

Mar 26, 2025

## Impairments after stroke

00:00:00 **Speaker 1**

This lecture is about impairments after stroke and I will provide an overview of what the research tells us about impairments after stroke and their contribution to activity limitations and evidence around intervention at the level of impairment and Obviously this information is critical, not just because it's one of my

00:00:24 **Speaker 1**

areas of research, but because it means that we are providing intervention that targets the impairments that are the ones that need to be targeted.

00:00:37 **Speaker 1**

We need to have a very clear idea about what is known about impairments after stroke so that we're not targeting the impairments that aren't the ones that are causing the activity limitations in either our analysis or our intervention.

00:00:57 **Speaker 1**

These are the learning outcomes for this presentation. At the end of this lecture you should be able to understand and describe the important impairments after stroke and to talk about them in terms of their relative level of importance in their contribution to people's activity limitations after stroke.

00:01:22 **Speaker 1**

And this will help us to identify a clinical reasoning process that we can apply to the analysis of movement problems in the upper limb after stroke.

00:01:33 **Speaker 1**

And that clinical reasoning process will be firmly based in the evidence that we have for the contribution of impairments to activity limitations after stroke.

00:01:47 **Speaker 1**

The take-home messages of this lecture are that it's the negative impairments that have the greatest impact on people's problems at the level of activity after stroke.

00:01:59 **Speaker 1**

And by negative impairments, that means the things that have been lost.

00:02:05 **Speaker 1**

So remember at the ICF level you have body systems and functions and impairments is when you have something going wrong with those body systems or functions and by negative impairments it's when you have lost something.

00:02:21 **Speaker 1**

So the really big ones are loss of strength and loss of coordination.

00:02:26 **Speaker 1**

And of these, of course, strength is absolutely critical.

00:02:29 **Speaker 1**

If you can't produce force in your muscles, you can't move your arm.

00:02:34 **Speaker 1**

So that has to be our absolute priority in our analysis process after stroke.

00:02:43 **Speaker 1**

As well as strength, we need to be able to coordinate the muscle force that is produced and so beyond strength we need to look at people's ability to coordinate their muscle activity to produce the movements that they're trying to produce.

00:02:58 **Speaker 1**

And this is where our analysis and training should focus.

00:03:04 **Speaker 1**

This outlines our movement analysis process, so first of all we will observe somebody's performance doing a task and here we can see a man who's had a stroke called Ngoc and Ngoc is trying to drink from a cup and you can see the way his arm does that activity

00:03:27 **Speaker 1**

is very different from normal.

00:03:29 **Speaker 1**

So first of all in that observation we will identify how the kinematics that you see there deviate from normal kinematics and you might want to think about how you would bring your arm forward to bring a cup up to your mouth and one of the first things you would

00:03:47 **Speaker 1**

notice is that you don't abduct and bring the cup up this way but that your arm comes into forward flexion and you'd bring the cup up with your shoulder in a position of forward flexion.

00:04:00 **Speaker 1**

So one of the kinematic is a reduced amount of forward flexion at the shoulder.

00:04:10 **Speaker 1**

After identifying the kinematic deviations that you've seen we can then hypothesise about what's causing the kinematic deviations.

00:04:20 **Speaker 1**

So in this example where we've identified that Ngoc has decreased shoulder forward flexion, we could think about the potential impairments that could be contributing to that.

00:04:32 **Speaker 1**

And a very likely one is weakness in the muscles that forward flex the shoulder joint.

00:04:40 **Speaker 1**

There might be some others that you want to add into that but that would be that loss of strength in the primary muscles producing that movement would be the first place to start.

00:04:55 **Speaker 1**

For each impairment we'll have a look at the characteristics of that impairment, how is it associated with performance at the level of activity, and what are the implications of this information for our analysis and training of upper limb tasks after stroke?

00:05:17 **Speaker 1**

So we're going to start with spasticity/tone and I've put those words together because they're often used interchangeably but we're going to discuss about how that is problematic for our analysis and intervention.

00:05:36 **Speaker 1**

We'll look at loss of strength, loss of coordination and loss of sensation and contracture as well.

00:05:46 **Speaker 1**

Starting with spasticity.

00:05:49 **Speaker 1**

Spasticity is an increased reflexiveness of the stretch reflex and it is velocity dependent.

00:05:58 **Speaker 1**

So spasticity is elicited with a fast stretch, but not with a slow stretch.

00:06:04 **Speaker 1**

Clinically people often use the words spasticity and tone interchangeably but this causes a lot of over-attribution of spasticity as causing people's movement problems and we need to be very clear that spasticity and tone are not the same thing.

00:06:27 **Speaker 1**

Spasticity is an increased reflexivity of the stretch reflex, tone is resistance to passive movement so hypertonia is increased resistance to passive movement.

00:06:41 **Speaker 1**

Tone has been described as an extremely ill-defined notion within descriptions of movement and movement disorders and that's because if you think about all the things that can cause resistance to passive movement, it's very unhelpful to

00:07:02 **Speaker 1**

bunch those all together under one umbrella term.

00:07:08 **Speaker 1**

So if we think about what can cause hypertonia, hypertonia can be caused by a multitude of things after stroke.

00:07:17 **Speaker 1**

It can be caused by spasticity, it can be caused by contracture, it can be caused by muscle stiffness, it can be caused by somebody excessively turning their muscle on and not being able to relax it as you passively move it.

00:07:32 **Speaker 1**

So it's very unhelpful to have a term that can mean so many different things.

00:07:40 **Speaker 1**

And as Latash and Zatsiorsky say, that it leads to misunderstanding.

00:07:47 **Speaker 1**

So it would be extremely beneficial for all of us as therapists to avoid the word tone and describe somebody's problems as what they are.

00:07:56 **Speaker 1**

Do they have a contracture?

00:07:57 **Speaker 1**

Do they have spasticity?

00:07:59 **Speaker 1**

Do they have increased stiffness with movement?

00:08:01 **Speaker 1**

Do they have trouble turning the muscles off?

00:08:03 **Speaker 1**

Do they have overactivity that is the result of a coordination problem?

00:08:08 **Speaker 1**

If we can describe accurately what we're talking about that's obviously going to be very helpful for providing intervention that targets the actual problem.

00:08:23 **Speaker 1**

So is this concept useful to us in the description of people's movement problems?

00:08:28 **Speaker 1**

When you think about it, hopefully you agree that the answer is definitely not, because it doesn't tell us what the actual problem is and as clinicians we can distinguish between whether somebody's got a contracture or whether they've got spasticity or whether they've got full passive range of movement.

00:08:47 **Speaker 1**

but there is an increased stiffness to that movement, or if they have trouble turning their muscles off.

00:08:53 **Speaker 1**

Whereas to describe somebody as having increased or decreased tone doesn't tell us anything about what the actual problem is.

00:09:05 **Speaker 1**

And the most common method of measurement, which is of course the Ashworth or the modified Ashworth, again doesn't tell us what the problem is.

00:09:13 **Speaker 1**

It tells us that there's a change in resistance to passive movement, but it doesn't identify what is causing that change.

00:09:23 **Speaker 1**

And as clinicians we can identify whether

00:09:28 **Speaker 1**

somebody has spasticity, so we can use the Tardieu test to identify whether somebody has spasticity and we'll provide a link to that so that you can follow that up if you want to find out more about that and this is much more useful.

00:09:44 **Speaker 1**

Obviously if you really need to determine whether spasticity is present we can determine the difference between whether somebody has true contracture or whether they just have muscle stiffness, or in our analysis process we should also be able to identify whether they have a coordination problem that is resulting in excessive overactivity of muscles and that they're

00:10:07 **Speaker 1**

having trouble relaxing them and turning them off.

00:10:14 **Speaker 1**

This is a systematic review that summarises the outcomes of studies that have measured increases in tone.

00:10:23 **Speaker 1**

This systematic review is published as a review of the prevalence of spasticity after stroke.

00:10:31 **Speaker 1**

However, we need to realize that the studies use the Ashworth scale or some other measurement of tone.

00:10:41 **Speaker 1**

These are not true measures of the prevalence of spasticity.

00:10:48 **Speaker 1**

Having said that, what this systematic review shows is that the prevalence of increased tone after stroke is in the order of 40% looking at these studies and you can see that it increases over time.

00:11:03 **Speaker 1**

The first group is people early after stroke and the latter group is people more than six months after stroke.

00:11:12 **Speaker 1**

If you were measuring accurately for the presence of spasticity, as I mentioned earlier, you would use the Tardieu test.

00:11:23 **Speaker 1**

And the reason that the Tardieu test can accurately ascertain whether somebody has got spasticity is because it looks at the muscle's response to stretch when it's a fast stretch or a slow stretch.

00:11:36 **Speaker 1**

And so if somebody has some response in their muscle that isn't there on a slow stretch, but is there on a fast stretch, then they have spasticity.

00:11:50 **Speaker 1**

And there's research that shows that the Ashworth scale probably over estimates spasticity by about a third and the Tardieu scale is an accurate measure of spasticity.

00:12:04 **Speaker 1**

And as I said, we'll provide a link that you can follow if you want to find out more information about the Tardieu scale.

00:12:18 **Speaker 1**

So, how concerned should we be about spasticity?

00:12:22 **Speaker 1**

The research that has resulted in people not being quite so concerned with spasticity as they were 50 or 60 years ago comes in three main areas.

00:12:37 **Speaker 1**

And the first one is that people used to really make assumptions, well I say used to, I think often they maybe still do, but people used to very much assume that when somebody had trouble with movement that it was caused by excessive activity in the antagonist muscle and that that was spasticity.

00:12:58 **Speaker 1**

So if they were looking at somebody who could not extend their wrist, well, the assumption would be that that was because of spasticity in the wrist flexors.

00:13:07 **Speaker 1**

One area of research is that people started measuring strength. They started realising that actually this person can't extend their wrist because they have weakness in their wrist extensors and it's not related to the antagonist muscle, it's the agonist muscle, the wrist extensors, cannot

00:13:24 **Speaker 1**

work well enough to produce enough force to extend the wrist.

00:13:30 **Speaker 1**

Now, I think we need to be very, very clear on this because this research has been around for a long time now and people have spent decades and decades and decades focusing on the reduction of spasticity and it has never been shown to result in improvements in function.

00:13:50 **Speaker 1**

And the systematic review to have a look at here is, if you want to follow this up further, is the systematic review by Andringa, and that systematic review looks at the effect of Botox in the upper limb after stroke and it pools data from a lot of randomized clinical trials of Botox in the upper

00:14:13 **Speaker 1**

limb after stroke and it concludes that use of Botox

00:14:18 **Speaker 1**

improves passive range of movement, it can improve hygiene and dressing, it can reduce pain but it does not improve arm function and this systematic review states quite categorically that this is robust evidence now and says we need to stop asking the question, don't keep researching this question

00:14:43 **Speaker 1**

because there is enough research done already to say quite categorically that using Botox does not increase function in the arm.

00:14:54 **Speaker 1**

While it might have benefits for other things, it does not improve function.

00:15:00 **Speaker 1**

The third area of research is studies that have measured impairments and function or activity after stroke and looked at the correlations and we'll have a look a bit more at some of that research but what that research shows is that there are not high correlations, and there's often no

00:15:25 **Speaker 1**

correlation at all between spasticity and people's performance at the level of activity after stroke or traumatic brain injury as well.

00:15:37 **Speaker 1**

So going over the main messages about spasticity, the prevalence is not high, so remembering the systematic review that showed the prevalence of increased tone was 40% and that probably overestimates spasticity by at least a third.

00:15:57 **Speaker 1**

Louise Ada, who does a lot of research in this area, thinks that probably the true prevalence of spasticity after stroke is in the area of 25%

00:16:06 **Speaker 1**

so it's not high prevalence when we compare it to loss of strength and loss of coordination for example.

00:16:14 **Speaker 1**

The associations with activity limitations are unclear but certainly often not there at all.

00:16:22 **Speaker 1**

It should not be a priority in the acute phase after stroke because it's not the cause of people's movement problems.

00:16:30 **Speaker 1**

However, in the more chronic phase where people can have more problems, particularly if their upper limb remains quite disabled, they can have problems with contracture and that can interfere may be related to spasticity and then that can interfere with dressing and hygiene and Botox is a good intervention most

00:16:58 **Speaker 1**

probably for these people because it has been shown to be able to improve hygiene and dressing, increase passive range of movement to decrease pain.

00:17:08 **Speaker 1**

So particularly in the chronic phase it may require some intervention,

00:17:14 **Speaker 1**

but bearing in mind that does not mean it will change people's arm function because that evidence is quite clear that Botox doesn't improve arm function after stroke.

00:17:28 **Speaker 1**

So moving on now to loss of strength after stroke.

00:17:33 **Speaker 1**

Loss of strength is basically a loss of the ability to produce force with muscles and this is a very big problem after stroke.

00:17:43 **Speaker 1**

It's due to the loss of descending input from the brain to the muscles and that can be followed by peripheral changes such as loss of muscle mass from disuse, so muscle atrophy.

00:17:58 **Speaker 1**

There are particular characteristics of the loss of strength that is seen after stroke and they include the inability to produce force very quickly, difficulty sustaining force and difficulty producing force in the inner range and just remembering that's when the muscle is in its shortened range.

00:18:18 **Speaker 1**

So if we think about the wrist extensors, for example, my wrist extensors are in their shortened range here, where the wrist extensors are shortest.

00:18:27 **Speaker 1**

That's their longest position, this is their shortest position.

00:18:30 **Speaker 1**

And so I will have more trouble producing a lot of force in that inner range.

00:18:35 **Speaker 1**

And so after stroke, that problem is even much, much more so than it is in people who haven't had a stroke.

00:18:44 **Speaker 1**

And if you have a look at Ngoc here, lifting a cup to drink, you will see that he exhibits all those characteristics of loss of strength after stroke.

00:18:57 **Speaker 1**

So you can see how slow he is to get that cup up to his mouth, he can't produce force quickly.

00:19:04 **Speaker 1**

He can't sustain force well and that's part of the jerkiness that you see in his movement. You can see how much harder it is when he gets into the very shortened range of his biceps and he's having a lot of trouble getting the cup right up to

00:19:17 **Speaker 1**

his mouth he's having trouble getting enough elbow flexion amongst the other problems you see but those show some of those characteristics of loss of strength after stroke.

00:19:29 **Speaker 1**

What is the prevalence of loss of strength after stroke?

00:19:33 **Speaker 1**

This study looked at over 500 people admitted to hospital and remembering when you look at a study like this, it includes all people admitted to hospital with a stroke.

00:19:44 **Speaker 1**

It will include people with TIAs and very mild stroke.

00:19:49 **Speaker 1**

In these people, about 20 % of them have severe loss of weakness and about 30 % mild to moderate, that's of upper limb weakness.

00:19:58 **Speaker 1**

So about half of them have little or no loss of strength, but remembering that this is all stroke survivors.

00:20:08 **Speaker 1**

Of the people that we're working with, people who have had significant strokes, the prevalence of upper limb weakness will be much more than 50%.

00:20:21 **Speaker 1**

This slide looks at the associations between upper limb strength and activity after stroke.

00:20:29 **Speaker 1**

And so what these figures are, are correlations.

00:20:34 **Speaker 1**

Remembering that when you're talking about correlations, zero means no correlation between the two variables and one is a perfect correlation.

00:20:44 **Speaker 1**

So correlations that are more than 0.5

00:20:49 **Speaker 1**

are reasonably large, and when you're looking at correlations that are then around, as you can see in some of these, 0.7 or 0.8, those are really large correlations between these variables of strength, and if you have a look down this column you can see that these are different muscles that

00:21:08 **Speaker 1**

have been measured, and down the bottom a combined upper limb strength score, and these are the measurements of function.

00:21:16 **Speaker 1**

So you can see box and block is very highly correlated with grip strength but also with shoulder flexor strength and to a lesser extent with elbow flexor and extensor strength.

00:21:30 **Speaker 1**

The Chedoke arm and hand activity has high correlations with grip strength, the combined strength measure, the motor activity log again has relatively high correlations and the arm motor ability test has really quite high correlations with wrist extensor and wrist flexor strength.

00:21:52 **Speaker 1**

So strength is playing a very important role in these activity limitations being measured by these upper limb outcome measures. So what are the implications of this information?

00:22:08 **Speaker 1**

The implications are that when people have loss of strength, we really need to assess the strength of the critical muscles.

00:22:18 **Speaker 1**

But when we talk about assessing strength, it doesn't mean that you need to go through and do a manual muscle test of every muscle strength through the entire arm.

00:22:30 **Speaker 1**

You can still put it into the context of: this person can't reach to grasp this cup.

00:22:36 **Speaker 1**

And they've got reduced shoulder flexion, they've got reduced elbow extension, so how much force can they produce in these muscles?

00:22:44 **Speaker 1**

When you're looking at strength, you could look at it as a manual muscle test, but what is most useful to know is what exactly can they produce and do you need to support the weight of their arm?

00:22:55 **Speaker 1**

Do you need to put something underneath their arm to reduce friction?

00:23:01 **Speaker 1**

So that what you're identifying is how to set up their intervention so that your analysis process is leading into the intervention plan for that person's arm. So we say, know the strength but that's not necessarily knowing that it's a 3 plus or a 2 minus, but knowing

00:23:20 **Speaker 1**

that this person can flex and extend their elbow if their arm is fully supported and they've got a frictionless whatever it is, something to reduce the friction underneath their forearm, that they can produce movement in that position.

00:23:37 **Speaker 1**

So that's how they need to be set up to do their strengthening practice for those muscles.

00:23:46 **Speaker 1**

It's very easy to explain concepts of strength to the stroke survivors that we're working with.

00:23:53 **Speaker 1**

You know, you need to strengthen this muscle group so that you can lift your arm up when you're reaching for something.

00:23:59 **Speaker 1**

You need to strengthen this muscle group so that you can straighten your elbow as you reach for things.

00:24:05 **Speaker 1**

So it's very, very easy to put these exercises that might not look like functional practice because they're isolated strengthening exercises, it's easy to put them into the context of function when

you're explaining the relevance of people's practice and when you're explaining what you're doing in the analysis process too.

00:24:33 **Speaker 1**

And we can talk about the fact that you need certain amounts of strength in your shoulder forward flexors and external rotators to be able to lift your arm up against gravity.

00:24:44 **Speaker 1**

Certain amounts of strength to be able to lift an object up towards your mouth.

00:24:48 **Speaker 1**

And so that can help to explain the importance of doing strengthening exercises where they are required.

00:24:59 **Speaker 1**

And what this information tells us in those high correlations between strength and measures of arm function is that when people have severe weakness, then we cannot change their arm function without changing their strength.

00:25:18 **Speaker 1**

So we need to identify what their current levels of strength are and identify interventions that can help them to increase their strength and there will be a lot more information on this as we go through this content.

00:25:36 **Speaker 1**

So when you have a look at the implications for assessment and intervention, we need to think about what does the evidence tell us about intervention.

00:25:45 **Speaker 1**

This is information taken from the Australian Stroke Guidelines and we will have much more detailed information coming up about intervention.

00:25:53 **Speaker 1**

This is a brief summary.

00:25:55 **Speaker 1**

There is a strong recommendation for the use of progressive resistance training,

00:26:00 **Speaker 1**

But progressive resistance training refers to moving against added resistance so obviously that's not suitable for muscles that are very weak if you can't even move against gravity you can't really move against added resistance so that's a very specific, classic strength training where you lift a weight that you

00:26:22 **Speaker 1**

can only lift for 10 repetitions maximum for example, so you can only do 10 you can't do 11 and so it's high load low repetitions so really pertinent for muscles that are grade 4 for example.

00:26:38 **Speaker 1**

There are weak recommendations for the following interventions, I'm not going to go into these in detail because we will cover them later.

00:26:46 **Speaker 1**

For assistive technology, and here that's talking about the smart arm device and the SABO Flex device.

00:26:55 **Speaker 1**

Constraint-induced movement therapy increases strength.

00:26:59 **Speaker 1**

Robotics have been shown to increase strength, so has mental practice and mirror therapy,

00:27:04 **Speaker 1**

and functional electrical stimulation. And by functional it means electrical stimulation done in the context of somebody practicing a task at the same time.

00:27:15 **Speaker 1**

The main messages are that you should assess strength but by this I mean not assessing in isolation from other parts of your assessment and assessing every muscle group known to humankind but starting at the level of activity and assessing the strength of muscles that you need to know about

00:27:37 **Speaker 1**

because it's having an impact on somebody's performance at the level of activity and then you can put your strength assessments in context for the stroke survivor that you're working with.

00:27:49 **Speaker 1**

And what information you are getting is what muscles need to be doing some isolated strengthening because they have very significant weakness and what is their current level of strength so that you know how to set up that intervention.

00:28:05 **Speaker 1**

So you're only getting the information that you need to drive your intervention.

00:28:10 **Speaker 1**

And train strength particularly in muscles that are very weak because you will not get improvement at the level of activity unless there is improvement in the strength of very weak muscles.

00:28:26 **Speaker 1**

Now we're looking at the impairment of loss of coordination.

00:28:31 **Speaker 1**

So the characteristics of coordination I'm defining it here as the production of muscle force, muscle activity, to meet task requirements.

00:28:46 **Speaker 1**

And within that context we can think about spatial accuracy, that you produce exactly the right amount of force to get to the right end point that you're trying to get to.

00:28:56 **Speaker 1**

I'm producing exactly the right amount of force in my biceps to take my hand to my nose.

00:29:01 **Speaker 1**

And I'm getting to there, I'm not stopping here and I'm not going past, that's coordinating that muscle activity and producing it at the correct timing for the task.

00:29:15 **Speaker 1**

So we're not talking about coordination as an isolated component here, we're talking about it as muscle activity matching the task that you're trying to do and when we think about our analysis it's going to be much more useful to look at coordination in the context of the task that

00:29:36 **Speaker 1**

somebody wants to practice than it will be to do isolated coordination tests.

00:29:43 **Speaker 1**

Doing somebody's finger-to-nose test is probably going to tell you that they've got reduced coordination.

00:29:48 **Speaker 1**

It's not really going to help you identify what's going to be useful practice for them to get better at writing or drinking from a cup or whatever their goals are.

00:29:57 **Speaker 1**

That is about the assessment of their coordination of doing that task, as they do the task.

00:30:07 **Speaker 1**

Here we see a man called Rob, who has some reasonable strength in his right arm but significant coordination problems.

00:30:16 **Speaker 1**

And you'll see he has trouble with the spatial components of coordination.

00:30:23 **Speaker 1**

So in his pre-shaping, the aperture that he makes with his hand is much wider than it needs to be for the cup

00:30:31 **Speaker 1**

that he's picking up, whereas normally our aperture is very closely matched to the size of the object that we're picking up.

00:30:37 **Speaker 1**

And you'll see when he pours water that again the end point that he gets to is kind of all over the place and quite inaccurate and he has this jerkiness which probably reflects an inability to time appropriately the muscle activity produced by the agonist and antagonist muscles as he

00:30:57 **Speaker 1**

does the task.

00:30:59 **Speaker 1**

So he has very significant coordination problems that need to be targeted in his practice.

00:31:34 **Speaker 1**

The prevalence of loss of coordination is very high after stroke and even when people have very significant loss of strength, it's been shown that they've got significant coordination problems.

00:31:47 **Speaker 1**

So Colleen Canning has done some work looking at people with very low strength in their arm and measuring their ability to coordinate that muscle activity using a very frictionless device and having a look at their ability to get to the right end point so their spatial accuracy and their ability to change their timing of their

00:32:08 **Speaker 1**

muscle activity and it's very impaired after stroke even when it's hard to measure in people that are very weak it's very impaired and then obviously it's often very impaired when people have greater strength but still have significant problems with their arm function.

00:32:29 **Speaker 1**

So what are the implications for assessment and intervention?

00:32:33 **Speaker 1**

Coordination, absolutely critical to task performance.

00:32:37 **Speaker 1**

If you can produce a lot of force in your muscles, as in you have some reasonable strength in your muscles, but you cannot coordinate that muscle activity, your task performance will be very impaired.

00:32:51 **Speaker 1**

It's easy to communicate about coordination, so needing to practice this task so that you get better at coordinating that muscle activity to produce the right amount of force, to produce it at the right amounts, at the right timing in order to improve your ability to do

00:33:10 **Speaker 1**

the task.

00:33:11 **Speaker 1**

So here what I'm looking at is the recommendations for improving arm function after stroke.

00:33:19 **Speaker 1**

Because while that's reliant obviously on having adequate strength, it is also absolutely reliant on coordination.

00:33:26 **Speaker 1**

And because we're looking at coordination as being measurements of producing force as required to do the task, we're really thinking about task performance here.

00:33:36 **Speaker 1**

The only strong recommendation for upper limb function after stroke in the Australian Stroke Guidelines is for constraint induced movement therapy (CIMT).

00:33:47 **Speaker 1**

There are also weak recommendations for repetitive task-specific training, which is obviously also a very large component of constraint induced movement therapy (CIMT), for robotics, virtual reality, functional electrical stimulation, remembering that's electrical stimulation applied while somebody does a task, mirror therapy, and mental practice.

00:34:10 **Speaker 1**

So all of those interventions have been shown to have some impact on improving upper limb function after stroke.

00:34:22 **Speaker 1**

So what are the main messages about coordination?

00:34:26 **Speaker 1**

That it should be assessed but it should be assessed in the context of task performance.

00:34:33 **Speaker 1**

It should be part of training because what we're addressing in training as well as strength problems is coordination problems because our training is looking at identifying what problems are people having with their force production and how can their training be set up to address that and we'll be looking

00:34:52 **Speaker 1**

at a lot of very specific examples.

00:34:57 **Speaker 1**

We're moving on now to sensation and this slide is a summary of the prevalence of loss of sensation after stroke.

00:35:06 **Speaker 1**

This study by Sarah Tyson looks at over 100 people and they are people with weakness so it's not everybody with a stroke, but people that have some muscle weakness. What you can see here is that most people have intact proprioception but only roughly half of them have

00:35:24 **Speaker 1**

intact tactile sensation and actually a quarter of them have no tactile sensation in their affected arm.

00:35:33 **Speaker 1**

So some very significant loss of sensation when we're looking at tactile sensation and a much smaller number of people having some loss of proprioception.

00:35:45 **Speaker 1**

What is much less clear is what is the relationships between sensation and activity because I think we often assume that a loss of sensation will therefore result immediately in very significant loss of function but that hasn't really been shown in the research that's been done in this area.

00:36:14 **Speaker 1**

So I think what it's telling us is that we need to take this on a very individual basis. I'm sure you will have worked clinically with people who seem quite disabled by a loss of sensation in their hand and it seems to have quite a big impact on what they can do.

00:36:31 **Speaker 1**

I can remember a stroke survivor that I met who was a very high level violin player and for her the loss of sensation in her left hand meant that she couldn't really feel how much force she was applying to the violin and feel her fingers on the

00:36:52 **Speaker 1**

violin string.

00:36:53 **Speaker 1**

So it had enormous functional impact on that task of violin playing.

00:37:01 **Speaker 1**

But I've met other people who have quite significant loss of sensation and are able to compensate for it relatively well in their upper limb.

00:37:09 **Speaker 1**

So I think it's maybe again, something that needs to be taken on an individual basis, but don't assume necessarily that it's going to be a very disabling impairment like loss of strength or loss of coordination can be.

00:37:26 **Speaker 1**

If you have a look at these studies, they came up with quite different conclusions when they measured loss of strength and looked at its relationship to function.

00:37:41 **Speaker 1**

So in one study, it's not predictive of variability in motor performance.

00:37:47 **Speaker 1**

In another study, some predictive capacity of proprioception on the motor activity log quality of movement outcome, and in another there was some correlation of loss of sensation and the motor activity log, but not a very high correlation.

00:38:05 **Speaker 1**

At 0.4 it's still probably significant, but remember those correlations between loss of strength and arm function are often sitting at double the correlation that we see there. So this research is really quite inconclusive.

00:38:24 **Speaker 1**

What are the messages from that?

00:38:26 **Speaker 1**

Well, not that clear really are they?

00:38:30 **Speaker 1**

But I think what it is telling us is don't focus on it unless for the person in front of you it is a particular problem.

00:38:41 **Speaker 1**

When you think about something like playing the violin, doing something where you can't see what your fingers are doing and you have to be able to feel what your fingers are doing, obviously then loss of sensation could have a very, very big impact on that task.

00:38:56 **Speaker 1**

Don't spend a lot of time assessing it unless it is something that you are going to provide specific intervention for.

00:39:04 **Speaker 1**

Otherwise, you're just wasting your time and more importantly, you're wasting the stroke survivor's time.

00:39:12 **Speaker 1**

But if you are going to focus on it and there is some weak evidence for sensory-specific training, then there's a reason to do some

00:39:24 **Speaker 1**

more detailed assessment and across the different modalities of loss of sensation, tactile discrimination, two-point discrimination, hot-cold discrimination, proprioception, etc., all those different modalities.

00:39:39 **Speaker 1**

There is a weak recommendation in the Australian Stroke Guidelines for sensory-specific training and we will provide a link to some more information about that training

00:39:54 **Speaker 1**

That type of training looks at training sensation in a very task-specific context, using it to explore the objects that you're interacting with, which is the way that we use sensations.

00:40:07 **Speaker 1**

It's not about doing some kind of isolated practice that's not task-related.

00:40:11 **Speaker 1**

It's about the exploratory role of sensation in informing us in our interactions with the objects that we use.

00:40:23 **Speaker 1**

Main messages.

00:40:25 **Speaker 1**

We just said them.

00:40:26 **Speaker 1**

Only assess where necessary.

00:40:28 **Speaker 1**

What's the fastest way of finding out if somebody has loss of sensation?

00:40:32 **Speaker 1**

Just ask them.

00:40:34 **Speaker 1**

People will have thought about this a lot and will be able to give you quite a detailed summary of what's going on with their sensation.

00:40:47 **Speaker 1**

If you're going to do specific training, then look up the SENSE training that's been established by Leanne Carey and target that training to the specific modalities that are really affecting the person that you're working with.

00:41:08 **Speaker 1**

What about contracture?

00:41:10 **Speaker 1**

This study looks at the prevalence of contracture in a large group of people followed up at six months after their stroke.

00:41:19 **Speaker 1**

Half of them have a contracture in one or more joints.

00:41:22 **Speaker 1**

The elbow and the wrist are quite common sites of contracture in those people.

00:41:30 **Speaker 1**

The other very interesting outcome of this study was that it showed us that we are very bad at predicting who will get contracture.

00:41:39 **Speaker 1**

I can remember we were quite surprised about the outcome of this study because we would have thought that we were quite good at predicting who would get contracture.

00:41:48 **Speaker 1**

But in this study, if you had a look at severity of stroke and amount of weakness, that only explains a very small proportion of the variability of contracture in these 160 stroke survivors.

00:42:04 **Speaker 1**

There's a lot about contracture that we don't know, but we're also very unclear on the cause of contracture because some people with the same kind of impairments after stroke will not get contracture and some people will.

00:42:21 **Speaker 1**

So I think there's a lot of research still to be done in this area.

00:42:29 **Speaker 1**

The relationship with activity limitations is a bit harder to see in the research, but I think it's very clear to us at a clinical level that if somebody can't extend their wrist because they've got a wrist flexion contracture, then that is an absolute limitation for them in their task

00:42:47 **Speaker 1**

performance of anything that they're trying to do that requires wrist extension.

00:42:52 **Speaker 1**

So obviously it's something that needs to be assessed when we're looking at analysing people's movement problems.

00:43:02 **Speaker 1**

If you've got your list of kinematic deviations and one of them is reduced wrist extension, for example, then it is probably going to be worthwhile having a quick check that somebody has

sufficient passive range of movement of wrist extension if they don't have sufficient active range of movement.

00:43:26 **Speaker 1**

This is a more unusual recommendation in that we have a strong recommendation to not routinely apply stretch and splinting in people after stroke.

00:43:39 **Speaker 1**

And that's because there's robust evidence saying that stretching and splinting does not reduce or prevent contracture.

00:43:47 **Speaker 1**

This is very important information for us because clinically, particularly if you're as old as I am, you've probably spent a lot of time putting people routinely into upper limb stretches or if you're an older OT you've probably spent a lot of time routinely making splints for people after stroke.

00:44:10 **Speaker 1**

And that is wasting the stroke survivor's time, and wasting our time.

00:44:17 **Speaker 1**

I'm not saying never splint or never stretch people because there will be instances when somebody's got no active movement and you are doing what needs to be done to try and maintain enough range to be able to have good hygiene and stuff around the hand.

00:44:42 **Speaker 1**

But this should not be routine interventions.

00:44:47 **Speaker 1**

The consensus-based recommendation is for serial casting if other therapy has failed but remembering that consensus-based recommendation is expert opinion so absolutely lowest level of evidence but we have some evidence very very low level which is why it comes in under this form of recommendation for serial casting.

00:45:09 **Speaker 1**

And for active motor training or electrical stimulation.

00:45:13 **Speaker 1**

We'll have a look and see exactly how that might be applied in this context.

00:45:18 **Speaker 1**

So if we think about electrical stimulation and you're working with somebody who, for example, is getting reduced range going into wrist extension or reduced range of their thumb webspace, then applying electrical stimulation that takes them to their end of range, particularly, is probably a very good idea to do.

00:45:40 **Speaker 1**

But, you know, there's not reasonable evidence, but it does seem like a sensible idea to do because we know that it's also got benefits for improving strength and activity after stroke.

00:45:54 **Speaker 1**

In this video you see Ngoc practicing shoulder external rotation which is a movement that he needs to increase his strength of but you can see it also would have added benefit if he was starting to develop some contracture of his shoulder internal rotators which is very common after stroke,

00:46:18 **Speaker 1**

to lose range

00:46:21 **Speaker 1**

of the shoulder internal rotators, thereby limiting the movement into external rotation.

00:46:29 **Speaker 1**

But he's repetitively going to the end of his active range of external rotation, which is actually quite close to the end of his passive range, and you can imagine the fact that he's repetitively doing that, you would think would help to maintain length of the internal rotators of his shoulder.

00:47:04 **Speaker 1**

So the main messages about contracture is that it requires assessment, we need to assess passive range to see whether it's contributing to people's movement problems.

00:47:17 **Speaker 1**

In terms of intervention, not so clear there, but the things that come under an expert opinion guideline is for active retraining, to monitor and to intervene as required.

00:47:32 **Speaker 1**

And obviously the most difficult thing there is people who don't recover upper limb movement and are developing contracture and then maybe we do need to fall back on some of the individual application of splints and stretching - and we're just remembering that they are not recommended as routine practice.

00:47:55 **Speaker 1**

So the summary about contracture is that obviously we do need to assess to see what impact it's having at the level of activity.

00:48:03 **Speaker 1**

In terms of intervention, there is a lack of an evidence base really to guide effective long-term interventions for prevention and management of contracture.

00:48:14 **Speaker 1**

We know that serial casting has some transient benefit, but that's a fairly weak level of evidence.

00:48:21 **Speaker 1**

At an individual level I think we need to monitor.

00:48:25 **Speaker 1**

We do need to intervene.

00:48:26 **Speaker 1**

We probably need to rely on the kinds of traditional methods we've relied on that don't have good evidence, but measure and have a look at the effect that they are having.

00:48:38 **Speaker 1**

If we increase motor activity and active practice, that's probably the best thing that we can do, but that obviously doesn't really answer the questions of what to do when people have more severe levels of disability.

00:48:53 **Speaker 1**

We do know that if people have spasticity, that using Botox will help increase passive range of movement, but that doesn't carry over at the level of activity.

00:49:07 **Speaker 1**

So going back and looking at a summary of the associations between impairments and activity, it's the negative impairments that have the largest associations with activity limitations after stroke, loss of strength, always, always implicated, loss of coordination as well.

00:49:27 **Speaker 1**

So these are the impairments that we need to assess and that we need to focus intervention on.

00:49:35 **Speaker 1**

Looking at the other impairments, loss of sensation, inconsistent associations with activity, so shouldn't routinely be part of our assessment or intervention but may be implicated for some individuals.

00:49:54 **Speaker 1**

Contracture definitely needs to be assessed where it's implicated in our analysis process.

00:50:03 **Speaker 1**

If the movement that somebody's doing is limited, if their active range of movement is limited, and it's a site that is prone to contracture, then assess the passive range.

00:50:15 **Speaker 1**

Spasticity/tone, inconsistent associations with activity, do not need to be part of routine assessment, but may require further assessment with the smallish group of people for whom they are problematic and may require some specific intervention because they're having difficulty

00:50:43 **Speaker 1**

with a very tight wrist or hand, for example, that is interfering with hygiene and dressing but this should not be part of routine assessment.

00:50:58 **Speaker 1**

So our implications for intervention, it is critical to assess and to increase strength when people have very low levels of strength.

00:51:09 **Speaker 1**

When people have greater amounts of strength and still have significant problems at the level of activity, then it is coordination that needs to be trained.

00:51:24 **Speaker 1**

This representation of the relationship between strength and activity after stroke I think is very useful for us to guide our analysis and intervention.

00:51:37 **Speaker 1**

What you have here is measures of activity represented on the y-axis, measurements of strength represented on the x-axis and what this tells us is that where people have low levels of strength - so down this part of the graph - there is a linear relationship, a very direct relationship between strength and activity.

00:52:00 **Speaker 1**

Where people have high levels of strength - so up this part of the graph - there is no relationship, that's now a flat line.

00:52:08 **Speaker 1**

You can see that what this tells us about low levels of strength is that if you increase strength, so say for example you've got somebody here and they increase strength from there to there,

00:52:18 **Speaker 1**

that means that their performance at the level of activity, they've increased from there to, they've moved strength, moved to here.

00:52:26 **Speaker 1**

So now they've increased from there to there.

00:52:30 **Speaker 1**

They've improved their function because of that direct relationship where you have lower levels of strength.

00:52:37 **Speaker 1**

If you're working with somebody who has better strength, but has some significant movement problems, then the focus needs to be coordination.

00:52:47 **Speaker 1**

So if we think about Rob pouring water from cup to cup, he didn't have very significant loss of strength, but had very significant coordination problems doing that task.

00:53:00 **Speaker 1**

So his training needs to address his coordination problems.

00:53:04 **Speaker 1**

And coordination problems is addressed by doing the task that people want to get better at doing because it's about producing the muscle force as required to do the task.

00:53:15 **Speaker 1**

So train coordination as your task specific training but identify what the specific problems are that people are having with their coordination, with their production of muscle force as required to do the task that they're trying to do.

00:53:33 **Speaker 1**

And here, a summary of that information in terms of the association between impairment and activity limitations.

00:53:43 **Speaker 1**

The question mark here under contractures is because we know that it has big implications but it's not represented in the research. It's obvious when we have somebody in front of us who can't straighten their elbow because of an elbow flexion contracture for example.

00:53:58 **Speaker 1**

So we know it's got big implications but not seen so much in the broader research.

00:54:08 **Speaker 1**

So what are the implications for analysis?

00:54:12 **Speaker 1**

We can be very efficient and think about what needs to be assessed and not do a bunch of things that don't give us useful information that makes a difference to intervention.

00:54:26 **Speaker 1**

What is critical to look at?

00:54:29 **Speaker 1**

Passive range of movement where active range of movement is limited, so the decreased forward flexion or decreased elbow extension. Check passive range of movement to see if there's

contracture. Check strength, but check strength in the context of thinking about what can the intervention be?

00:54:48 **Speaker 1**

How much can that person turn that muscle on?

00:54:51 **Speaker 1**

What sort of practice can they do to increase strength of that muscle?

00:54:55 **Speaker 1**

Look at coordination because coordination is critical regardless of how much strength you have if you cannot coordinate that muscle force as required to do the task, then you're going to be limited in your function.

00:55:11 **Speaker 1**

Then there's additional impairments that may need more detailed assessment, but should not be routinely assessed.

00:55:18 **Speaker 1**

Only assess them if there's a reason to assess them, if you're going to do something about them.

00:55:23 **Speaker 1**

Don't assess things that you're not going to do anything about.

00:55:28 **Speaker 1**

So these three as being major contributors to loss of function and these that may require assessment and may have an impact on the way that we set up somebody's practice.

00:55:41 **Speaker 1**

But might not need very detailed assessment and again thinking about sensation, just ask somebody, don't do a detailed assessment of sensation unless you're going to use that information to do very detailed SENSE retraining, but there's no indication to do detailed assessment unless you're going to do that.

00:56:01 **Speaker 1**

Otherwise, you're just wasting people's time that could be better spent setting up some useful practice for them to do.

00:56:10 **Speaker 1**

This is a summary of the recommendations and the strength of those recommendations.

00:56:18 **Speaker 1**

So yes, we can make a big difference to strength and we've got progressive resistance training as a strong recommendation, but we do have other strengthening interventions for weaker muscles as well that come under a weaker recommendation, there is a variety of interventions.

00:56:35 **Speaker 1**

Strong recommendation for constraint induced movement therapy, a weak recommendation for task-specific training, but remembering that a very large component of constraint induced movement therapy is task-specific training.

00:56:51 **Speaker 1**

Sensation, a weak recommendation for sensory specific training.

00:56:56 **Speaker 1**

Contracture, a strong recommendation to not routinely apply splinting or stretching in rehabilitation.

00:57:05 **Speaker 1**

Spasticity, a weak recommendation for Botox and rehab, with a comment that it is unlikely to improve activity in weak stroke survivors.

00:57:19 **Speaker 1**

So that's a very clear message there that there is a role for Botox but it's not in improving arm function.

00:57:27 **Speaker 1**

We will put some links to some more detailed lectures on contracture and spasticity that you can access on the StrokeEd website if you like as well because they are such enormous topics.

00:57:44 **Speaker 1**

This model proposed by Louise Ada from the University of Sydney provides an outline of how we can target our intervention according to the level of strength that somebody has and so you can see if somebody has paralysed or very weak muscles that the intervention needs to target strength.

00:58:12 **Speaker 1**

However if somebody has stronger muscles and still has activity limitations, then the intervention needs to target coordination and remembering that coordination training is our task specific training that addresses the specific coordination problems that somebody is having as they're doing the tasks that they want to be able to do.

00:58:34 **Speaker 1**

Here we look at a man called Joe. You can see here, where he tries to reach for the cup, that he has some very significant loss of strength in shoulder flexion, wrist extension, thumb abduction, finger extension.

00:58:53 **Speaker 1**

And so he can't transport his arm, he can't pre-shape his wrist and forearm, wrist and hand, and he can't grasp the cup effectively.

00:59:05 **Speaker 1**

He has a bit more luck with a heavier cup, but you can see that he's really quite limited by his strength problems.

00:59:14 **Speaker 1**

So here, his intervention really needs to target the strength problems that you see there.

00:59:21 **Speaker 1**

Now we see Joe further down the track and if you have a look at his movement now, you can see that he's got a lot more strength in his left arm, but he still has some problems.

00:59:32 **Speaker 1**

He's picking up a much harder cup.

00:59:34 **Speaker 1**

It's a light polystyrene cup, it's much harder to pick up and he can do that, but you'll identify that he's still got some kinematic deviations as he does that practice. Look how much better his transport phase is, how much better his pre-shaping is, and his ability to grasp.

00:59:55 **Speaker 1**

He can do it, which he couldn't before.

00:59:58 **Speaker 1**

So can you see that now his practice should target task-specific practice, and target within that some of the problems that he still has.

01:00:07 **Speaker 1**

He still has some decreased supination and wrist extension and some decreased thumb opposition but all of those things could be targeted during his task practice and probably don't need to be done as isolated strength exercises which is what he would need in the first instance to increase of his arm.

01:00:34 **Speaker 1**

The take-home messages, in the interest of repetition, negative impairments have the greatest impact on activity after stroke.

01:00:42 **Speaker 1**

Don't focus on spasticity, sort out the way you describe things, don't use tone, talk about what the problem is.

01:00:54 **Speaker 1**

And the biggest problems in the upper limb after stroke are the loss of strength and loss of coordination. Strength is critical for function.

01:01:06 **Speaker 1**

Without adequate muscle force production, you cannot move at all, or you cannot move well.

01:01:12 **Speaker 1**

Strength is absolutely critical.

01:01:14 **Speaker 1**

Where people have adequate strength, you need to address the coordination problems that they're having, and that's done within the context of practicing the tasks that they want to practice.

01:01:26 **Speaker 1**

So our analysis and training should focus on people's strength and coordination impairments.

01:01:33 **Speaker 1**

I'll bring up now the references but we'll also add the references as a separate document so that you can access any of those references that would be useful to you.

01:01:58 **Speaker 1**

And that's the end.

01:02:00 **Speaker 1**

See you later.