all. So just, as you're listening, just understand that it's not as black and white. And he's come out with a couple very recent papers that have talked about this too. But I think we all need to understand the concept behind it first. So, acute load. This is what you've done in a week. So, it's Friday. If your training week started on Monday, and you're gonna rest over the weekend, so this would be day five of your training week. So, your acute load. So, the amount of weight lifted through today is your acute load. Or the amount of miles you ran or swam, all that. The chronic load is over the past four weeks, your average. So, each of those weeks, what was the average?

Each of those four weeks, what was the total work? And then you average all that together. If you take a ratio of the acute to chronic load. So if you take a ration, if you take the work that you did in the past week, and you put that in to the work you've done over four weeks, that gives some insight into the athlete's current status. So, research has shown that there's a sweet spot. It's .8 to 1.3, and we'll talk about how to calculate this, in healthy athletes.

Now, the thing that I find fascinating is if you have a ratio over 1.5, you have a two to four times increase risk of injury the following week. And then, it even goes up higher from there. So, how many times have you guys had an athlete come in and be like I saw feeling so good. Oh my god, I don't know what happened. I'm hurt and I literally don't know what happened. I was having this awesome training, these awesome weeks, and then it all fell apart. It's amazing that there's numbers that can kinda put to light that this, we see it happen, but we know from the research, that it really does happen. And this is why. So, how do we monitor it? What are things that we talk about loading. We talked about amount of weight lifted. We can also look at heart rate average over the course of a week and then four weeks. All of those things are internal load. Then power output, speed, acceleration, GPS tracking for certain team sport

athletes, that kind of a thing now. Those are external work. So, take your sport, take an objective measure, and monitor it. If it's weightlifting, it's really easy, it's pounds lifted. If it's running, it's mile run. But you may have some combination of that. So, we're gonna, marathon running I think, is a good example to start with with this. So, let's see, this is their peak week. So, week eight of their training, they run 21 miles, and they ramp it up every week, and then get get to 30 miles total by week 11. So, your acute load is that last week you did 30 miles. Now, if we take that, and we divide it into their average mileage before that was 24.75. So, if we take that ratio, it's 1.21. So, we're right in that safe zone. Then, we talk about tapers and D-load, this is where I think you can kinda see it being applied. We can still look at that. So they were ramping up their training, it was good. Now, we look at their mileage. I'm gonna flip back to the other slide really quickly so you can see. So, they were running 21 to 30 miles. Then, they're tapering down.

And they're running from 28 back down to 18. They're giving less every week 'cause the week after is race week. That acute load, right before going into the race is only 18 miles, versus the last example it was 30. Their chronic load, still in the 20s. But you look at that ratio, and it's .7. So, that's still within that sweet spot. So, even though they're detraining, they having such a good base that they're gonna be okay for race day. And this is a thing with the runners that we work with, they freak out if this is their first marathon. We talk about the taper crazies. And if you've ever run a race, you know what those are like, where you just don't feel like you're working as hard, you think this weird hunger, and you're cranky, you're not in your groove of training. And you're freaking out like how the heck am I gonna run? 'Cause I don't feel like I'm in my optimal. Well, there's this kind of magic in that taper, where you've done the hard work for enough weeks before, you've built that base and you're gonna be okay. You're just letting your body recover and those training effects are still there. And you're gonna be fine for race day. But, the science says it, but until we get them to feel it, sometimes our athletes don't believe it. Very quickly, just another one you can see, I'm not gonna

go through all the detail of this but this is more for weightlifting. So, three sets of eight squats at 100 pounds, you can do the math on that. These numbers get a heck of a lot bigger than mileage of running. But then, you look at acute and chronic load of all of the exercises they're doing. So squat and bench press. Or maybe you just need to look at all the lower body, 'cause that's applicable to the sport. So maybe it's squats and lunges and you don't calculate the bench press, or whatever it is. Calculate that. And just looking at acute, chronic load, just seeing if it's within that sweet spot, safe zone. So, the reality.

The science is very cool. And I think we see it. We can see it being applied. But I firmly believe not everything in life is black and white. This is what the research is saying right now in terms of this too. We can't rely only on calculated load. So you have to take into account the age. If you're older or younger, you're gonna be at increased risk of injury. So just take those, I mean, that sweet spot's not exact. The ratio needs to be adjusted a little bit. What are their physical qualities? What's their training history? Have they ever trained before? Are they really experienced? Are they not? What's the timing? What's their injury, what kind of injury are they coming off of? Stress, anxiety, sleep, diet, huge, huge, huge in this.

We can write the best paper or training plan on Earth and if they have crappy sleep or something happens in their life that is causing them to have crappy sleep or a lot of stress at work or life, it's gonna affect their training. And we just have to accommodate for that. And we have to acknowledge it. This is a quote that I love. Dawn Scott, if anybody followed the US Women's Soccer Team, and their world cup this summer, which was pretty cool and inspiring, they credit Dawn Scott, their performance coach with a lot of their success. And she actually just left the US team to go back to England, where she's from, and work with the English, the Lionesses, they're a national team and it's actually being seen as a very big deal for the US and our team because of how awesome she was. And this quote, I'll let you guys read it. We get too caught

up with the data. So, just understand that it's something you can use, but you can't be end all be all with your athletes just on data. You have to have a relationship with them and know them. And know what they need or what they don't need. What you need to ramp up or down. Again, this is another great quote from a researcher who has put out quite a few papers. Again, great references. Just looking up some of the work that his group has done on training load and just on training in general. So, just that when an injury occurs, we're really quick to be like oh, training load, oh they're working too hard.

And that gives information, but we can't, I love this, give these magical numbers powers that they just don't have. Injuries are complex. So we can try to mitigate the risk as best we can, but we cannot 100% take away injury risk. So, other considerations. Tim Gabbett, I keep talking about some of his work. I think it's like November or October, his most recent paper came out talking about from the floor to the ceiling. So the floor is that current capacity. What is your athlete coming in the door with? And then, what do we need to get them up to the ceiling? And the challenge is the time. As I said, for some, we don't have 18 weeks. Sometimes we have four weeks. Too little time is increased injury risk, but we have to figure out what to do and how to bridge that gap.

So, he talks about, it's what I talked about earlier, maintaining that adequate fitness really helps to climb off the floor as quickly as possible. So, as much as we can do, and this is off-season, or this is injury. So they can't sit around and eat Bon-Bons all off-season, but also, with an injury, there needs to be a baseline level of fitness, safe and applicable to that athlete. So, just be realistic about what's needed for that with the athlete. Do the best you can and be creative, but make sure the athlete understands what challenges or what's needed to get there, or if it's realistic or not. And plan for those differences I mentioned earlier. Every athlete's different. And even the same athlete within different times of their life is different. So, gonna finish with case studies, here. And we are going to take a couple questions afterward. So, couple

different sports. So Cleveland Marathon training. I'm gonna talk to you guys about a runner, an example of somebody that I have worked with in the group. That's a picture of the group that I work with through Fleet Feet sports. They're a national chain so I'm sure many of you have heard of them. With their training group. So, my job is awesome, in that every Saturday and a couple days a week, I get to run with these runners. We actually have about 100 runners in our groups that span all of Cleveland. And then, I do an injury clinic afterwards. So, sometimes it's inside one of the Fleet Feet shoe stores 'cause we'll run out of there. Sometimes it's down in the flats. So this was pretty fun to get to set up a treatment table next to Cuyahoga River, and work on somebody's IT band, which is what I was doing. So, anyway, the particular runner I'm gonna talk about right now, we had a runner, first marathon. He had run multiple half-marathons.

So it's not like this was a couch to 26-mile deal. Our training programs go 14 weeks. The runners do three to four short runs per week. They do one to two cross-training sessions, and then they do one long run every Saturday. Sunday's a recovery day. Monday starts up with a cross-training or a very short run as well. And then we kinda ramp up through the week. So, this particular runner of mine, ours that we worked with, ended up having posterior tendonitis and some knee issues. It was related to biomechanics. We did a gate analysis on him, actually, prior to training. Gave him a couple tips. He was having trouble implementing some of the strength training and gains for a number of reasons. But then, started to have some issues, unfortunately.

So, when it's your first marathon, your goal is just to kinda lay down the mileage. And get the time on your feet. So, his legs hadn't felt that kind of stress before. So, obviously his goal was to continue doing the run, and what we would do is, from a rehab perspective, I had different rehab things that I needed to have him do. Which you can imagine what those are. And I'm sure you all have your own ideas on that. But then, what we also did, was, myself and the other, there's four other coaches, we

would check in with him multiple times throughout the week. And especially after every long run to see how things went. So, what we did was our goal was to get him to do those long runs and to lay down that time on his feet. Then, we would have him bike Mondays and Tuesdays. This is in addition to doing all of the rehab things that I was having him do. Wednesday or Thursday of that week, we would have him do a short run, only if he felt okay. So, it would be no longer than a half hour. Only if he was able to do it. If it would be pain-free. We rest Friday. We try to ramp up that run on Saturday. And then Sunday. So, that's great, but then we talk about real life and the gray area of everything, he also had signed up for this marathon and he had signed up with his wife for a bunch of fun runs, like five and 10Ks. And then, a run, a half-marathon that was supposed to be right before his taper week.

So, his thought was my wife and I are gonna go to Nashville, run this fun, Nashville half-marathon. It's a 13-mile run, it's right in my taper. I did my 20-miler the week before and then I'm gonna ramp down. This in theory sounds like a good idea, and a lot of fun, and they had already booked that trip. So, how do you have him run and try to have him cool it down and not race that run, when A, he's hurt. He was pain-free enough to make it through, but then when you talk about load, is that gonna put him over the edge and screw up marathon training? So, when you talk about understanding your athlete and a training plan and how things go on paper, you know, sometimes it's a week-to-week or day-to-day, in this case, consultation between myself and then the other coaches, just trying to put our heads together. And then the athlete, of how he's feeling and ramping up or down training. Couple CrossFit examples, because I think CrossFit is tricky, because as I mentioned in my earlier example, it's varied movements. They could be doing one thing one day and one thing another day. And you need to figure out how to coach for that and make a generalized recommendation for it, and to be more specific of a recommendation. So, athlete with shoulder pain for two months, he was training for a competition. And then, trying to train through pain, and then after the competition ended, the CrossFit open got moved from February to

October of this year. But the first competition was in September. You think you're gonna take time off and then you get sucked into everybody at your gym doing these CrossFit open, high-intensity, and no matter your best intentions, you get peer-pressured into pushing it when you shouldn't. He rested one month, he was no better. He would rest, just come in and go on the bike, and then go over to the pull up bar and try to pull up and be like damn, my shoulder hurts. And then rest for another week. It wasn't really, he was doing some band work and foam rolling, 'cause people at the gym were like you should do that. But nothing specific. So, came to see me. We worked on some shoulder mobility using some of those band exercises because he was very limited with his overhead mobility and his anterior capsule of the shoulder joint. I moped him as well. Then we started targeting rotator cuff and scap strength, and then I would build in little pieces of some of those lifts that he needed to do week-to-week.

So, maybe, in terms of maybe he needed to do power cleans. Maybe we started with pulls from the ground. We were just working on that pulling motion before you have to dip under the bar. Those things. So, I am going to, for sake of time, I do have one more case study, but I actually wanna open it up to questions right now, if anybody has them, about anything. We do have one comment from James about Nolan Ryan, and I think it's a very good point.

He says Nolan Ryan swam, sprinted, ran hills, not very sport-specific. I agree with you. When you think about those concepts of what he was doing, I think it actually had a good base for what he needed to do. So, he was a pitcher. Hill running is some power. And sprinting is a little bit of power training. I don't know and if you do know James, please, I'd be interested from a volume or a load perspective, how many sprints was he doing? Was it at the same amount that an outfielder would do? Probably not. I don't know, if he was, Nolan Ryan was one of those amazing, freak-of-nature athletes. Kind of like a LeBron James that could clean 115 pounds. Which, if you know weightlifting,

may not be that much for an athlete, relatively that size, or people kinda make fun of his squat form. But he's a freak-of-nature athlete. So, why would we change that at that point in his career? I don't know. But I think you bring up a very good point that sometimes there are exceptions to some of these rules. And the gray area and everything. So, thank you for that. Anybody else have any other questions? I will, what I'll do, is I'll go over this last case study but if you have questions, please interrupt me and I will gladly stop with the last one and get some good discussion, hopefully. So, last study is going to be a high school athlete, a soccer player. I actually mentioned this one earlier. Athlete with back pain. She had seen a physician, had an MRI, had been cleared for no spondy, but as we know, sometimes there is kind of a stress issue developing. May or may not show up on imaging. So, we end up treating this athlete kinda like a spondy, shut her down for a period of time, but then, as we're ramping her back, having back pain.

And the issue is having to modify some of the training, starting her with running, that's actually something we could start pretty early on, it didn't aggravate the issue. But then, just trying to ramp up sprints, speed, acceleration and agility drills, but then constantly checking in with her and her parents to how she was feeling with certain things. 'Cause I would let her go to practice and do foot skills or light running or different things on the sideline. And some days things felt great. We could kinda ramp up. Some days they didn't and ramp down. And just a matter of what she would be able to do or could she participate in warmups with the team and then go off to the side, do her rehab exercises and just understanding that training schedule. The week that she had practice and working along with that. So, one more question. What age athlete do you think it's okay to start doing Olympic lifts? That's an awesome question, Holly, because it's a very, it's something that's debated a lot. That being said, there's different schools of thought about it. My belief is that once they have the proper form, so I will start with athletes in middle school or even younger. I mean, I've even started with people like nine to 10, with things, not Olympic lifts, but basic form. So, basic

squatting, basic pulling form, basic things that are, hip stability, strengthening, sprint form, running form, all of those jumps, proper plyometric form. And the thought is that once they have a base of that, where it is that they have a good strength base, you can start to do certain things that are relative to Olympic lifts. That being said, it may be something that is like a PVC pipe or a training pipe or a training bar that's like 15 pounds, and just getting them to get that movement pattern down, is perfectly safe to do. Strength training has been shown to be perfectly safe to do in youth athletes too, as long as the emphasis is on form.

So, you may have lower intensity, focus on form, and then ramp up volume from there, so it's lighter weight, higher volume. Again, making sure that they can do it safely. And then, just going from there. I know that there is a movement. I think now, because CrossFit has brought lifting into light and the more and more youth athletes are recognizing the importance of strength and conditioning, and some of these lifts are being introduced a little bit earlier, which is interesting, just in terms of long-term athletic development, as some of these athletes have started earlier than I got to start, or I think any of us got to start.

Just seeing how they will do in the long-term, I think, is gonna be really kind of fun to watch, to be honest. James just said we're talking about Nolan Ryan. Overused delusions of grandeur, parents dreams for athletes. Yeah, or is this in terms of Nolan Ryan or is this in terms of just general athletes? In terms of general athletes, yeah. Does anybody else get this all the time? I think our joke is kinda along the same lines, if somebody comes in, is like I have a really high pain tolerance. I think anytime somebody says that, I know that they probably don't have a high pain tolerance. Same thing with some of these parents of walking in and they always will say, my kid is the real deal. And that's always kind of a red flag in my head, when they come in saying something like that. Or I gotta keep an eye out for overuse or high pressure on that poor kid, poor athlete. There's just things may be a little bit more muddy with that, and

just the pressure on that. And that does affect how you are training with them. So, sometimes I talk about a load, and appropriately ramping up, some of those people I'm appropriately ramping down. Or load managing, to use a trendy term, that in some of those cases, people may understand 'cause they saw an athlete, or LeBron or somebody doing load management. And I can get them to buy into something like that too. Yeah, that's a great point.

- [Calista] All right, well, thank you so much Carol. We're gonna go ahead and initially close out today. And thank you everyone for attending. Awesome.

- Thank you. Thank you Clalissa, thank you all for attending. I appreciate it. Oh, thanks April.

- [Calista] Have a great afternoon, everyone.

- [Carol] Bye guys, thank you again.