

This unedited transcript of a PhysicalTherapy.com webinar is provided in order to facilitate communication accessibility for the viewer and may not be a totally verbatim record of the proceedings. This transcript may contain errors. Copying or distributing this transcript without the express written consent of PhysicalTherapy.com is strictly prohibited. For any questions, please contact customerservice@PhysicalTherapy.com.

Upper Extremity Rehabilitation Following Stroke

Recorded June 26, 2020

Presenter: Jill Seale, PT, PhD, NCS
PhysicalTherapy.com Course #3764

- [Christy] At this time, it is my pleasure to introduce Doctor Jill Seale. She's gonna be presenting "Upper Extremity Rehabilitation Following Stroke". Doctor Seale has been a licensed physical therapist for 24 years. She received board certification in the area of neurologic physical therapy from the American Physical Therapy Board of Clinical Specialties in 2004, and then re-certification in 2014. She has practiced almost exclusively in the field of brain injury and stroke rehabilitation. She has a variety of teaching experiences in physical therapy academia, as well as in the healthcare community at large. Doctor Seale is currently faculty in the Department of Doctor of Physical Therapy Program at South college. Thank you for joining us, Doctor Seale, and at this time, I'll hand this mic over to you.

- [Jill] All right, well, thank you so much, Christy. You set a high bar by saying these were gonna be the best two hours of your day, man, I hope I can live up to that. But anyway, thank you guys for all attending on a Friday in what seems like a week that has lasted about three-months long, for many of us, I'm sure, so. I hope wherever you are, you are safe and healthy, and staying such. But thanks for joining us. I do have a lot of material to cover, so let's get through this first housekeeping part. I don't have any disclosures, I have no financial disclosures or non-financial disclosures, this doesn't focus on any product, and the course is presented by physicaltherapy.com. I will be showing you some slides that have pictures of some products, those are no kind of endorsements, it's just to be able to show you some examples of things that we might utilize for some of our patients. In terms of the learning outcomes, after this course, participants will be able to describe at least three abnormalities and the typical presentation of the upper extremity following a stroke, including challenges and barriers to your recovery. You're going to examine the evidence on upper extremity recovery and identify at least three evidence-based tools for upper extremity rehab, rehabilitation, develop at least three evidence-based interventions for the common activity limitations and impairments of the upper extremity following stroke, and identify

at least three appropriate outcome measures for utilization in upper extremity rehab. So as I said, I do have quite a lot of slides in the presentation, and I want to leave a lot of time for questions and I want to leave a lot of time to show you some videos of some patient activity. So if it seems like there are some slides that I speed over a little bit, or I don't spend as much time, it's just 'cause I'm trying to balance this out to make sure that we cover everything. Some of this is definitely information for you to have as a reference and to come back to, but, anyway, so let's jump in. So I would start with just an open-ended question, and you can either think about this, or if you wanna type a comment in the Q&A, you can, do you find upper extremity recovery after stroke to be challenging, maybe more challenging than other things that we deal with in our patients who have stroke, is it something that's challenging?

I'm guessing if you're thinking about this, and you're honest about this, most people are saying yes. When I teach courses with live audiences, yeah, I get a resounding yes, yes. So yeah, "Challenging, but fun," I love that, I love that 'cause I think it can be fun too, I think it can be fun. And then also, while you're thinking and reflecting on sort of where you are, I'd love for you to think about what are your beliefs about upper extremity recovery? Do you fully believe that upper extremity recovery is possible, or is it unlikely, or is it not possible? If you could sort of put yourself in one of those three categories, which would you choose there in terms of your beliefs about upper extremity recovery?

And you can feel free to type in, or just spend a moment thinking about that. I think it's really important for us to reflect and think about, what's the perspective I bring to upper extremity recovery? I will tell you that a lot of people in healthcare, and a lot of patients, believe that it's an unlikely-to-not-possible category. Gina, thanks for saying that it's possible, I fully believe it's possible too, otherwise I wouldn't be spending two hours talking to you about it. But I think physicians and some other healthcare providers, I shouldn't say all physicians, some physicians, and some healthcare

providers, sort of start from a mindset of, well, it's unlikely or it's not possible, or, just again, strongly unlikely. And so the people that are saying definitely possible and possible, I think that's awesome. I think there are quite a few myths about upper extremity recovery and you can think about maybe some myths that you have heard. Think about what you might have heard, other clinicians say, or physicians say, some of the things that patients say that they've read or heard, that you might consider to be a myth. You can think about those for a second. A lot of times what I hear some people saying, and I won't just blame physicians 'cause I think it's clinicians too, they'll say something along the lines of well, the upper extremity, anatomically, upper extremity doesn't have the capacity to recover as well as the lower extremity.

And that's a myth, that's a myth that the upper extremity doesn't have the capacity to recover. And they typically refer back to the neuroanatomy, there's nothing anatomically that says, the upper extremity doesn't have the same potential for recovery. The only thing, anatomically, that sort of lends itself to this discussion of the upper extremity is the fact that the majority of people who have a stroke have a middle cerebral artery stroke, and the middle cerebral artery distribution, when there's an infarct in that distribution, that means that your upper extremity is gonna be impaired more than your lower extremity.

So doesn't necessarily mean anything about recovery, just means that in those patients, in the majority of patients who have a stroke, you do see more upper-extremity impairment than lower-extremity impairments. So those are some of the myths. And we'll be talking about what we know that's true based on the evidence. And there's some good news, and then there's some not so good news, and we'll go through and talk about that. So I wanted to start out by talking, everybody pretty much agree that there's challenges and barriers, and I'd like you to take a moment before you necessarily look through the slides, and again, just in the 30 seconds while I'm talking here, just think to yourself about what do you consider to be, and you can kinda

prioritize them, what do you consider to be the biggest challenges, or barriers to improving upper extremity function in our patients with stroke? Take just a second here and jot stuff down as I'm changing the slide, and sort of see where your perspective and your feelings that you're bringing to this course, line up.

Then we're gonna talk through all of these. So, lack of motivation, I'm just gonna read these off and not spend much time talking about them 'cause we're gonna talk about them in a second, lack of motivation, carryover to function, alterations in muscle tone, whether it's hypo or hyper, both of those can certainly be a challenge to the upper extremity, positioning challenges of the upper extremity, whoops, didn't mean to go backwards there, weight-bearing challenges, we know weight-bearing is important, but how do we do that, the complexity of the upper extremity, the relative instability of the upper extremity, maybe our patients have some neglect and inattention and that may pose sort of an extra challenge or barrier, pain, we know that's common in upper extremity, we're spend some time talking about that today. Maybe they even have some diagnosis like complex regional pain syndrome, and certainly, that can be a significant impact to the upper extremity.

Gina chimed in and said compliance, and I don't have compliance on here, but I think that's a big one. I don't have that on my list, I should have to alter these and add that. I think we could make that a little bit of a subsection around motivation potentially. Certainly, if a person has a stroke that causes some ataxia, that can significantly impair the upper extremity, probably even more so than the lower extremity. So we got a lot of barriers and a lot of challenges. So let's talk through some of these. One of the things that I put on my list there, was the relative instability of the shoulder girdle. I always say our shoulder is held together by strings, a couple of strings, right? So you have this large humeral head and this small glenoid fossa. The humeral head doesn't quite all fit, I shouldn't even say doesn't quite, it actually, a lot of it hangs out. If you look at that picture there, lemme get my pointer here. Oh-oh, my pointer got stuck, thank you. If

you look at this picture here, you can see that the humeral head is kinda hanging out in the glenoid fossa. If you think about this in comparison to the hip, where you have a large acetabulum and a large femoral head as well, they fit together very congruently, I mean, they fit in there very tightly and very well, and when we look at the glenoid fossa, and the humeral head, not so much, really not fitting in that space very well. It's not connected to the body very well, it has some muscular connections, it has some ligaments, but it's just not very well-attached to our body under the best circumstances. It's really dependent on muscular support for its security there in the joint, and if that muscular support goes away, in terms of something that takes out the rotator cuff, then we're in trouble.

And then also there's a lot of force to be overcome because we use this in an open-chain position, we have the weight of the arm, we have gravity, we have the length of the lever arm, so most of the time when I'm doing things, my arm may be fully extended, and so now I've got a really long lever arm, and I have in then, the weight of an object. So all of that is creating a really high-torque demand on the muscles around the shoulder girdle. So there's a high torque demand and some relative instability. There's also a lot of complexity of the wrist and hand. You might be saying, "Well, why did I jump through the elbow?"

Well, the elbow is just not as complex, so we don't talk about the middle joints quite as much, but there's a high degree of complexity of the wrist in hand, there's a lot of joints, and a lot of bones, don't make me name all of them, 'cause I really can't, but there's a lot of movements. And saying a lot of movements is a good place to interject a comment here about when we say a lot of movement. Hopefully everybody understands the term degrees of freedom. Degrees of freedom has to do with the number of movement options that we have at any given joint. So when we think about all of the joints of the fingers, wrist, forearm, elbow, shoulder, we have a lot of degrees of freedom in the upper extremity, we have a lot of possible movement choices, that's

good, we need to be able to do a wide variety of things with that upper extremity. However, the more degrees of freedom that we have, the more control we have to have, right, I have to have excellent control. If I have a little bit of muscle weakness, if I have a little bit of instability, if I have a little loss of range of motion, that can have a big impact when I have so many degrees of freedom to control. And one of the things we'll talk about, and ways that we intervene for the upper extremity, is to sometimes eliminate, temporarily, some of these degrees of freedom, to help our patients be able to start to move with a little better quality because we eliminate some of their degrees of freedom for them so they can manage. That's getting a little bit ahead, but that was a good place to put that in there.

The other thing to say about the wrist and pan, is it's 100% dependent, I shouldn't say 100%, it's largely dependent on the shoulder girdle. So when I need to do something with my wrist and hand, if my shoulder girdle is unstable, what I do with my wrist and hand is going to be affected. And we see this oftentimes in our patients with stroke, sitting at rest, they may have some nice isolated wrist-and-finger movement. But then when I put that into a whole-arm movement where they're reaching forward, maybe to get a cup or to pick up an object, by the time they get to that object, I noticed that their fingers are now closed, the wrist may be flexing, they seem to have, what a lot of people will label as spasticity or hypertonicity, but we didn't see that before when they were at rest.

They have some changes in their ability to use their wrist and fingers because they don't have that stability at the shoulder, and we sort of sacrifice the wrist and hand to try to make the shoulder more stable. And obviously, it's very susceptible to changes in muscle tone, more susceptible because it's not a weight-bearing limb. We also bring to this party, all of our premorbid muscle imbalances and poor posture. Many of you are sitting at a computer right now, your shoulders are probably rounded, your head is probably in a forward position, your thoracic spine is probably kyphotic, right? And if

we do much sitting or driving, that's kinda the posture that we have, and we also tend to have some muscle imbalance to the front, right? We have stronger pecs, oftentimes, than we do those posterior muscles, we work out even, and we strengthen sometimes, over-strengthen our anterior muscles and we sort of under-strengthen our posterior muscles, so we don't have good balance, and then we have a stroke, and it just exacerbates that, right? So we have these common muscle imbalances where the muscles in the front, the anterior muscles are maybe stronger, but also may be more tight and may be more prone to hypertonicity, we have a common posture of thoracic kyphosis, forward head, rounded shoulders, and then we have this upper extremity that doesn't work very well.

So what we bring to the party, in terms of our premorbid, just gets exacerbated by then when we have a stroke. And so this is just a schematic just to remind you of the muscle bulk we have in the front, really again, with the pecs being really big contributors, and then the muscle bulk that we have in the back, much, much less except for the lats. Now, you might be thinking, "Well, those lats are poster muscles, and those are really big muscles, that's an internal rotator."

What do we not want our patients with stroke to have too much of, internal rotation, right, we oftentimes really fight with getting them to be able to externally rotate, and so the lats are a big culprit of being a little bit more active and causing too much internal rotation. The other thing I wanna say about the lats while we're here is that if I'm a person who has instability in my trunk and I don't have good postural control in sitting, or standing for that matter, and I'm trying really hard to just pull everything I can together to make my core more stable, the lats, which is an upper extremity muscle, right, the lats can be activated to try to increase core stability. You can picture it, right, it's a giant muscle on my back inside, so you can imagine that I could try to use that muscle for core stability, but if I tighten my muscle, trying to tighten up its connection to the thoracolumbar fascia, and thereby the pelvis, if I tighten this up and activate this,

then what's that gonna do to my arm, it's gonna internally rotate my arm. So oftentimes, when I see patients who are struggling and their arm keeps wanting to go into internal rotation, one of the first things I look at is are they stable in sitting or standing, and if they're not, I try to give them some stability in that position, so that hopefully they can relax their lats and not be using that as a postural muscle. That's just a little tip. Hopefully that makes sense to everybody. And then there's just a huge degree of complexity that we need in the upper extremity that we don't need in the lower extremity. I don't do any fine motor things with my feet, I don't need near as much graded force and activation with my feet as I do with my upper extremity. And also our upper extremity is very dependent on other systems, it's highly dependent on vision, it's highly dependent on my sensory system, probably more so even than our lower extremity, so there's a lot of interconnection.

And the upper extremity, the things that we do, are typically some more big motor movement like reach, and then some more fine motor movement on top of that, and so we're combining those movements, and again, anytime we combine and we have so many muscle groups and joints working, we have more room for error and for problems to happen, we have a lot of degrees of freedom to control. If we just were using our hand and wrist without combining it with reach, we might do a better job. And that's one of the ways that we can start in our treatment, is trying to not have patients do such large total-arm movements too soon.

So I wanna shift to talk about motivation for upper extremity recovery. And I don't know what your experiences are, you can take a moment as I'm talking to sort of recall what you think your experience has been in terms of motivation for aperture recovery, but I know when I go in to see a patient, and I say, "Mr. Smith, what are your goals for therapy?" they all say they wanna walk, and I know when my OT colleagues, many, I shouldn't say all of them, but I think most of them, when my OT colleagues go in and say, "Mr. Smith, what are your goals for therapy?" they say, "I wanna walk," or maybe

they wanna be able to toilet and that kinda stuff. But very seldom do they say, "I wanna be able to use both my hands," or, "I wanna be able to use my effected hand to be able to do X, Y and Z," they, unfortunately, I believe, they learn really quickly that they can accomplish a lot of tasks with just one hand, right? So I feel like we're starting in a hole a bit in terms of motivation. The patient's goals don't always align with wanting, they want upper extremity recovery, but I feel like that's not the priority goal for them. And then all the myths that we've talked about, just really impact this motivation, I think. I think they hear people say, "Yeah, you probably aren't gonna get recovery in your upper extremity," or, "upper extremity recovery doesn't really happen too well or too much, or too often, or it's uncommon, yada, yada, yada," and that's gonna shoot their motivation in the foot, right?

And we know, this is actually in 100% juxtaposition to what we know about motor learning because we know that motor learning, motivation is a key element for motor learning. So one of the reasons why we may have struggled to really improve motor recovery, the re-acquisition of upper extremity skill in these patients is that we haven't gotten that motivation factor there. And so I think that's really, I don't wanna say low-hanging fruit 'cause it's not low-hanging fruit, but I think this is an area that we really need to work to improve, right?

And I'll give you just one anecdotal illustration. This was not my patient personally, this is one of my colleagues' patients, but we all knew about this patient, we all worked with this patient a little bit, but we had a patient, this is 100 years ago, as I like to say now, that I've been practicing for almost a quarter of a century, it's a long time ago, but we had a patient that came to our inpatient rehab, she had had a stroke during childbirth, either shortly before or shortly after childbirth, and she happened to be a woman who was deaf, sorry, I didn't pronounce that very well, and she used sign language as her primary means of communication, right? So she comes to inpatient rehab, she, A, has a high motivation 'cause she has a baby, and it's really, I don't have

children, but I can't imagine trying to do anything much with just one arm, I feel like that would be really hard, so that was an increased motivation for her to be able to truly be able to care for that child. And then the other motivation is, it's really hard to communicate if all you can do is sign language with one hand, you're sort of left to just spelling out a bunch of stuff.

And so she really needed to be able to sign to be able to communicate with those around her, her spouse was also deaf, so she really needed to be able to sign and we didn't stress, "Hey, we need to really work on your upper extremity recovery 'cause this seems like a priority for you," we didn't do any of that. Her therapist that saw her gave her the same intervention that anyone else would get. But I wish we had recorded this, I wish we had gotten the outcome measures, my gosh, we really didn't use outcome measures back then unfortunately, but this woman had just amazing upper extremity recovery probably at a rate higher than her lower extremity recovery. And there's all kinds of things we could point to about that. Really, I think people that are smart-thinking might say, "Well, maybe she was more primed for recovery of her upper extremity because for her whole life, she'd been using her upper extremity a different way.

She probably already had more cortical territory that was designated for the upper extremity 'cause she used her upper extremity way more than the average person." And that's possible, her neuroanatomy was likely already adapted, in some ways because of her use. But I can't help but think that a big part of her recovery had to do with her motivation. Her motivation being different, maybe than the majority of our other patients, right? And there's other I get, I don't know that there's research evidence, but there's lots of anecdotal stories like that out there that point to this idea of when the motivation is high recovery is better, so. I wanna show the first video here just really quickly, and I just do this just kinda to set the stage. This is one of my patients, and that's occupational therapist. And he was so excited to get out in his

garage, I have the sound, they removed all the sound, which I wanted, but as he's doing this, he's saying, "My garage, my garage." So we're working on him being able to get out and take care of his garage, which was super important to him, right? And now we're just filling him kinda as he is, we're really not imposing any sort of therapy here, we're not asking him to do it a certain way, and certainly, this was something that we worked on sort of just this way early on, because he really wanted to be out there and sweeping out his garage, and we needed to make sure, from a balance-standing-walking standpoint, he was able to do that. But this is oftentimes how therapy goes, right, we do therapy, this is the whole, we're just working on things related to the functional task, not necessarily incorporation of the upper extremity in the task, we just allow people to be able to do things as they can without the other arm.

So this is where we started this, but certainly, really quickly and probably within this same session, we started problem-solving, "Okay, how can we help you utilize your affected upper extremity some?" At this point, this patient's pretty flacid, and he needed some assist, he needed to have something that helps secure his hand on the handle, but we certainly went right into working on, "Can you utilize your upper extremity for this task?" at least in our therapy sessions.

That didn't mean that once he was safe, he wasn't gonna go out there and sweep with just that left hand, he may have been gonna do that, but we always were encouraging him to figure out how he could incorporate his upper extremity into that task. And so as we go forward, I'll show you some other examples of that, with the same patient, of some things that we did to get him more towards that. And I would say that, by the end, and I'm sorry, I don't have a video of that, but by the end, he was able actually to do those kinds of tasks bimanually, so, which was great. But that's just to kinda set the stage. I'm sure all of you are sitting there going, "Yep, yep, seen that patient, right, does everything with just the one hand and we just sort of try to work to make sure that

they're safe in doing those functional tasks," and we oftentimes neglect the upper extremity. And for my PT brothers and sisters that are on the call, we oftentimes look at that and say, "Well, I'm just working on their gait and balance here, I'm just making sure they don't fall," and that's absolutely not how we should be looking at things we need to quit looking at things in terms of the upper extremity being OT scope of practice and standing and gait being the PT scope of practice. Sweeping out my garage is a bilateral, or bimanual, whichever way you wanna say it, upper extremity task, along with postural control, balance and walking, right? And so we need to quit subdividing those tasks and only working on one part of it. That's my soapbox, I'll step back down now.

One of the things that we put on the list was carryover to function, or use of the arm as being a barrier, or a challenge. And compliance could go in here too, somebody suggested compliance. The question becomes, do we actually get carryover into function? So we get improvement in upper extremity, we get increases in overall activation, we get increases in motor activity, we even can get, in cases, improvements in dexterity, so we increase capacity, but does this capacity equate to the patient actually using their affected upper extremity?

And as a therapist, I firmly wanna believe yes, right, I wanna say, "Yes, of course, if I'm improving their ability to move and use the upper extremity, it has to lead to improvement in their actual use." But what we know from the literature, especially more recent literature, is there's really a high degree of variability in the upper extremity functional capacity and upper extremity performance. So changes in upper extremity capacity don't necessarily equate to, or result in, increased upper extremity performance in daily life. Upper extremity capacity and upper extremity performance are really two different constructs, they're two different things. And we probably need to make sure that we're, A, measuring both of them and they're measured differently. And this wonderful paper that I've referenced there, that was published in 2016, and

there's probably actually some other works around that, but this was a paper where they started out with looking at intensive practice for the upper extremity 'cause they really felt all of you, unless you're living under a rehab evidence rock, you know that the biggest thing that's come along in the last decade has been this idea of the importance of intensity, intensity of practice. And so they said, "Maybe what's been happening with the upper extremity is we just haven't been practicing intensely enough." So they designed a study to be able to really focus in on intensity, and what they saw is that yes, people responded by improving their upper extremity capacity, but it didn't actually improve, or lead to, in many cases, improvement in the actual use.

Why is that? Maybe that goes back to motivation, maybe that goes back to habits. If they have a habit of only using the one arm, even if they improve capacity, they may really just stay within that sort of habitual track they're in, right? If they have improved capacity, but not normal capacity, maybe they always, the unaffected arm always wins out because it's faster, it's more accurate, that kinda stuff.

So it's an interesting thing to think about, a little bit disheartening for us to think about, but again, I think it points to the need for further focus on that motivation piece, potentially. So one of the things we put on our barrier list was pain. I'm gonna guess that a lot of you put that at the top of your list of challenges and barriers, I don't know, maybe not, but I feel like in the clinic and when I'm out teaching and getting to talk to people face to face, when I ask them what their issues are, a lot of them point to pain in the upper extremity. And it is true, pain in the upper extremity and the hemiplegic shoulder specifically, is really common. You can see there the statistics are very wide-ranging, but on average over 50%, we would say, have a painful upper extremity, or specifically a painful shoulder. And oftentimes, people make some assumptions about what is the cause of that pain. And oftentimes, and I'm jumping ahead a little bit, but oftentimes people will make an assumption that the cause of that pain is subluxation, so they have a flaccid arm and they have subluxation, and that's painful.

But in fact, when we look at the literature as a whole, it would seem that the majority of pain results from immobility. So they develop, they're either flaccid, or they have a lot of hypertonicity potentially, but they have a loss of range of motion. And then also there is that imbalance that we talked about, around the shoulder girdle, and we have an imbalance of muscle tone that develops around the shoulder girdle with our flexors tending to be more hypertonic and our extensors tending to be lower in muscle tone as they start to experience changes in muscle tone. And then also, impingement can develop.

And certainly that can be painful if you think about the typical posture of the hemiplegic upper extremity, and we'll get more in detail about that in a second, but if I don't have normal biomechanical alignment at the shoulder, and I attempt to move it, or someone else moves it for me passively, you can certainly imagine that impingement would be possible, right, we all can picture that. We all can picture that, but we oftentimes don't think about that in our patients with strokes. We wanna make sure that, I feel like this gives us sort of a starting point for what do we do about pain at the shoulder, we wanna maintain range of motion, we wanna try to regulate muscle tone if we can, and we want to align structures, we want to do what we can to normalize the biomechanical alignment.

So, again, I jumped ahead a little bit to ask what was the mechanism of the pain? I think a lot of people, and based on the literature, we know that a lot of people believe the mechanism of pain is subluxation. And certainly, our patients who experience a stroke acutely, they're gonna be very placid most of the time, and that flaccidity on an unsupported arm is going to cause subluxation, right, and then that subluxation is gonna stretch the capsule, and it's gonna stretch the ligaments, and certainly that could result in pain. But is it the cause of most people's pain, is that an actual true statement? And in fact, I've already given you the answer that that is not, right? But before we move on from talking about subluxation, let's talk about that for a second

before we talk about those things that are the more common cause. In a flaccid upper extremity, right, we know what that means, there's little to no muscle activity, there's that gap between the acromion and the humeral head, you guys all can picture that, right, and we put our fingers in there and we count how many fingers we can put in that space, and that's oftentimes how we document an inferior subluxation. What also goes along with that that's really important to recognize, is a downwardly rotated scapula. Normal position of the scapula should be upwardly rotated. The upward rotation helps to hold the humeral head in that small glenoid fossa. But when I lose activation in my rotator cuff, my scapula downwardly rotates and it just creates like a slide to dump the humeral head out, right? And then there's, on top of that, the scapula is also abducted.

Again, part of this has to do with our regular posture, part of this has to do with muscle imbalance, but our scapula in a flaccid upper extremity is gonna typically rest in abduction further away from the spine than it needs to be, and then a thoracic trunk, if we have a kyphotic thoracic spine, sorry about that, that's going to only contribute to that abducted scapula, right, so it pushes it even further out. So the trunk posture that we take on, or our patients take on, does not help this situation, it actually adds to the situation.

So in terms of inferior subluxation, again, we talked about the things that contribute to that downward rotation of the scapula, we can rotate our cuff muscles, and then over time you get a loss of joint capsule integrity because of that sort of permanent stretch, right, you get this constant stretch, you get creep of the capsule, and now we have a saggy sort of stretched-out capsule then. And then obviously the weight of the unsupported arm, which again, if this is part of what contributes to subluxation, right now I'm thinking, "Okay, one possible, not solution, but one possible step towards helping solve this problem is to figure out some ways to support the upper extremity." So, I already said, it's not the most common cause of pain, but it is pretty common in

terms of occurring. There's a lot of variability in the literature and that's because it's diagnosed differently, we talked about number of fingers, we do radiological exams, it's different depending on the time since stroke, but in general, you can see there most likely a large number of folks that have a stroke experience some type of shoulder subluxation, and here, again, we're primarily talking about inferior. But going back to is it the most common cause of pain, this is a study from way back, but I can tell you that this pattern repeats throughout the literature. These were all folks that had hemiplegic shoulder pain, and the most common cause of shoulder pain was adhesive capsulitis.

And subluxation was a cause of pain, 44%, but it wasn't the most common cause. And adhesive capsulitis makes a whole lot of sense, right, how does one end up getting adhesive capsulitis, well, typically it's from a lack of mobility of the shoulder, right? We know some of those times, sometimes adhesive capsulitis happens idiopathically, but that's not what we're talking about here. If I'm not able to move my arm much, or any, I'm not moving that shoulder throughout its normal range of motion, it's a very good bet that I'm going to develop some adhesive capsulitis. Subluxation is a common cause but not the top cause.

And again, this is repeated over and over in the literature. The scary thing there is that almost a quarter of people had rotator cuff tears. And you might say, "Well, a person could have a premorbid rotator cuff tear, maybe they weren't even aware of, right, some of us have some degree of rotator cuff tear, it's just not bothering us," but I'm also gonna suggest that we as clinicians give a lot of rotator cuff tears, or we give a lot of rotator cuff damage by how we handle the patient, not just us as clinicians, but how the entire healthcare team, nursing, family, the patient themselves, how they handle their arm can greatly contribute to developing a rotator cuff tear. So that's really important. And then you have about 16%, which in this day, they talked about shoulder hand syndrome, we would call this complex regional pain syndrome. So in terms of the relationship between subluxation and pain, just a little bit more information here before

I move on, shoulder pain tends to be more significant in left hemiplegia. But again, I think that makes sense because in left hemiplegia, we're more likely to have patients who have left neglect, and if they have neglect compounding that you can imagine that they're more at risk for harming that arm, not really maintaining good positioning of that arm, so you have sort of an additive effect there, which could be why we see shoulder pain more significant in those with left hemiplegia. Really that next bullet not so important that when you have a severe inferior subluxation, you have a tendency to have medial displacement of the humeral head as well, so the humeral head becomes more abducted, but the third bullet point there, really important, there's a correlation between pain and range of motion, especially external rotation.

So when we lose external rotation, that seems to increase or correlate with an increase in pain, telling us again, this evidence could suggest that A, maintaining the range of motion is key and external rotation range of motion may be really key, right? And again, this study supports that adhesive changes were seen in most of the subjects. So leading back to that idea of adhesive issues being the leading problem. And I wanted to just make sure I said, because I don't want you to think that all patients just have an inferior subluxation, inferior subluxation is common in our patients who have an acute stroke.

So in those first, however, much time lapses when they have relatively low tone, they're flaccid or they have hypotonia, that's when we see the inferior subluxation. We may see an inferior subluxation continue as they start to develop muscle tone, but as they develop too much tone, if they develop hypertonicity, then what you're gonna see is more of an anterior subluxation, the humeral head is pulled forward out of the glenoid fossa and that has to do with hypertonicity. And I don't even wanna just say hypertonicity, it really has to do with stiffness and potentially some hypertonicity of more of those anterior muscles, right, all of those things that are pulling me forward, again, pecs being a real contributor there, part of it also being my posture is a

contributor there. If, over time, I'm not using that arm, I've rounded my shoulder even more, I've now become more stuck in a thoracic kyphosis, that's all contributing to that anterior subluxation. So certainly, we've talked about the things, in terms of postural considerations for inferior subluxation, but when you have an anterior subluxation, here you're dealing more, as I said, with hypotonia and those muscle imbalances. So our internal rotators tend to be greater than our external rotators in terms of their activation, and potentially over-activation, adductors tend to be greater than our abductors, and then flexors tend to be greater than extensors. So when we have this type of muscle imbalance happening, I can't really help but have that humeral head pulled forward.

So again, when I look at this data, or not this data, but I look at this information that comes from the research, I'm thinking, "Okay, for my patients, I wanna make sure that I'm emphasizing external rotation, both range of motion and strengthening, I wanna be emphasizing abduction, both, again, mobility, range of motion, and strengthening, and I wanna be emphasizing extensors or flexors, right? So this gives us an idea of how to go forward and treat.

So what do we do when our patient does have a subluxation? We wanna maintain that pain-free range of motion, which I've already said like three times now, so it must be important, or I'm just highly repetitive, which also could be the case, we want to always facilitate those stabilizing muscles of the trunk and shoulder girdle. And I would say this holds true for any problem that any of these patients are having with their upper extremity. What's your first step, get stabilization of those muscles in the trunk and the shoulder girdle. The arm is not going to function in an open-chain way if we don't have stability in the trunk and in the shoulder girdle. So if your patient doesn't have that, quit trying to have them reach and manipulate objects, and all that, get this for them, help them get this first, and then those other things are gonna come much easier. You wanna try as much as you can to maintain proper alignment of the scapula, the

humerus, and the trunk, lots of postural reeducation. Oftentimes, we jump right to the arm and neglect the trunk, and we really, again, we need to be looking at what's the alignment? If the biomechanical alignment isn't there, we're not going to get normal movement. We're gonna do some things to normalize muscle tone, which we'll talk about, and that typically means some type of weight-bearing. So in terms of subluxation, e-stim can also be helpful, we'll talk about supports cannot be helpful with some type, and positioning. Let's talk a little bit about that. We wanna position the upper extremity, obviously, to decrease subluxation, that seems kinda like a double bullet now that I read that, and we wanna maintain optimal range of motion, we wanna do some things to prevent hand edema.

So if the arm is in a dependent position, and relatively non-moving, and the hand is really non-moving, then it's not gonna take any time at all before I have a very edematous hand. And so we wanna prevent that, it's very painful. An edematous hand is going to, almost certainly, prevent any activation in the hand, the fastest way to get them not to be able to use their hands to let it be edematous. So we wanna make sure that we're addressing that, we wanna keep the arm safe from injury and that becomes a greater challenge in our patients who have neglect, but we certainly wanna address that, and we want to, of course, maximize function, right?

So just a few pictures here, and some thoughts about how we do that positioning and support oftentimes coming together. So making sure whether my patient is laying down, supine sideline, whichever way it is, that we are supporting the arm and positioning the arm optimally, so positioning it away from the body, not up close to the body. If you see the picture there, let me get my pointer, I don't know why every time I click on my pointer, it gets stuck, but you can help me unstick my pointer from over there. This picture here of the patient who's laying on her side, oftentimes people will say, "Well, I don't think I wanna have the patient lay on their affected side," that's perfectly fine to have them lay on their affected sides, it's good weight-bearing, It frees

up the other arm to be able to move and do things functionally if it needs to, but we wanna make sure that we have a position so that they don't have a great deal of pressure on their acromion. We wanna make sure that we have it elevated, right, we want hand higher than the elbow and potentially the elbow higher than the shoulder to prevent that edema. If you look at the other two pictures, the patient is in sitting, oftentimes when patients are sitting in a wheelchair, we could use some type of lap tray that would be optimal to position them, either half-lap tray, or full-lap tray. Key things here are don't over-correct their subluxation.

So I need to be able to adjust this lap tray up and down, which means I need to be able to adjust the armrest unless it just happens to be perfect, I need to be able to adjust those to, A, close up that subluxation, I wanna reduce that subluxation, but if I put them on a lap tray that's raised too high, I'm actually then cramming their humeral head up into their acromion and that could be causing an impingement. So we wanna be careful, we want to use supports but wanna use support correctly, and not just check to say, "Hey, they're supported, that's great," but actually check, and feel, and palpate, and see, does this feel like I've, A, reduced the subluxation but not over-reduced, over-corrected, and caused now an impingement, 'cause both of those could cause problems.

Christy, can you try to get my pointer unstuck from over there, it's still not happening for me. Let me click off and click back on. Ah, thank you, thank you. All right, so supporting the arm when the patient isn't standing, right? We know this is important, but I feel like this is something we've really struggled with. This is how we used to support them, right, we put them in what I call the the blue broken-arm sling. I don't know what the technical term for this is, but that's always been my idea, so if I see one that's not blue, I don't really know what to call it. But this is how sometimes people have thought, "Well, we can support the arm in standing," and I guess if I have no other way, then maybe this, I don't wanna say it might be an okay option, I guess it might be

okay option, but what's the problem with this sling? Well, it certainly does support the arm, my arm is not hanging down causing that stretching of the capsule, stretching of all the structures that we don't want, but now the person is in the position that we would like for them to avoid, right, they are internally rotated, they are adducted, and their elbow is flexed. So they're sort of in the position that we want the patient to be most out of, right? And this also really contributes to what I call the security factor, where the patients need to have the arm right up against them. You can't see me now, but I'm cradling my arm against my body, just like cradling a child, right? And you've all seen it, right, patients develop this need to protect that arm, that I feel like this sling does exactly what patients are wanting to do.

But yes, surely this does remove the external rotation, actually makes external rotation impossible, right? So Iona, I'm sure they will be helping you with that tech issue there. So the second one here is kind of an old picture, you can tell it's an old picture, but this was an attempt to use a roll underneath the hemiplegic arm. You can see here, there's this sort of roll of material in this figure-eight position here. And this roll of material was just meant to comfortably abduct the arm away from the body and hold the arm away from the body.

And so that's certainly important, but it really only got it one aspect. And then we went to these things, humeral cuffs, and we still utilized some humeral cuffs today, and the idea here was that that humeral cuff, because it has a large surface area, is going to sort of capture that arm and help to, using that figure eight around the other arm, help to suspend or lift up the arm and support the arm, reducing the subluxation. And again, all of these probably works to some degree, and there's not a lot of evidence out there comparing types. In more recent years, in the last, I don't know, 20 years or so, or maybe less, not exactly sure how long I've been using and seeing these, they GivMohr Sling came along, and this is a picture from their website, you can go google GivMohr and see this. And again, the idea here is that it got them out of that blue broken-arm

sling position, it got them into something that allowed the arm to be more abducted away from the body, the elbow is now more extended, the arm is less into internal rotation, it's not like it's in external rotation, but it's less into internal rotation, and the hand, if you can see here, or those of you who've seen this before, the hand is supported on a piece of, kind of a cone-like material there. And so the idea was this made it sort of a semi weight-bearing kind of sling, the hand is actually in a weight-bearing position. And so this was a good idea, novel at its time, right?

There is one study that did compare these three devices that you can see here, or well, no sling, and then the GivMohr, and then that humeral cuff that we talked about, and they found positive results for the GivMohr Sling over that humeral cuff or no device in itself. But I would ask you, for those of you who may have used this device, like everything, right, there's positives and negatives, we think about the benefit-risk ratio, if you wanna type in the chat box, what are some of the negatives related to this device? The positives are definitely that it puts it in better biomechanical alignment and it seems to support the arm well, but anybody experienced any negatives with this that they wanna share? I'll give you time to type in but I'll go ahead and be talking about what I see clinically. I attribute this to me being a PT but I have a lot of trouble putting it on my patients.

Sometimes I put it on backwards and upside down, but I struggle to put it on a little bit. Most of our patients can't get it on themselves, I guess there are some who can, but fewer can. And even family members oftentimes may struggle, it's a little bit of a challenge putting on and off, or putting on. The other thing is when the patient sits down, it kinda comes out of position, or they need to take their arm out of the sling, and then, again, it's just kinda a little bit in the way and a little cumbersome, and a little bulky. But it's a great device compared to the things that we've talked about thus far, and certainly it is important. I would say it's imperative to support the upper extremity when the patient is upstanding, standing and/or walking. Another device that I've been

using more frequently and seeing used more frequently with my patients, is this device by Ottobock, which tried to do a similar thing as GivMohr, right, tried to have not only a proximal support, or the proximal support of like the humeral cuff, but then the distal support of the GivMohr Sling. And so this is a neoprene material here, that kinda has that same humeral cuff support idea that we talked about, but then it attaches to a distal component that attaches to the arm, and that distal component, again, helps to reduce that subluxation hopefully, a little more.

There's not a study, to my knowledge, that's looked at this particular device and compared it against any others. But I have found this to work well in, I will say some of my patients because nothing works well in 100% of our patients, typically, some positives that I would share just based on my experience and my patients' experience with this device, is it's much less bulky. Patients can actually put this on next to their skin and put a shirt on over if they want, if they were so inclined. Most people don't, but they could, and it's easier for them to put on and off. I have patients who, I would say, much more routinely can put this on themselves and not have to have a caregiver do that. And then when they sit down, nothing really comes loose, and nothing really gets in the way.

The other thing is this, this distal piece here is snapped on. So they can unsnap that and be able to move and manipulate their elbow, forearm and everything freely, without affecting the configuration of the brace, and then just snap it back together. But even if they don't unsnap that sitting down in the chair, sitting on a couch, whatever, it doesn't really get in the way, and it's a little less cumbersome. So again, both are really good devices with pluses and minuses, but my suggestion, the reason why I'm including these is we have to think beyond just supporting the arm and think about what's the position that we're supporting the arm in, and how we're doing that. So I hope to see more studies out there looking at comparing actual devices and helping us understand which devices may be best. But that's yet to come, I think. There is a recent, in 2017,

review paper that looked at orthotic devices, but they didn't really compare devices, they sort of looked at them globally 'cause they're looking at all the research that's out there. And the key to this, I've kinda summarized the study here, but the key, the cliff notes, is that when using the orthosis, it immediately reduced the subluxation on X-ray, but those improvements weren't maintained when the orthosis was removed. So wearing it over time did a great job of reducing the subluxation but didn't necessarily result in improvement when outside of the device, right? And they also had some evidence for orthosis that had both the proximal and a distal attachment when worn for up to four weeks, in terms of management of pain.

But the other things I think are important in this study is that there weren't any adverse effects in terms of spasticity, or contracture, or hand edema, when compared to wearing nothing, and also that they were generally well-tolerated by most patients. I think oftentimes, therapists are reluctant to provide an orthosis for the patient 'cause they feel like the patient isn't going to wanna use it, or utilize it, and this study found that that in fact wasn't true, wasn't true based on the evidence that's out there. So I would encourage you that your patients who have hemiparesis, who have especially a flaccid upper extremity, they really need some type of support if they're gonna be standing and walking.

And I think, yeah, insurance may not cover these devices, if they're not covering these devices, I still talk to my patients about them, give them the information, talk to them about looking at how much that would cost to happen out-of-pocket. I can't quote you any prices, nor do I wish to, but I would say that neither of these are exorbitantly priced, neither of the last two that I showed you are exorbitantly priced, and many patients will choose to pay out of pocket, when they understand that it's really something that they need, that's gonna benefit them. And I think the issue of not getting carryover has to do with, I still don't think we're really treating the upper extremity well, I don't think we're doing all the right things to get upper extremity

recovery. I think using a shoulder orthosis is sort of a stepping stone to preserving the arm, to making sure that it's not getting too tight, that we're not getting damage to the joint, and then we really need to focus more on what are we doing with arm to actually get recovery, right? Oftentimes, we're just putting them in this device and sort of maybe that's the end of our intervention, unfortunately. So that gets us to weight-bearing challenges. We said that was one of the challenges, was weight-bearing. We know that weight-bearing is important for our patients, it helps to normalize muscle tone. If they're in good biomechanical alignment, that's a real important caveat there to that first bullet, weight-bearing in any old way is probably not helpful, but weight-bearing with normal biomechanical alignment, or as good-as-possible biomechanical alignment is important.

And we know that in the upper extremity, close chain activities are really the first step in our exercise progression, but our upper extremity isn't really a weight-bearing limb in function. We're not quadrupedal and so in contrast to the lower extremity, it's not a weight-bearing limb, so we have a lot of trouble coming up with meaningful weight-bearing activities to do. The other thing is that in my lower extremity, if I transfer, if I stand, if I do any amount of mobility, I'm going to get a little weight-bearing through my affected lower extremity, right, so weight-bearing is just really easier to have happen throughout the day in my lower extremity, versus in the upper extremity weight-bearing is something I have to make a plan for, right, it's not occurring in normal everyday life.

So we have to think about what are some solutions, how can we incorporate some ways for weight-bearing throughout the day, make it more of a normal part of our patient's life, potentially. And then we need to talk about how we progress because what I see therapists doing is they go from weight-bearing on the arm, they do some nice weight-bearing, and then they go right from there to, "Okay, now I want you to raise your arm over your head." It's like weight-bearing, close chain, straight to open

chain. And what they find is the patient can't really do the open chain activity, they can't raise their arm over their head, and they're like, "Well, I don't know what to do." I just did weight-bearing, and now they still can't move, right, there has to be some interim steps to progress from weight-bearing to actual use of the arm. Keep in mind what you learn in PT school in terms of motor learning, is that we start off, we think about mobility to stability. I'm sorry, that didn't come out quite right, we think about mobility to stability, to control mobility, to skill.

So what does that mean for the arm? That means that I first need to make sure I have the necessary range of motion, the shoulder, at the trunk, throughout the arm, and if they don't have that mobility, if they don't have that range of motion, I need to give that to them, right, in terms of passive range of motion, not talking about active here, right? And then the second step is I need stability. And typically we're thinking about stability in the trunk and the glenohumeral joint, the scapula, and then from there, I build into controlled mobility. So can they move and still make good control? And then we move on to skill. And oftentimes we just jump ahead and we try to jump right to skill, and then we wonder why our patients don't do well. I'll tell you one quick story about weight-bearing challenges.

I had a patient one time who had had a stroke, he's a young young man, and I followed him for quite a while, he came back to outpatient clinic and I would get to see him and update with him there, and he came in one day for clinic, and I said, "Well, tell me about how you're doing. Tell me a little bit about your home program," and he had affected upper extremity, like most all of our patients. And he said, "Well, Jill, I start each day with a weight-bearing activity and a bowl of Captain Crunch." And I was like, "What, what are you talking about?" And he goes, "Well, I know I need to do my weight-bearing exercises, so I come into the kitchen, I get my arm in weight-bearing on the counter, and then while it's in weight-bearing, I open the cabinet, get out my bowl, and get out my spoon at the drawer, get out my Captain Crunch, get out my milk," or

he's already gotten out his milk, "so I get all those out, I make my cereal. And while I'm eating my cereal and watching the news, I do my weight-bearing activities." That was just his his day, right? And I thought, "Isn't that amazing if I could get patients to, all my patients, to just have a relatively regular routine and be very intentional about their weight-bearing activities?" But that's hard to get because, again, they're just not a normal part of our life. It's very important to think about progression, I've already suggested that but we wanna think about progressing, starting with bilateral or bimanual, whichever word you wanna use, activities to unilateral. Our patients oftentimes have very little going on in that upper extremity that's affected, but bilaterally, they can start to move and do some things. Start there, and then progress to those unilateral.

Think about starting your activities in more of a mid range position where contraction is easiest, right? We all learned in school, in kinesiology, or movement science, or wherever it was, that it's easiest to develop a contraction in the mid range position. So starting those mid-range positions and then move to those more in-range positions. Start with a short-moment arm, or lever-arm, whichever word you wanna use, and progress to a longer-lever arm. Don't do activities with the arm and the shoulder in 90 degrees and the elbow fully extended, that's really hard to control, right? Let the elbow be flexed, bring the hand back closer to the body, shorten the lever arm, and do those activities first, and develop that control there. Start your weight-bearing activities on a more stable surface and move to a more compliant surface. And make sure that you're progressing from fully weight-bearing to barely weight-bearing, and we'll talk about what barely weight-bearing means here in a second. So I've given you some examples here, some pictures of places that I might start, right? If the patient is sitting on a hospital bed or on the plinth, there's all kinds of ways I can do unilateral weight-bearing like this woman is doing here, or I could have both arms in weight-bearing, she could be doing bilateral weight-bearing, I can get the person prone and do prone weight-bearing. I love prone position for my patients because it has so many

wonderful, I call it a bang-for-the-buck exercise, right, 'cause I'm getting hip flexor stretching, I'm working on stability around the scapula here, I could be also working on strengthening of the lower extremities, I'm working on trunk extension, I'm helping to hopefully flatten their curve in terms of their thoracic kyphosis, boy, that term means something different now, flatten the curve, but these are positions that I might have my patient start with. I can do weight-bearing in sitting, obviously, that's fewer degrees of freedom, right? And you can see here this person is doing weight-bearing, they're shifted over their arms, they can be shifting their body from one side to the other, potentially, and what am I doing as a therapist, I'm making sure that they're stabilizing here at their scapula, that they're able to keep their elbow extended, and if they're not, I'm using some handling skills to help make that happen, right, to make them safe and stable, and providing as minimal input as I can.

Over here, the sitting at the table, this is a nice example of starting to move from some weight-bearing to some weight-bearing mobility, right? She's weight-bearing into the table, but now she's working on pushing this away and pulling this back. So she's still in a weight-bearing position, that's still decreasing her degrees of freedom some, it's taking a whole lot of stress off the shoulder, but she's working on that forward reach component, which is so important, right?

Oftentimes, we go right to saying to my patient, "Just reach your hand forward," and they can't do it. But if I take some of the weight of this arm, take some of the stress on the shoulder, I can help them be able to accomplish that task while working on strengthening the shoulder girdle for stability, right? So really important to think about this as a stepwise process, and not really jump steps. And we can make weight-bearing as complicated or easy as we want. We can move on to other positions. So we've already talked about sitting, I can have them do weight-bearing in standing, I can combine this weight-bearing with other activities I'm doing with the lower extremity in the trunk, I can have them do weight-bearing in kneeling, I can have

them do weight-bearing in quadruped. And the key here is thinking about what positions give me the most bang for the buck, where I'm working on the upper extremity as well as other things I need to be addressing hopefully, and where can I get them in the best biomechanical alignment and what are the safest positions for me to start with now, okay, and again, trying to think about progressing more from bilateral weight-bearing to unilateral weight-bearing. We can create very challenging positions for upper extremity weight-bearing, right? And we do this with our our patients who have a musculoskeletal injury but we sometimes don't think about that for our patients with neurological injuries.

But I can do, this a little bit easier 'cause I'm doing quadruped over a ball, the ball is taking part of the stress, this can be for somebody, a starting thing that we do in quadruped, I can make it more complicated by doing quadruped with the hips support on the ball, right, that's way more challenging. I can have them on a compliance surface, they're on Airex pad here, and they're doing clock exercises. And now you might say, "Well, clock exercises, they normally do those with their arm has some problem," here, the arm that is probably the affected side would be the left, the one they're holding stable, and the one that they're moving to change the position of the clock, could be the right, or it could be the left, we could be working on either one of those.

Plank positions, great positions to work on stability of upper extremity. And although very challenging for the rest of my body, think about the arm here, it's actually in a quite, I don't wanna say an easy position 'cause it's not easy, but it's in a nice mid range position, easy to hold stable if you're guarding and helping them, the elbow is not extended, the hand doesn't really have to be involved in this. This could actually be a nice bang-for-the-buck activity that gets both upper extremity and obviously the core, which is what we typically think of plank exercises being for. Let's talk a little bit about this barely weight-bearing and weight-bearing with movement 'cause here's

where I think we fall short. As I said, I think we go from, we know how to do a lot of weight-bearing activities, the things I just showed you like, "Yep, I do those," but then we go from those to trying too quickly to just move the arm in open chain, right? So we will talk about some ways to do bimanual activities where the unaffected arm is supporting the affected arm, we'll talk about some ways to start with some more stability activities, and I'll show you some video of this gentleman here, but we have to be able to add movement into our weight-bearing before we move to just movement, right? So let's look at some examples of that. I do have some examples, let me, I'm sorry, I spoke ahead.

Again, I have this, it's a little bit redundant here but I put this progression slide in again, just to give you this is a little bit more in depth, we're gonna think about weight-bearing in close chain progressing to non weight-bearing in open chain, we're gonna think about starting with gross motor movement, and moving to fine motor movement, we're gonna think about isometric activities first, moving to eccentric, and then concentric. So if we can just develop a contraction that they can hold isometrically, that's really our first step, being able to grade off that movement eccentrically is really our second step, and concentric is gonna be our last. Concentric is really hard for our patients to do, decrease activation, decrease force production after a stroke. I always think of it as sort of zero to 60 in a car, right?

If we go through isometric and eccentric, we warmed up the car before we have them really have to contract. Now, you might have learned eccentric is a challenging contraction, right, certainly is, but we also know in patients with stroke, eccentric contraction tends to be more preserved than concentric. Again, we wanna think short lever on to long, I said that earlier. Think about gravity-assisted, how can I utilize gravity to assist in my activity and progress them to gravity-eliminated against gravity? We wanna first try to get automatic types of movement. So can I get automatic movements with the upper extremity and then move to something that requires more of a cognitive

overlay, a cognitive input? We wanna do everything we can with an open hand first, before we move to grasp. Our patients have very little trouble developing grasp, what they can't do is let go. Doesn't help if I can pick up my cup, if I can't ever let go of my cup, right? So we need to be able to do everything open hand first before we develop grasp, and as we develop grasp, again, we can go through a very specific progression, starting with large objects to small objects, non-weighted objects to more heavy objects, firm objects to more compliant objects, without any arm movement, progressing to grasp with arm movement. Those are the kind of progressions that we wanna think about as we go forward. So, bilateral activities can certainly help us do this. The patient has limited movement.

I can think about active assist, I can use a cane, I can use a dhow, I can use lots of things to get bilateral movement. I will say, in this position, I included pictures of the person laying down because oftentimes we start these activities in sitting or in standing. If the patient doesn't have good stability, they're not gonna perform those well, and they're gonna do all kinds of compensatory things, they're gonna be putting their shoulder at risk for impingement. So start these activities with them supine, so you can really isolate out the arm movement, and you're not so dependent on stability of the scapula and the trunk, again, you've decreased the degrees of freedom, and then progress these to sitting and standing, and those other positions that you can think of. I put a couple pictures in here of some products that are available.

Again, I'm not a real product person, I like to figure out how I can sort of make this out of stuff in my patient's house, or in the clinic, or things I bring from home, but these are a couple of products that are commercially available. I can't think of what the left one is called, something sled I think, and the other one is called the Upper Extremity Ranger. But that's just allowing, and this is allowing us bilateral activity, and this is allowing the arm to be somewhat supported. You can imagine this device is taking some of the weight of the arm, taking some of the stress off the shoulder, so this person can start

moving without all the compensation, poor movement, extra activation in the hand that they might get if they're struggling to do this open chain completely. They're in sideline, good position to start upper extremity activities, and then of course, you could progress that to any number of ways sitting, standing, as this person is doing here. But the key is this is taking part of the weight of the arm, and it's reducing the degrees of freedom. So it doesn't matter what device you use, if you use a device that you bought versus something you made at home, or made in the patient's house, it's just how can I support their arm? I do this a lot with just their cane. That was single point cane, I put their hand on the handle, and we use that as a way to start mobility with some weight-bearing. Super important, if your patient can't actively put their arm out in front of them, or abduct it out to the side of them and hold it there without hiking their shoulder, without losing their elbow extension, without losing their open, relaxed hand, then they need some support, and we need to back down to doing some of these activities.

This is an example of my patient doing what I would call mobility with very little weight-bearing, right? The same guy from earlier, his right side is his affected side. You can see he actually has that Omo Neurexa that Ottobock orthosis on. Not that that matters, but he is using a paint roller in his garage. His left arm is doing most of the driving here, but his right arm is helping with what it can. But this is a very, I'm controlling the degrees of freedom, right, we're working within his range of motion. If we moved closer to the wall, he'd be going through less range of motion of his affected arm, moving further away from the wall and allowing him to go up higher, we're moving through more of the range of motion. I can vary a whole bunch of factors here, right? Now, didn't have to be using this paint roller, that was just something that was interesting to him. I do a lot of cleaning of walls in people's homes and garages, and we get a towel and we wipe stuff off the wall, working on those same sorts of activities, but the thing is, is that wall is guiding the movement some, it's taking part of the weight of the arm, it's decreasing the degrees of freedom. And then there's lots more that can

be talked about here, but I did wanna say for the hypertonic upper extremity, again, weight-bearing is the key. So we're doing very similar things, we're probably doing heavier weight-bearing more of the body through the arm to try to get a reduction of that muscle tone. If their wrists and fingers are very tight and stiff, I may have to start my weight-bearing through the elbow, if I can't do weight-bearing activities through the hand, right, but I wanna think about reducing the overall demand and helping to lower the resting muscle tone. Muscle tone goes up when the demand is greater. If I give the person an activity that's too challenging, too difficult, the muscle tone is gonna go up, right, that's what you and I, that's a normal response, right?

If I need a greater amount of muscle activity, I'm gonna try to get it from my toe flexors, or somewhere, so muscle tone everywhere goes up. So when I think about prolonged stretching activities, I wanna think about distraction of the joints, I wanna think about managing their shoulder pain, that's also gonna continue to that hypertonicity, and then includes mobilization. Don't forget what you learned about musculoskeletal issues of the shoulder, we didn't really talk about how do we treat the most common cause of pain, which is adhesive capsulitis because that's really a musculoskeletal issue that gets beyond kinda what we're talking about here.

But joint mobilizations, soft tissue stretching, those kinds of things are gonna be super important and safe to do with these patients, if you, again, use the good judgment that you learned in school, right? We need to give these patients, just like those with a hypotonic upper extremity, lots of proximal stability, so we need to figure out how to strengthen, or we need to support the arm to take some of the stress off the shoulder joint during these activities. People with a hypertonic upper extremity are more likely to need some type of medical interventions, potentially some type of antispasmodic to help with that, but certainly we can come up with ways to accomplish reduction in their muscle tone without activities as well. So I wanna go through some video examples of the stuff that we talked about. So if we could go to Number Two, Two Scott One is how

it's labeled. So this is an activity that looks simple and boring, but my patient has had very little movement. He had some movement, and it was nice movement, but just was really hard for him to see and feel because it was so small. So this is where I started him, his elbows actually supported on his kitchen table, and I gave him this ball, it was a kickball kind of thing, didn't matter, it could have been a soccer ball, a basketball, I do this with anything the patient has or I have in my car, and all he did at first really was just work on could he hold this ball on his leg without it falling off? So he just had to develop sort of an isometric contraction, just a little bit of push down into that ball, probably using some triceps and some shoulder musculature.

And my first thing, we've progressed beyond it now, but my first thing was just don't let it fall off, and he worked on just developing some concentrated activity. But now I've actually progressed him to, "Okay, you're holding it well, you're keeping your hand relaxed. Now let's start to impose some movement on that stability. You had stability, now let's have a little controlled mobility. So he works on rolling it in, super easy 'cause he's got internal rotators out the wazoo, but then he has to work on rolling it out, which is getting an external rotation and he has an external focus there, of every time he comes in, he has to come back out and hit the table with the ball.

So I'm incorporating some motor learning principles there to get him to hopefully have an external target for that external rotation activity that he's working on. And you can see that's challenging, right? We can have them work on rolling the ball backwards towards them, and forwards away from them on their leg, and certainly I do that. Now let's go to the third video. So this is him again using that same ball. And again, this is something, sorry about my finger there, this is something that I would say is getting at more mobility and less weight-bearing, but still some weight-bearing. So in this configuration, his right hand is his affected arm, in case you forgot, and it's on top. So it's essentially being supported by the ball and the left hand is the driving force, right? But now, when he turns it in this position, he has to develop some muscle activation

between the two hands. So what I'm cuing him here is just lightly squeeze the ball, don't grip it, just push together. I didn't want him really using his hand, I wanted him more using his shoulder musculature. And yes, thus strengthening a little bit more of his adductors and internal rotation, internal rotators as well a little bit, but I'm looking here for him to get some bimanual symmetry, right? You can see he's not perfect here, he developed to be way more symmetrical. And then as I wanna progress this activity, he could move that in all kinds of different directions. We moved from here to him being able to push the ball out to touch a target, to being able to raise the ball higher over his head, and really the whole time, all I'm cuing him to do is push into the ball with both hands, right?

Now, if I wanna make this even more challenging, and in terms of how I progress, now I have him seen if he can roll the ball, such that his right hand would be on the bottom. And I don't have a video of that, but that's where we progressed to. Now can you go through these same movements, but with your right hand on the bottom, which means it's more of the driving force of the activity, right? And again, seems simple, and see there where he's trying too hard, things start to kind of unravel a little bit, we start to lose his hand.

And so that's when I tell him, "Okay, I need you to back down your effort. Give me 50% less effort, or give me 10% less effort." And when patients struggle and try too hard, that's not gonna work well. Okay, go to the next one, please. This is going backwards just a little bit in the progression but this is more of a weight-bearing activity of him doing prone. Again, tons of things that we can do in prone. I'm supporting his arm, I'm constantly maintaining his, or monitoring his alignment, I'm letting him do some stretching out here trying to get that scapula in a better position and just let sort of ease into there and stretch out as we're talking, but the other thing that I have him do in this position while he's just doing some passive stretching of his upper extremity, and I think there's a picture here but I'm just gonna talk through it for time, is in this

position while he's just sort of stretching and getting some nice prolonged low-load stretch of his arm, I can have them do some lower-extremity activity in terms of hip extensions. And I think I get to that here in a second, let me, yeah, so having him tried do some activation on his right leg, which is his weaker side, right, but when I have him do left leg, oh, he's alternating back and forth, when I have him do a left leg activity, I thought I had a picture of that, I don't, let me pause here, when I have him do left leg activity, so if you can imagine yourself laying prone when the person extends their left leg, muscles around the right shoulder girdle activate. So if he has decreased activation around the right shoulder girdle, one way I can just sort of trick his neurological system into increasing activation is by having him do opposite leg extensions in this position, right?

So again, good bang-for-the-buck exercise. Can you go to Number Six, please. So, thinking about some heavier weight-bearing activities. He's doing countertop push-ups here. This is not where we started with him, this is where we progressed to. Certainly when we started these activities, I had to help support his arm a little bit to make sure he maintained good alignment, that he kept activating those kinds of things, but this is part of his home program that he progressed to being able to do countertop push-ups. And then again, if we go back to more open-chain activities, but with bigger movements, if I could go to Number Seven, I move the patient back down to sitting for this to decrease degrees of freedom.

So he wasn't really focusing on his balance and those kinds of things, he's really just focusing on his upper extremity. And so that's the occupational therapist, we were co-treating for this. He's using his assistive device, which is a walking stick, and paper towel there to decrease some freedom. And at this point, his hand is actually, A, strapped on the device, he progressed to being able to hold the device, but this is a great example of starting something bilateral, right? He's using his left as little as possible, we have to count on him to be able to understand that and be compliant with

that, but then we would progress this to him being able to do it without that active assist of the other arm, okay? And then if you could go to Number Eight, please. And we progress to him being able to move it by himself. Now he's showing you how he can work on moving it forwards and backwards. And this was pretty early on, so the movement is minimal. But the fact that he could see his stick moving forward, and if we had a stick on something like a paper towel or whatever, again, it gave him a lot more visual feedback about the movement that he was doing, and he progressed to having much bigger movement here. But again, just a way that we would progress through this. And then if you could show Number Nine, please. So here, we're taking some of those same ideas, but now we have him in standing. So we're adding back those degrees of freedom.

Now he has to focus on being able to stand, maintain his balance, have good posture, while he's doing these same sorts of tasks. And there's nothing special about the tools that we're using here, but we used his counter, or his cabinets there, to block adduction and internal rotation. He oftentimes wanted to pull too much into adduction internal rotation, by the setup that we have here, we're disallowing that, and he can only have the movement in more of a straight plane.

Obviously, we have to progress to take away those blocks, but this was a way that we could give him, again, home program exercises that he could do to be able to work on that little bit of movement that he had to progress to bigger movements, which he was able to do. Okay, I think if we can go back to the slides. Hopefully that was helpful to see some activities. Again, it's really only limited by your creativity. We also did lots of things like bilateral carrying of the laundry basket, and we did things where he was weight-bearing in one hand while cleaning the counters, or doing cooking tasks, and that kinda stuff. When we start to get the patient towards reaching grasp, we wanna think about, we've done a lot of weight-bearing first on an open hand and now we wanna start thinking about how do we get to grasp? So we kinda need to go back to

that idea of barely weight-bearing. I really should be working on grasp first while my arm is still supported, it's just maybe barely supported on something, but my arm is somewhat supported, taking away some of the stress on the shoulder, so I can more easily open and close my fingers. When you don't have that initial support and the shoulder is a little bit overstressed, the fingers are gonna close, the wrist is gonna flex. So when think about some activities that provide some upper extremity support, so oftentimes starting to set a tabletop or something like that. Again, I will even use the patient's cane, picture their cane in front of them, I have their arm resting on their cane, the cane is kind of right at their wrist level. Now we can have a little bit of weight-bearing support there, and then we can work on grasp and release, right? And we wanna progress then to more fully open chain.

But again, think about maybe small-moment arms first progressing to longer-moment arms. The key is when they start to lose that grasp and release, or more specifically, when they start losing that ability to release, you need to stop and go back to something that's in weight-bearing and get control of that, get that hand back open and relaxed, look at what's happening at the shoulder, and then come back to those grasp-release activities. Once they start losing that ability to extend and let go, we need to back down a little bit, rather than trying to bulldoze forward.

Again, I think I've already said this, focus on the release, not the grasp, we want much more practice of release than we do grasp. Return to weight-bearing when you need to, as I said, practice more of a gross motor movement before fine, short-moment arm before progressing to longer and then I've already gone through the progression of grasp there. But it's really important to go through the stepwise process. If we don't, we make things too challenging for the patient. If something is too challenging, it's gonna cause way too much overflow of muscle activity, and we'll say something like, "Oh, look, they have too much hypertonicity, or spasticity," or some label that we put on it, and in fact, the task is just too hard, and they're over-recruiting to try to meet the

demands. So back down, give them more support, take away some degrees of freedom, something along those lines. For patients who have neglect or inattention, I already mentioned this comes with an increased risk for the upper extremity. You've all seen the person with neglect and their left arm is hanging off beside the wheel on their wheelchair and they're rolling along, and their hand gets caught in there, or they pinch their arm between their wheelchair and the door, there's just a higher degree of risk for injury. And certainly this negatively impacts upper extremity recovery. So we need to think about ways to draw attention to the limb, ways to keep the limbs safe. It is very challenging to position but we really need to focus on that and try to prevent injury. I feel like these are the folks that end up more often with significant upper extremity pain, and maybe even developing something like complex regional pain syndrome. So we wanna make sure that we're addressing that.

And again, bimanual activities are where to start. If they can see their affected arm and they're stronger, less-affected arm moving together, that's a good way to start. If a person has ataxia of the upper extremity, again, focusing on weight-bearing, doing things to provide compression of the limbs, or the joints of the upper extremity, thinking of ways to decrease degrees of freedom. So maybe I splint the elbow in some way, not long term, but temporarily, so that they don't have to control the shoulder, elbow, wrist and hand, maybe they just have to control three of those joints. So thinking about what are ways that I can take away a joint from having to be controlled to work on fewer degrees of freedom to control?

Again, focus on those mid-range movements, 'cause that's where patients with ataxia have the most problems, and again, bimanual is a really good starting point. Think about use of weighted objects, not weighted objects that are gonna be unsafe and they're gonna drop on themselves, but weighted objects are gonna provide a little bit more compression, and oftentimes that can be helpful. Don't do so much weighting of the limb. Oftentimes, people will put a cuff weight on the wrist, and I will tell you that

maybe in a few patients that works, but if you put a cuff weight on the wrist, that's gonna cause distraction, and distraction does not increase activation, it actually reduces activation. So I would think about more weighted objects that they're using rather than than weighting of the actual limb. Weighting of the trunk could be very helpful but weighting on the limb, I don't find it to be as helpful. I've mentioned a complex regional pain syndrome a few times, some of you may not be familiar with that, we formally call it CRPS. This is a chronic condition that affects typically one limb and usually after injury. So you might be wondering, "Why do my patients sometimes get that?" Well, they get it potentially, it's not really well-known what the mechanism is, but potentially they get it, we know that they have an increased inflammatory response.

Why it is that we see that in patients with stroke, maybe it has to do with trauma that's created through overuse, through poor handling, those kinds of things, maybe it's related to that adhesive capsulitis that we talked about, soft-tissue injuries that occur relatively easy with these patients, but for whatever reason, they develop this complex regional pain syndrome. You'll see things like they'll have edema, they'll have hair loss on the limb, their skin becomes kinda shiny, and they have significant pain. This is the person that holds their arm to them and doesn't want you to take it away. And they yell if you, you don't have to touch it, you can just look at it, if you look at it too hard, they're they're gonna yell out.

And oftentimes medical intervention needs to happen here, medication, or some type of block may be necessary. But my point in saying this is not to tell you everything about CRPS, but it's to say, let's try not to let our patients get to this point. Once they get to this point, I feel like they're in a very deep hole for use of that upper extremity, so try to avoid bi-maintaining range of motion. Again, we feel like what we know is that maintain range of motion is our best chance for avoiding that, maintaining range of motion and increased weight-bearing through the arm. So I wanna talk about a few interventions in the literature to give you an idea of what's out there. This is not

exhaustive, and I'm not gonna go into the details of everything, but I put this here to give you some ideas and some tools for your toolbox. I want you to take a look at, if you haven't already before, but take a look at this app, this is the upper extremity decision-making app called ViaTherapy. This was developed by a group of really smart, smart people. This was developed based on a working group that looked at all the literature that's kinda out there. This first was introduced in 2015. And it's an app that's free, you can click on this link, you can put this link in, you can just google Via app, and it is a decision-making algorithm, and I couldn't put the algorithm in here, but essentially, it's gonna ask you a series of questions starting with, can your patient produce any movement?

And if the answer is no, the good thing is it gives you a box of activities and what you should be doing at this point, right? And if the answer is yes, then it moves on to the next question, which is asking if they can produce any shoulder abduction. And again, if the answer's no, it gives you a box of here are activities and tools that you could be doing at this stage, and if it's yes, you move on forward. And then you can see there, the next question, can they initiate finger extension? And again, if the answer is no, you get appropriate activities and you move forward from there. So it's looking at what can your patient currently do and not do, and it provides you with, based on the evidence, some tools, some activities and ideas that you can do, and there's prompts to readdress each week.

And so I encourage you to take a look at that. I think it's pretty useful tool. Other things that we know for sure that we see over and over in the literature is the importance of repetitive task practice, right? Identifying some tasks that the patient wants to carry out, this is key, it needs to be activities that the patient wants to carry out because we need that motivation factor, right? And we want to do a good task-and-movement analysis and identify what are the patient's impairments to being able to do this, what are the components that we need to remedy, and determine the appropriate level of

challenge. Challenge is important, we wanna find the optimal challenge, right, not too much challenge, not too little challenge, I call it the Goldilocks challenge, 'cause it's just right. Finding that appropriate challenge is what's gonna keep them motivated, and motivation is key. And then we have to figure out how to take these things that we're doing in therapy. And this is the hard part, figuring out how to transition this to home because they have to be able to do this in the home. The last few years, most of the practice I've done, well, I shouldn't say that, a portion of the practice I've done has been in home health. And I've just loved that because I don't get stuck in, well, this is how we do it in the clinic, but I don't know how you would do this at home 'cause I was only in their home. So you wanna be able to transition this. And we wanna give them some tool to be able to monitor their use, and track their progress. So there's like a motor activity log or there's other tools that we could use that will help to track their progress for these tasks that we're giving them. Mental practice, I don't know how many of you utilize mental practice.

There's a whole body of evidence about that, but specifically with the upper extremity, there's a large body of evidence that talks about how this is shown to trigger the same neural pathways and musculature that we would use during physical practice. So I don't have to be physically practicing all the time, I could use some mental practice. This really needs to be combined with task-specific practice. This isn't necessarily something that the patient can do solo without task-specific practice and have a significant benefit. But over and over, this is shown to accelerate motor learning and improve movement. It's usually, in most of the studies, provided right after a session of training, of task-specific practice, and that's usually done about three days per week, and most of the studies looking at about a 10-week period. But the coolest thing ever is that when the person mentally practices, they get the same activation in the neural structures that they would get if they were doing the physical practice. So if we need a way to get more activity throughout the patient's therapy time, this is a way to get that, we always want more time, more time to work with them, this is a way to put that in

there. This is an article that was published in 2014 by several people who've published a lot in some of the stuff we're talking about. You'll notice Page's name is listed a lot here in some of these articles. And this was an article where they talked about the use of really figuring out how to apply motor learning principles and principles related to neuroplasticity. And you can use this as a guide for kind of whatever you're doing with your patient in terms of upper extremity. We do need to think about whole-versus-part practice. We know we need to get to the whole practice to be functional, but for the upper extremity especially, we may need to break it down into some component parts, and practice those component parts and put them all back together. We wanna make sure we're always ending on putting them back together.

We need repetitive and goal-focused practice, we need activities that are meaningful. I feel like we struggle with this so much in upper extremity rehab, especially in the weight-bearing phase, how do I make functional things, how to make meaningful things when weight-bearing isn't typically how we roll with upper extremity? Client needs to be driving, very practical base. We do need to address impairments, and I would say some of the primary impairments that we need to address are tightness and stiffness, tightness and stiffness of the trunk, tightness and stiffness in the shoulder girdle, and then obviously the arm itself, right, but we need to address those impairments that are directly limiting the function.

And again, finding that perfect challenge, making it appropriate, and making sure that there is always a challenge and then really celebrating and emphasizing their accomplishments. And this sounds kinda common sense, but for every intervention you're doing, overlay this and say, "Am I hitting all of these points?" I think it's a good idea. We've all looked at information related to constraint-induced movement therapy. I think that's something people are pretty familiar with. This was sort of the original protocol that got so much press, problems here were that it really only applied to about 20 to 25% of the entire population of folks with stroke, because they had to have this

10 degrees of active wrist extension and 10 degrees of extension of the thumb, and at least two fingers. So had great results that showed yes, we can change upper extremity function, but again, it was really challenging for patients to be able to carry forward, so it wasn't really clinically applicable to the whole population. Then came the advent of modified constraint-induced therapy. And this is where they spread out the therapy over a longer period of time, 10 weeks, and they sort of backed off of some of those original constraints in terms of what patients needed to do to be able to start out, but they kept all the same principles, and they found this to be as efficacious as constraint-induced movement therapy, but obviously with more clinical utility, because it was something that was more doable in typical rehab timeframes, and again, it reached a few more people than the first protocol did in terms of being able to apply to.

And then I just wanted to include this, this is a more recent overview, a systematic review of constraint-induced movement therapy, and overall, the studies are pretty heterogeneous, meaning there's a lot of variation in the studies, but they do still find superiority of constraint-induced movement therapy over other interventions, but the superiority is weak, so better than other interventions, but not necessarily extremely superior to other interventions, and of course, need better clarification of optimal dose and optimal time, figuring out what is the best thing dose, the least dose I can give to get the max effect.

And that's still something that remains unknown. Bilateral arm training, I've already mentioned, is an important step to do things bilaterally, and there are some studies that have looked at bilateral arm training with some positive findings. For one thing, many of our activities in daily life are bilateral, so we wanna make sure that we're training that. Just working unilaterally doesn't improve bilateral tasks, so we have to, from a task-specific training, make sure that we're doing that. But the other thing is, is that when we're doing bilateral tasks, the arms are coupled together, so the stronger more

normal arm can really contribute a lot to the affected arm. There's modeling that goes on, there's increased activation probably that goes on because of the two arms being linked, and there's a lot of good feedback about the movement based on the movement of the stronger, less-affected arm. So some definitely positive findings for bilateral arm training. And again, when they talk about bilateral arm training, there's number of ways that they've looked at that in the literature, the device on the left is one way that's called a BATRAC, B-A-T-R-A-C device. Again, nothing special about the device, this was just something that was used in the research. And the one on the right is more of a robotic device that's supporting the arm and generating movement just based on how much the patient is able to move.

So there's a number of ways that we can get at that, but as we've talked about, there's also a number of ways that we can do bilateral active assist type of exercises just in our clinics, or in the home as well. FES for the shoulder, we mentioned that that was one way that we can address subluxation. Certainly, that's something that can be useful. We typically wanna think about avoiding activation of the upper trap that's very easily gotten in this situation, but we wanna think about that, we do need to get that super supraspinatus or that teres minor because that's what helps to pull the humeral head up in the socket, but then we also wanna do something that's going to get typically an external rotation of the upper extremity.

So we can oftentimes stimulate the middle deltoid, or even the teres major to get some external rotation of the upper extremity while we're doing FES. What does the evidence say about shoulder subluxation and FES? It's really been found to support the short-term effects but really inconclusive for long-term effects. So we get some immediate reduction, but we don't get long-term reduction, when the device is off, we aren't seeing a sustaining. But again, I feel like if we use this as a device to then apply some other interventions on top of, I think that's how we need to be using it, right, it's a device to get them to be able to have less subluxation, have less risk involved with

subluxation, and then we're applying some other good therapy on top of that. There's also been lots of devices for movement of the arm and hand using e-stim. And again, the data there is relatively variable. And again, not finding really a significant effect on upper extremity motor function, or not finding a significant effect that sustains over time. Again, I think we have to think about, "Can I use this device to sort of jumpstart the patient's movement, but then I have to quickly move to something that is based in motor learning so that the patient is contributing to?"

And even when I'm using these devices, I always want to be giving them this device with instructions that when you feel the stimulation, is when you contract, right, or if it's a biofeedback trigger device, you contract the muscle, and then you'll feel the stimulation, there has to be an active component by the patient in order to get the best results for all of these devices. In terms of mirror therapy, this has been something that's been more popular in the last few years and I feel like it has some good results, especially for the upper extremity, but in mirror therapy, you're using the mirror to improve motor function. It's placed in the mid sagittal line, the patient is gonna look at the mirror, the affected arm is behind the mirror, and they're gonna look into the mirror and they're gonna see their strong arm, their normal, arm moving, but it's going to look as if their affected arm is moving, right?

The affected arm is behind the mirror, and they're seeing the strong arm move, it's reflecting that movement and it looks as if the paretic is moving. So they'll go through a series of motions multiple times, so lots of practice going on with this. You can ask the patient to attempt to move their affected arm along with what they're seeing, and there have been some positive results. In 2017, I thought this was really surprising. There was a mirror therapy study that showed mirror therapy alone had better results than mirror therapy combined with conventional, which I was surprised about. Most studies suggest that it should be used as an additional intervention, that this could be an adjunct to your more traditional repetitive-task-practice kind of intervention. But I found

this to be helpful to get movement in patients who just have very little movement in their upper extremity. Virtual reality is something that you may not have access to necessarily, but I just wanted to put this in there to say that for virtual reality and robotics for which is the next slide, that there's some pretty significant evidence out there that shows that there may be some promise to that, again, as an adjunct, and as a way to get a higher dose of therapy. And there's no really strong conclusive evidence that says, "Yes, virtual reality, and yes, robotics are way superior to everything else," there's still some conflicting evidence out there, but I think this last bullet point here about a good adjunct and a way to get higher doses, and I feel like that's the same for robotics.

Again, evidence is a little bit conflicting, but a way to get more time moving in a way. Again, robotics is really just supporting that arm and decreasing degrees of freedom, which is what we've been talking about finding some physical ways to do without technology. But I wanted to make sure that you had this evidence on different types of interventions that you might have access to, and I wanted to also mention this one study here that was about acute management. And I'm sorry, I did not cite this, I don't have it written here in my notes, but I can get this citation if you're interested, I'm sorry, I've failed to put that on there, but I think it's in the references, but I failed to connect it here with a citation.

But this was a systematic review, pretty recent, focusing on interventions in the first four weeks of strokes. So for those therapists working in acute care, or maybe early inpatient rehab, the key findings were that there were still positive effects for modified constraint-induced movement therapy, task-specific training, those were really the two interventions that they found the most positive effects. There was some positive findings for using biofeedback and e-stim as a supplement to those other interventions, and they did talk about how the Bobath intervention, or what we would refer to probably as MDT, was not supported. Weren't saying not to do that, they were

just saying that the evidence didn't find substantial support for that intervention. So I did wanna mention that specifically 'cause I feel like acute care, acute management, can be really challenging. And this is a paper that was published back in 2002 that tried to summarize best-practice recommendations. And I put this in here kinda as we're wrapping up. They said, "Educate in proper handling," meaning teach the patient, teach the family, teach the caregivers, how to safely handle the upper extremity to avoid us imposing impingement, rotator cuff injuries, other kinds of things that I feel like a lot of our patients get. So that was really one of their strongest suggestions, supporting the arm at all times when there was a flaccid shoulder, in all the ways that we talked about doing that, using FES, using some type of orthosis, using positional devices.

And I would say making sure that you're using them correctly and not over-correcting the arm. And then they also talked about the potential need for analgesics and antispasmodics for a person that has more of a hypertonic upper extremity. This was published in 2002, and I think that these practices still pretty well hold true. We don't have a lot of just really critical new information, we have some new technologies, but they all kind of try to get at the same sort of thing. So I think those are pretty good words of advice to sort of round out. I wanted to also make sure that I mentioned outcome measures.

So I feel like outcome measures oftentimes get overlooked in upper extremity rehab. We choose some global measures like the FIM, and the Functional Independence Measure just doesn't really tell us anything about the upper extremity. So I could dress myself, and I could do all my toileting and hygiene, I could do all of that with just my, quote unquote, good arm, and score really well on the FIM and still have a very non-functional upper extremity, but oftentimes, those are the kind of measures that we're using. So I've gone in and listed measures that are appropriate for acute on this slide and then on the next slide, the inpatient and outpatient rehab, and so there's

quite a bit of crossover there. But what I wanted to mention, I don't have the time to go into every measure, and that's not really the focus of the course here, but what I wanted to mention is that all of this information came from the StrokEDGE. So I wanna take a minute to throw that out there as a resource for you, if you're struggling with finding measures to use for upper extremity function, everybody can go to the Academy of Neurologic Physical Therapy. If you just google Academy of Neurologic Physical Therapy, stroke edge, or I've given you the link here, hopefully that's activated in your handout, you can find the upper extremity measures for stroke that they have done all the hard work at figuring out which measures are the best to use, which measures are the best to use based on the psychometrics of the measure itself, in terms of the research data, and also which measures are most clinically easy to do, have good clinical utility?

And so they've really done all of the hard work and the heavy-lifting, you can go to the website, you can see which measures they recommend, and I put them here, but you can also find access to all the measures. Another good place to find access to all of these measures is at the Shirley Ryan AbilityLab, or you can put in as rehab measures, rehabmeasures.org, and that will get you to the Shirley Ryan AbilityLab, and that will get you to a huge library of outcome measures, and you can find each one of these there, just put this in the search, and it'll bring it up and you can print this up, or save this, and have this with you.

But the bottom line is we have to use, we need to start using good outcome measures to document what we're doing with the upper extremity if we're addressing the upper extremity, and we need to not use just global measures of function that don't tell us anything about how they're using upper extremity. And I shouldn't just pick on FIM, any measure that's just looking at can they complete a task, can they complete sit-to-stand, can they complete dressing, can they complete whatever, doesn't really tell you about how they're using their upper extremity, so. So I provide a list there for

what's recommended in acute and what's recommended at the inpatient or outpatient rehab level, and the links there to the StrokEDGE. And I wanted to finish up with a couple of case examples. So we've got about 10 minutes here to kinda walk through some case examples and hopefully you guys will feel like contributing in the chat box and if not, at least thinking through this on your own and I'll be giving you some of my thoughts as well. So the first case here is a 62-year-old gentleman who had a right MCA ischemic stroke and the reason why that's important is that tells me that their right upper extremity is, I mean their left upper extremity is very likely impaired and it's gonna be more impaired than their lower extremity, most likely.

His stroke was two days ago, so he's very acute, and he's, oh, that should say, I'm sorry, that should say he's now being seen, that might have been my first typo that I found, he's now being seen in PT in an acute stroke unit. His left upper extremity appears very flaccid, with no volitional movement noted, right? And we've all seen that, can you move your arm for me, and they try, and they try, and they scrunch up their eyebrows, and make faces, and hold their breath, and no movement happens? Does that mean that they have no movement?

No, that means they're not able to make that connection, right, they're not able to recruit? Does that mean that they've had a loss of strength? No, in two days, this person has not lost strength, he has lost the ability to recruit those motor units for those particular muscles, right? And so we need to do things that are gonna help remake that connection for movement. I just throw that in there 'cause it's really important, especially when we think about the acute phase. So there's no volitional movement, I'm still thinking, you know what, I can probably put him in positions and different activities where he actually can move, I just have to figure out what those are. But what are my initial concerns? When I just read this, this isn't much information, obviously, you'd have a lot more information, but what are your initial concerns, just based on the information that's provided here? You may wanna just throw stuff out in

the chat while I take a moment to take a sip of water? Be brave. Well, hopefully you're thinking about it, and maybe some people will put some stuff in the chat, but when I read this, I'm thinking about it's really acute, and he's still very flaccid. And if he's still very flaccid, one of my concerns are subluxation, and what's this gonna be like when I get him, especially upstanding, which is gonna be one thing I'm definitely gonna wanna do, and so I'm thinking about how do I support the arm? And other thing I'm thinking about equally, or maybe even before that, is okay, they're flaccid, they have no active movement, how am I gonna get the arm movement moving and keep the arm moving so they don't develop those adhesive issues that we talked about? Those are some of my initial concerns that I'm thinking about.

So I'm thinking about trying to figure out how to position, how to maybe get some type of a device, potentially, to support the arm. We're in acute care, I probably can't get a device, but I'm gonna always be supporting the arm on something. So when we're standing, I'm gonna be supporting the arm on the bedside table or the back of the chair, or somewhere on me, maybe on my arm, or something, but I'm gonna think about always trying to support that arm and not just neglecting that arm and letting it hang down.

Even if I have no intention of really focusing my interventions on the arm, I'm there, I'm the PT, I'm only gonna focus on standing, I have a limited amount of time, we're in acute care, and I get that, but I can't just neglect the arm, and let it hang there, I guess it's the point I'm trying to make. So where would we begin? Hopefully, if you're thinking about where would we begin, we're gonna begin with some close-chain, weight-bearing kinds of activities. How do we do that in acute care? Well, sitting edge of bed, with the patient weight-bearing with their arms forward on the bedside table, or forward on me, if I'm sitting in front of them, maybe I'm having them weight-bear through my legs, if I'm sitting right in front of them, weight-bearing with both arms to the side on the bed. But I need to figure out some way to get the arm into some

weight-bearing positions, and that's where we're gonna be beginning. Maybe potentially, if they do have a little bit more activation, we're starting with some weight-bearing with movement. So maybe they're doing that weight-bearing on the bedside table and I'm having them push the bedside table away a little, or pull the bedside table back, or maybe their hands are on a towel, or a washcloth, and they're working on pushing that forward and pulling that back. They may not even be at that point, but certainly there are things that we can make this work in acute care using the bedside table that's available, using me as the therapist, my body if it's available, using the bed itself, using just tools that we have within the room, we could even start to work on some bilateral kinds of activity.

With the bedside table, they may not be able to push the bedside table away and pull it back with just their right arm, or with his left arm, sorry, with his left arm, but if I do that, bimanually, pushing it away, pulling back, maybe I'm having to do quite a bit of input on their affected arm. Maybe I'm supporting the weight of it, maybe I'm keeping their hand stable, but potentially while they're doing that bilateral activity, we might start to get some activation in that arm. It's quite possible, it's just oftentimes neglected. So those are the kinda things that we would start with, I would start with some bilateral active assists, and lots of weight-bearing kinds of things. Yeah, so roll him to the affected side, sure.

That would be something that we could definitely do. We're rolling to the affected side, we're gonna be getting some weight-bearing through that arm. Side prop push-ups that's another thing that I often do in acute setting. So I have them sitting with their arms to the side, and I'm gonna have them slowly, I'm helping them with this, I may be doing almost 100% of what's needing to happen at the arm, but I'm having them slowly lower down onto their affected elbow, and then trying to do a side push-up to get back up to midline, right? And again, they may be contributing very little, maybe nothing at first, and maybe very little, but that's a way that I can start at least getting

weight-bearing, and potentially getting some activation. There's a very strong impetus for the patient to want to push with that arm when they're trying to get themselves up from their side and you're not letting them use their stronger arm, so that could be something that we work on in acute care as well. There's lots of other things, and I'm happy to discuss any of them, but I wanna move on to the next case as well just so for the sake of time, this is a person that had a hemorrhagic stroke 'cause of long-standing hypertension two weeks ago, so a little bit further out, more in a subacute kind of phase now. She's an outpatient, so I mean, she's been progressing pretty well. She has activation in her shoulder, not full range against gravity, I didn't give you all minimal steps or anything like that.

She has active biceps, but only trace triceps, which is what we would expect, right, the biceps work too much, the triceps don't get a chance, and only trace in a wrist extension flexion and no activation in her fingers. She has some typical synergistic movements beginning and a tendency to compensate with the affected side, with the unaffected side, sorry. So we talked through concerns here, when I read this, and again, feel free if you wanna put things in the chat, but please do try to think along at least, and think about what you'd be thinking and feel free to add if I'm leaving something out, or I get something wrong, but my concerns with this patient is that this person is at risk for fully developing a synergistic pattern, right?

It says they already have some typical compensations and some typical synergistic patterns. Synergistic patterns in the upper extremity are gonna be those muscles that move against gravity, so that's primarily the flexors, and I wanna stop before she gets into that and before she gets stuck in that. And at two weeks post, I still have a really good chance at stopping her from getting stuck in those patterns, right? So that's really my big concern here. I also have concern about her biomechanical stability and alignment at the shoulder. If she's starting to do these movements on a shoulder that's too weak, and we have some poor biomechanical alignment, and every time she's

moving, she's impinging potentially. So I wanna make sure I'm really focusing in on her shoulder biomechanics with everything that we're doing, and now, she already has some movement, are you doing it well? Maybe she needs some correction in posture, maybe she needs some work to to get better activation around the shoulder girdle, the scapula specifically. With the movement she's doing in her shoulder, is she showing me a normal scapula-humeral rhythm? Everybody remember that, scapula-humeral rhythm, that takes you back to your PT or OT days, right? So that means that the scapula and the humerus move at certain times throughout shoulder flexion and abduction, and the scapula should be stable first, the humerus initiates the movement, and then the scapula moves. In most of our patients with stroke, the scapula moves first and initiates the movement, and very little movement then happens at the humeral head. So I wanna help to return that.

They don't have a normal scapula-shoulder rhythm, they're not going to have normal movement and they're at great risk for impingement. So where do I begin, I'm gonna begin with her with weight-bearing positions, but I'm gonna be much more aggressive probably than I was with my patient who was more flaccid. We're gonna do some heavier weight-bearing activities to try to help bring her out of those synergistic patterns. And I wanna strengthen everything that goes against the synergistic movements.

So I'm gonna really focus on shoulder abductors, shoulder external rotators, elbow extensors, wrist and finger extensors, right? But a lot of activities where the arm is supported and we're working on stability first, before we start to work on movement, and then when as we start to work on movement, we're working with the fingers open and the wrist extended, and holding that position, maybe flat on a table or something like that, a lot before we actually progress to working on grasp. And I wanna make sure that this woman actually has full passive range everywhere. And if she doesn't, then I'm gonna aggressively go after getting it, right? So stretching, mobilization,

remembering all the soft tissue that needs to be stretched, remembering my musculoskeletal skills. So I see that we're 49 seconds over now, almost a minute over, almost at two hours and one minute. So I'm happy to entertain questions for as long as there are questions. So Sherry, your question is about the test question. Let me open back up my, oh, it's gonna take me a second to open back up my email that has the question. Pain is common, motivation is not insane, the shoulder is not stable and carryover does not readily occur. I'm not sure if I'm seeing all of your, okay, thanks. So... it looks like actually on that question, Sherry, it looks like I made a mistake there because I think I meant to make that be an answer. Yeah, we're gonna have to give everybody credit for that. I'm sorry, I think I made a mistake there. I apologize. Christy, is that something we can take care of? Okay, thanks. I'm sorry, I tried to read those, but.

Anyway, I apologize for that, I hate to wanna do stuff like that. Gretchen has a question, any good ways to make sure the patient does not compensate during home back stretch program? Good tips. Yeah, so I need to teach them what compensation looks like and feels like. So I try to do a good bit of work, if their vision is normal, I try to do a good bit of work in front of a mirror maybe, so they can see visually, but I also, if I have access to using some type of biofeedback, where they get some auditory stimulation, when they're activating a muscle they shouldn't use, that's another way, but sometimes we don't have access to that. But I would say doing stuff in front of a mirror is really helpful.

Pointing out to them as they're moving, "Okay, so now I see your upper trap came on. Can you feel that, it's right here, could you feel that?" So just helping them understand the movements and when the movement is abnormal, and trying to get them to clue into that feeling, if they don't have an opportunity to see that. Those would be my best suggestions there, yeah. But the other thing is, is if I can use the room or the space to keep them from compensating as well, maybe early on, I really just need to block that

compensation. So for the example with Scott that I showed you earlier, we had it set up so the movement he was doing was right up against the cabinet. If he adducted or internally rotated, which be a movement he would do too much of, especially as the task got challenging, and he was really over-recruiting, and then there was just a physical block there where he couldn't. Then that's not a perfect solution 'cause I need to eventually take away that physical block, and he needs to learn how to control that without that physical block, but that might be a way to start, and then progress towards that. I do a lot of things with like tips, we use the lines in the tile, or we use things on the wall, targets to hit for, to kinda help them be aware of a normal movement versus a not-normal movement.

So hopefully that answered your question. Deborah says, "Have you had success with these strategies in chronic stroke patients? Starting to see patients several years post, never having rehab." The good news is, Deborah, the good news is that there's evidence that shows that those patients have the capacity to improve. But you're right, it's way harder because there's such ingrained patterns, there's such ingrained habits, and there's so much of their life that they have learned to do without using both arms, so there's also less motivation there, I think it wanes. But yes, I have had luck getting activation in folks that are fairly chronic.

And if you look at the research evidence, many of the interventions that we've talked about were first looked at in patients that were chronic before they were looked at in patients that were acute, and all of them show the ability to improve movement and activation, in those that are chronic. My thought is, and I can't say this with any certainty like the evidence shows us this, but my thought is, the more chronic the person, I would wonder if that idea of capacity versus actual use becomes an even bigger issue. In other words, you work with them and you improve their capacity for movement and activation, but they don't actually translate that into using that arm in function. Does that make sense? So if that didn't answer your question, feel free to ask

for more clarification there. In third-world countries that adds a whole new layer of difficulty there, so feel free to ask further questions, or email me about that. Anything else? Yeah, thanks, I didn't go forward to that. You do have my email there. If you have questions, I'm happy to try to answer those.

- [Christy] Thank you so much, Doctor Seale, for your time and your expertise. We're gonna go ahead and conclude today's webinar. I hope everyone has a great day, and thank you so much for joining us today on physicaltherapy.com