

**ROBERT LEE:** So no financial disclosures. These are the things you should learn from my talk today. So I'm going to review the common impairments and goals of our young stroke survivors. We'll also talk a little bit about the barriers that our young strokes face trying to recover in our current system.

I'll summarize some of the indications for when patients should be referred to rehab and also talk about the natural recovery process in our strokes and how we can time that with our therapies that we can give them.

And we'll also briefly go over some of the differences between the various options that our patients and family members have to kind of decide between when they're choosing what type of rehab to get. And then also I'll talk about how we should be able to maximize recovery within our current health care system.

Just briefly, so epidemiology stroke by the numbers. Well the NHIS study that they did back in '08 said there were about seven million stroke survivors living in the US. That number is closer to 8 million right now and CDC predicts that by 2013 that number is going to be closer to 11 million. So this is a huge growing issue in the US. Approximately 900,000 people a year are admitted to an ER with signs of a stroke.

When you look at the young adult population this is a sliver of that 900,000 but this number is growing. So depending on the study that you look at somewhere between 20% to 33% of stroke survivors are under the age of 65. 12% between 18 and 50. And 5% are under the age of 45.

And just looking at the prevalence in Texas, it's been fairly stable since the mid 2000s probably somewhere between one and two out of 1,000 patients are under the age of 50.

So all of the impairments, so we've looked at all these pretty pictures that have been presented earlier. We talked about TIAs and the vascular territories. But these are the things that our stroke patients have to deal with after they've survived a stroke or a hemorrhage.

Weakness on one side of their body impairing their ability to walk, use their hands, upper extremities. Difficulty communicating, whether that's understanding what people are saying or being able to express their thoughts. Difficulty swallowing, drinking water, things that we all take for granted that all of a sudden now the stroke has taken away from our patients. Incontinence, basic things that we don't even have to think of most of the time.

And when you're a young stroke survivor still gainfully employed, you've got young kids, you've got an active social life, you know these are things that really affect your quality of life. Balance and coordination, cerebellum does matter.

Patients don't like not having their balance or coordination very much, even though we can do things to help them. It's definitely a chief complaint. So vision whether that is the complete monocular blindness or just a field cut, this can be pretty disabling. Especially if our young strokes are transporting and driving, having a field cut and not paying attention to the left side of the road is a huge problem.

Sensory deficit, so not being able to feel or sense hot and cold. So if you're cooking a meal and you can't sense heat that's a big problem. And then cognitive deficits are a huge issue for our young strokes.

So even if they physically recover, many stroke patients still have the cognitive deficits that prevent them from being able to function in society and take care of young ones or get back to their previous levels of function. And depressions also a huge issue just being able to cope with the new impairments that they've had.

So you know the difference between an elderly patient and somebody who's fairly active still has young kids to raise, they're the primary breadwinner, they're working, just kind of climbing the career ladder, they've got lots of activities to partake in, whether it's the community, church, other organizations. Driving's a huge issue and just their hobbies, these are all things that if you're a young stroke you've got so many years to live and all these great things to live for.

Not to say that the elderly don't deserve as much therapy, but they've been able to experience the world and they've raised their kids and they've hopefully are close to retirement or retired and enjoying the later parts of their lives.

But for the young stroke survivors this is a huge issue. And they deal with a lot of challenges. So now you've got difficulty moving around, you've got difficulty buttoning your shirt, you can't pick up a cup, you can't feed yourself. Things that-- activities of daily living, dressing yourself, putting on a shoe, getting to the toilet, all things that they probably never even had to think twice about before.

But now, instead of caring for maybe their parents or their loved ones or their kids. Now they're the ones that need to receive the care. This can be a huge stressor not only on the patient, but also their family members and their support system.

Caregiver burden and burnout is a huge issue, especially for their spouse of the survivor. Patient, their sense of self can be affected from all of this. Not being able to do all the things that they were once doing. Having a psychologist on board is very important for the overall recovery process in these patients.

And then finally the economic impacts of having a stroke. The loss of time from work, all the recovery that needs to happen, the expenses that go along with trying to get through the hospital system, and all the bills that come along with that. And whether or not patients are able to eventually get back to work, that's always a question on their minds.

So all the barriers, you know it's not enough that they have to deal with all the impairments and you know the adjustment disorder. But now they've got to navigate through a system that's almost stacked against them these days. So we've noticed that there are shorter lengths of stay for rehab over the decades. This number has been gradually decreasing. I'll talk about this a little bit later.

Insurance is a huge issue. Whether-- well if you're uninsured you really have very little chance of getting into an acute rehab facility in Texas. But even if you are insured, there are still a lot of barriers that the insurance companies will throw at our patients to limit the amount of therapies they can get. Often denying higher levels of care that should be appropriate for these patients.

Geographically if you happen to live in a big city you're going to be in good shape, because there should be a major rehab center in that city, if not more than one. But if you live out in the country or if you're in an area that doesn't really support acute rehab or intense therapies and has a tendency to refer to skilled nursing facilities. You're going to be limited in your overall recovery.

Regulations usually with Medicare that impair a patient's overall recovery. Family support's a huge, huge issue with patients trying to recover. You need to have a support system. Trying to recover from the stroke by yourself is very difficult. Just simple things is getting to your therapy appointments, being able to take care of yourself at home. And then quality of rehab services vary across the system throughout the different levels of care.

So ideally a young stroke patient should be quickly diagnosed, they arrive at the ER, hopefully at a primary stroke center. They get their tPA, we minimize the initial insults and they quickly have a uneventful hospital course where they can transition to an acute rehab facility, get their therapy and hopefully go back home and continue with a good outpatient program or day program with a healthy family support system.

Unfortunately this probably isn't the case in most situations. You know when they look at levels of care, all the studies have shown that better clinical outcomes for stroke survivors come when there's a coordinated multi-disciplinary unit that's able to specialize.

So from the nurses, to the therapist, to all the physicians, they're specialized in stroke care. They saw in the 1980s that the overall mortality of strokes in general decreased once they were coordinated, neurologist and specialized stroke units in the US taking care of our patients.

This stroke unit's trial list collaboration review looked at all inpatient stroke unit care and compared it to other levels of care such as skilled nursing facilities. And these are big things. Being able to survive your stroke, being able to go home regaining overall independence. If you go to inpatient stroke centers you're more likely to achieve these things.

So just briefly, so an inpatient stroke rehab hospital generally they can be freestanding or they may be a unit in an acute hospital. But being part of a hospital it allows us to have access to imaging laboratory, consultants, specialists, access to an ER if something should go wrong, ICU transfers.

It makes things a lot more seamless if there is a problem. And as we know the first month after a stroke is when the patients are at their greatest risk of having recurrent strokes and a lot of complications. So just having an acute rehab facility where you're being monitored daily by skilled nurses and being seen by physicians every day makes a huge difference.

The amount of therapy that you get in an acute rehab hospital is generally per guidelines at least three hours a day for five to six days a week. And the average length of stay currently is around 16.5 days and generally, most of the patients that are admitted to an acute inpatient rehab hospital come directly from an acute hospital. So 95% of patients.

And things that we need to justify. So they need to have to see a physician on a daily basis to manage their comorbidities. They need 24 hour nursing needs and these things could be managing spasticity, diabetic management, hypertension, bowel and bladder issues, prevention of DVTs, pneumonia, aspiration, nursing issues we can usually easily justify.

Because after a stroke patients aren't able to move around in the bed by themselves. They can't do basic ADLs, they can't use the bathroom, they're at high risk of developing ulcers. So they need daily 24 hour skilled nursing.

This is the interdisciplinary team that helps our patients recover. It's a-- everybody plays a major role, from the physiatrist but all the way at the bottom. At the center of the team is the patient and the family members.

Our therapies are usually goal directed plan of cares involve each individual patient. Not every patient's the same, especially the young stroke patients who have different goals. Their goals usually revolve about getting back to work, getting back to their families as soon as possible, getting back to their hobbies.

But this entire team is there to help them through the process.

**AUDIENCE:** [INAUDIBLE].

**ROBERT LEE:** No. Well--

**AUDIENCE:** [INAUDIBLE].

**ROBERT LEE:** I did say at the very bottom the most important part was the patient and the family.

So inpatient rehab outcomes. So every decade or so they do a study looking at all rehab facilities and some of the skilled nursing facilities. And about 70% of patients who go to acute inpatient rehab are able to discharge the community. Probably two out of those 10 aren't able to go back to the community just because of lack of family support. There's a 0.2% mortality in an acute rehab facility. The length of stay is 16.5 days, like I mentioned earlier.

And FIM score I'll talk about in a little bit. But the average FIM gain for a patient who comes to an acute rehab is about 25 points or so give or take. Better facilities are closer to 30.

So gaining access to care. So first of all, sometimes it's easier to get into the White House but, this initially the physical therapists, occupational therapists, speech therapists will evaluate the patient sometimes the PM&R doctor will be consulted to help with guiding the patient through the acute rehab or the acute setting. And case managers play a huge role in not only the education, but also hopefully convincing insurance companies and family members that acute rehab is probably the place a young stroke wants to go.

So who needs rehab? If it was that simple anybody who has a stroke who isn't at their prior functional status should get rehab. With a stroke this is pretty easy to justify. They've got weakness, they're not able to communicate. They usually have swallowing difficulties and sensory deficits and definitely they're not able to do activities of daily living like they once we're able to. So if it was up to me any young stroke patient should get acute rehab.

This is the FIM score that the CMS developed, Functional Independence Measure scale. It's an ordinal scale from one to seven that basically looks at 18 different subgroups of activities. So activities of daily living, bathing, toileting, dressing, grooming, it also looks at mobility. So patient's ability to transfer out of bed, ambulate, and then cognitive issues. And they basically score these from one to seven.

So the patients that usually are the best candidates for acute rehab are the ones that kind of fall into this two to four range. You know the TIAs are going to be up there in the seven. So we usually don't see them. And then your massive intracranial hemorrhages where patients are completely dependent they're probably two level for acute-  
- or too low level for acute rehab.

But the patients that are showing progress from the initial PT and OT evals in the acute hospital that fall in this range are great candidates. And when you look at that 25 to 30 point FIM score improvement in the acute hospital that usually translates into probably a two point gain in all these subsets.

So if you can take a patient from minimal assistance all the way to modified independent where they can get around in their house all by themselves with maybe just a walker or a cane that makes a huge difference in their ability to go back home safely.

Same thing with-- even if a patient's not able to be completely independent. If you take them from requiring maximal assist with two therapist's to having their wife or loved one who weighs 70 pounds be able to kind of guide them out of bed, that's a huge difference in being able to go home. So going to acute rehab makes a huge difference in these patients.

So who qualifies? We talked about that. So there also needs to be potential for improvement. And that's usually where Medicare or insurance companies will get you. This is it's kind of a subjective evaluation, but patients need to be medically stable. They need to be able to tolerate the therapy that they're going to get in acute rehab.

So that's usually where we run into some issues. So insurance approval and also a facility approval. So they'll do their evaluations on our stroke survivors in the acute hospital setting which the length of stay these days are less than four days. So you don't really have that much time to see what the patients are going to do.

So you kind of have to make a judgment call in there and try to do your best. We've got a great team of liaisons here that are able to evaluate patients pretty quickly. And I think we do a pretty good job of getting patients to the right level of care.

So for the ones that really cause trouble. So we always have the ability to appeal an insurance companies decision or Medicare's decision. We can always get on the phone and hopefully do a physician to physician appeal. And we can usually convince the insurance companies to allow the patients that really do have a chance of benefiting from acute rehab to come in.

Now we don't want to use this appeal over and over again, because over time the insurance companies and Medicare will kind of flag your facility. Not only the rehab facility, but also you're acute hospital if we're appealing every single decision. But for select patients who we know definitely should benefit and they're just denying them for whatever reason we can usually justify it.

So Medicare. So what is a Medicare slide doing in a young stroke talk? But you know Medicare guidelines, usually the insurance companies follow what Medicare does. And just because somebody's over the age of 65 it doesn't mean that they're not still living an active life. A lot of 70-year-olds are still working and living probably more active lives than many 40-year-olds.

So looking at Medicare rules for who qualifies for acute inpatient rehab. They use this reasonable and necessary standard. So basically in terms of how much care they need from the physicians, nurses, therapists, and whether or not the treatment of the stroke condition warrants that.

And then the last thing is, that it needs to require an inpatient hospitalization. So we justify that. They've come up with eight different criteria. So the bureaucracy is a huge barrier in our patient's ability to get the rehab they need. And basically the first five are pretty self explanatory.

So they need to have a medical condition which requires supervision by a physician, that makes sense, 24 hour nursing like I talked about earlier. They need a-- require moderately intense rehab therapy. So they need to-- basically need at least two out of the three disciplines. So PT, OT or speech. And then they also need to have a multi-disciplinary team approach.

On this page this is the kind of the more subjective whether or not a patient will benefit. And this is where you can usually try a appeal if they deny a patient. So whether or not they're going to be able to achieve significant recovery, they're completely dependent FIM scores of one across the board, they're not following commands. That's going to be a hard one buy.

But if they are making some progress, so even our subarachnoid hemorrhages many of them recover great if they survive. They recover very well over the first month and sometimes they are completely dependent when you initially evaluate them. But when they transfer to rehab they make great gains over the next few weeks. And these are patients we definitely should try to at least give a chance to.

The patient's goals need to be realistic. So if they were in a wheelchair before, they can't want to-- walking is probably not going to be a goal of theirs in acute rehab.

The length of the rehab program must be reasonable. So you know these days the average length of stay is less than 2 1/2 weeks. So sometimes if we know that a patient is going to take two months to get home then it'll be hard to justify the Medicare. Because they'd rather send the patient to a skilled nursing facility than to acute rehab if they know the patient isn't going to be able to return home.

Major insurance carriers. So basically same guidelines as Medicare. I've kept this fine print just like they did. But anyways so the only real differences are they still need a physician, they need skilled nursing, they need to be able to benefit from the skilled therapies.

But at the very bottom there's an expectation that they should be able to transfer to a home setting. And then they also throw in that the patient needs to be willing and able to be an active participant in these therapies.

So if your patients in the acute hospital and they're just adamantly denying that they want to go to rehab and they're not going to participate that unfortunately is also something that our case managers sometimes have to deal with in convincing them that acute rehab is in their best interest.

So choosing rehabs options is complicated. It's not just as simple as sending everybody to acute rehab. For the patients that get denied or don't qualify there are other rehab facilities. So LTACH and skilled nursing facilities which I'll talk about now.

So these are the patients who have severe strokes, maximally dependent, who may not be able to participate in the three hours of therapy or just are not medically stable. We can't transfer somebody to acute rehab if we're just still managing all their medical issues and they can't really participate in therapies because they're hypotensive or they're having active seizures all the time.

Patients that are very lethargic and not responsive. Or patients who have had multiple strokes sometimes in their premorbid functional status is basically the same. So I have plenty of patients who are in Chicago that loved acute rehab so every time they went into the hospital for a hang nail, hypertension, something. They'd say, oh I had an old stroke get me to rehab. But we can't do that because there's no significant premorbid functional change.

And then so this last line. So just because they are discharged to an LTACH or a skilled nursing facility or sometimes patients go home. That doesn't mean that acute rehab is out of picture. Oftentimes as patients recover in the LTACH they get more medically stable, we are able to reevaluate them and bring them to acute rehab later on after they've shown some more improvement.

So skilled nursing facility. So these used to be nursing homes custodial care, but now skilled nursing facilities have done a better job of providing some therapies. The quality of therapy varies depending on who owns the nursing facility and how much they want to spend. But the therapies can range anywhere between just restorative care, which is 30 minutes of passive range of motion once a day, to some facilities do a good job of providing up to three hours of therapy a day.

Physician visits depending on who's covering the skilled nursing facility vary from weekly to monthly. Nurses aides will cover the patient's 24 hours a day. I haven't covered a skilled nursing facility in a while, but I think they do need some registered nurses for part of the day. But they don't require registered nurses 24/7 like acute rehab facilities.

And then this is actually a good option for patients who may not tolerate the three hours of care you know intense therapy right away. But they still will benefit from rehab and they may need just a prolonged stay. So you know if they can do an hour or two of therapy a day and they can stay at a facility for a month or two and then eventually transfer home this is sometimes a good option for some of our more elderly patients.

LTACH. So these are usually for the more medically complex patients who are still on vents or require IV antibiotics. You know generally they'll be there for over a month. We do you get a lot of patients back from LTACHs after they've been medically optimized and they've shown some improvement during this time.

So acute inpatient rehab versus skilled nursing facilities looking at some of the outcomes. So mortality you're less likely to pass away if you go to an acute rehab facility after a stroke. There are lower readmission rates to the acute hospital, shorter lengths of stay overall and patients are more likely to discharge home.

Other outcomes that rehab facilities have to monitor are all these things. There are some skilled nursing facilities that are starting to track these things. So when you look at these studies comparing the skilled nursing to acute rehab the ones that we are comparing to are probably the 10% of skilled nursing facilities who have actually taken the time and scores. So generally when you're comparing the top 10% of skilled nursing facilities to acute rehab we-- acute rehab definitely still comes out ahead.

All right so how do we get our young patients back to work, play, all the things that they were enjoying before their stroke event?

These are all the impairments again that we have to deal with. And you could spend-- usually it takes months to years to recover. You could spend six to 12 weeks just doing one of these therapy modalities to improve their swallowing or improve their walking or their upper extremity use. But we have to kind of balance everything in our current setting.

One of the most important things as far as overall recovery and looking at outcomes and disability in our stroke survivors, is early rehab. So you know the stroke guidelines basically-- as soon as the patient is medically stable, they should be mobilized out of bed. Physical therapists, Occupational therapists in acute hospitals should be coming into their rooms and starting to work with these patients.

Generally the studies have shown that even as early as 24 hours it's generally OK to start working with these patients. And then they should be evaluated for another rehab facility as soon as possible.

And generally when OTs and PTs are working with these patients it's range of motion, preventing contractures, just getting the patients to the edge of the bed so we can start working on tolerance, sitting and standing tolerance. Getting them used to performing their own self care so they don't get this learned dependency. And then being able to transfer to the next level of care as soon as possible.

So ideally we want to couple natural recovery with the intense therapies. --studies they looked at motor recovery cohorts in Framingham and Copenhagen. And they basically tracked motor recovery, sensory recovery, and cognitive recovery. And they saw that for at the rate of the greatest recovery is usually within the first three months for motor recovery. And up to about six months for cognitive recovery.

And there was this thought from these studies that natural recovery ended at six months and afterwards there was no chance for recovery after a stroke. Which we now know is completely false. But you know when we look at natural recovery in large strokes.

So there was a Doctor Twitchell in Boston in the 1950s who basically followed stroke patients. Mostly MCA strokes. And he basically examined them every single day and these patients unfortunately didn't get any therapy. They were just bedridden. So he basically performed detailed exams and monitored which strength came back, how their reflexes responded, spasticity.

And he noticed that there was initial period of felicity, followed by synergy patterns that developed over the course of weeks to months. And then as the patient progressed through the following months, patients were able to break out of these synergistic patterns and start doing individual joint movements and more coordinated movements. Volitional movement, generally for an MCA stroke what you'll have is you'll have proximal recovery of the hip flexors first, followed by your knee, then your ankle and then you start to get your shoulder, elbow and hand.

So this is useful to set the expectations for your patients so they're not frustrated when their hands not moving, because that's the last thing that's going to come back. But it also helps our therapist's kind of guide what to do with their therapy treatment plans. Because they know what should come back next and you know what to work on.

So we talked about this briefly just out early and getting rehab early. Just so they learn not to use that hemiparetic side. This is a problem with patients who are usually right handed and they end up with left neglect. Because in these patients who write--



[AUDIO OUT]

That don't even perceive that that hand is theirs. And if your brain is not activating [INAUDIBLE] over time even though there is a chance for recovery over time it just shuts down.

So wheelchair use is another thing that we see. So patients who should be able to walk who unfortunately just sit in a wheelchair over months to years they get conditioned to sit in a wheelchair and their muscles atrophy. And it becomes very difficult to get these patients up and ambulating.

So what else matters besides early rehab intensity. So basically you can't go wrong by giving the patient more therapy. Because a lot of the neuroplasticity that happens after six months of natural recovery requires repetitive therapies and skilled therapy.

So in terms of gait speed, dexterity, hand function, being able to do ADLs, balance coordination the more intensity that a patient receives regardless of the time that they receive the therapy improves all of these things.

Obviously the milder your stroke is the more the patient is actually able to do more complex tasks with the therapist, the more benefit that they get. And then the patient's overall just the take home point from all this is regardless of the level of care they go to, whether it's an acute rehab facility, skilled nursing facility, outpatient therapies they should try to get the most intense therapy that they can tolerate.

Duration also matters. So the amount of therapy and the time. So 1992 the mean acute length of stay at the acute hospital. So a patient would spend about 10 days at Saint David's and before they were transferred to any rehab facility.

And then back in 1992 this [INAUDIBLE] patients [INAUDIBLE] three months. So our therapist had a great time with these people. Because many of our patients would be able to go home. And skilled nursing facility discharges weren't as great, but that was 1992.

Today our patients spend less than four days in an acute hospital. And they're quickly shuffled to the next level of care at-- acute rehab now we keep them for 2 1/2 months if we're lucky. We can keep some patients who are at higher disabilities up to a month. Occasionally we'll keep patients for more than that, but that's becoming more difficult.

And you see when you look at the natural recovery graphs. Nowadays we're shipping patients out when they're just kind of halfway through their most rapid point of recovery. So a lot of their recovery is taking place in the outpatient setting these days.

So compensating versus recovery. Given that we-- patients are probably from stroke onset to discharge home now they've got sometimes three weeks. So in order to get a patient home, the goals now are mostly compensation. So a lot of times we're trying to compensate for their deficit. So teaching patients hemi-technique so using their good side to dress themselves or move around the house rather than actually working on plasticity and trying to get that paretic side working a little bit better.

So for young stroke patients unfortunately they've got years to live where they have to deal with these deficits. Compensating really shouldn't be their main goal. It should be recovery of their paretic side.

So neuroplasticity. So basically neuroplasticity is reorganizations of synapses, axons of neurons. And you can do this through-- you know it's been well studied since the early '90s that through repetitive motor learning that requires skilled motor practice.

So if you're able to do something over and over again with a skilled therapist and you're able to kind of shape what you're doing with more challenging tasks over time. And if you do this enough, it has to be a constant thing every single day for several hours. You are actually able to remodel your cortex.

And there have been many imaging studies which have actually shown that when you work out your fingers, or you work on certain dexterity those areas of the brain actually expand.

Last year I talked about the squirrel monkeys where they were able to put a mitt on-- we had monkeys that basically had strokes induced. And they were able to put mitts on the good arm and forced monkeys to use their hemiparetic arm and after two weeks those areas of the brain actually expanded and they were able to feed themselves. Do everything with that hand as if they didn't have the stroke.

So we know that this is definitely possible and with all of the current advances in rehab this isn't 1992 anymore. Unfortunately we can't keep patients for three months, but if we were our outcomes would be much better right now. And the good thing to know about this, despite the limitations that we have in our current system.

This plasticity can happen at anytime. As long as you get the intense therapy. And it's been shown in constrain induced movement therapy for upper extremity function, for swallowing, for ambulation, there are things that we can do if they're able to get the intense outpatient therapy that we can get patients back.

So our younger stroke survivors. So for these patients they are able to tolerate a lot more than the three hours of therapy a day that is required. There really haven't been any good studies that said three hours a day was the gold standard for what stroke patients need. That's just something that Medicare came up with and everyone follows.

So these patients, they've got less comorbidities, they're pre morbid activity they were all functional and usually motivated. So these patients should tolerate more aggressive therapy than our 80-year-old stroke patient. So recovery should be a greater goal for these patients, given that like I said they've got many years to live. And their chances of actually gaining neurorecovery is much greater.

So I'm just going to take ambulation as an example. So about 80% of stroke survivors will regain the ability to ambulate. Unfortunately this is usually limited by endurance. And they're also not able to walk as quickly as they once were.

Unfortunately when they did the cohort studies probably less than 50% of patients at six months we're ambulating. And a lot of this has to do with just learn non-use. When you're discharged out of the acute rehab facility so quickly a lot of patients are discharged with a wheelchair. And when your discharged with a wheelchair, you end up sitting in it most of the day. So it's a shame, but most patients aren't walking.

This is comparing stroke survivors to healthy aged matched individuals who are actually considered sedentary. So comparing them to sedentary adults they're actually still walking 79% less steps a day.

So there are several therapy techniques that they can use depending on the patient's stage in their recovery. A lot of the things-- even if the patient is unable to actively move their legs our therapists are able to do a lot of things to help them try to activate. We can use functional electrical stimulation to actually help their dorsal flexures.

Fire, partial body weight support, treadmill training I'll talk about in a little bit. But it actually gets our patients upright and walking quicker. There are robots that we can use to help them walk and then the bread and butter over ground gait training that our patients are able to do. And that actually helps with dynamic balance, endurance.

Body weight supported treadmill training. It's been well studied. This is generally something that we use in stroke patients who aren't able to fully bear weight through their paretic side because of weakness. But we are able to get patients upright with a harness that basically offloads their body weight, usually about 30%. Our therapists are able to use a treadmill to perform rhythmic stepping patterns with the patients.

And over time we're able to decrease the body weight support so they're bearing more weight through the leg and getting more sensory feedback. And then we can also adjust the incline to adjust their cardiac tolerance. This is well tolerated by stroke patients. Like I said, trying to get a patient walking on the parallel bars or over ground walking when they're pretty flaccid is rather difficult. But if you can put them on a body weight support treadmill. You can get them up weeks sooner than you could otherwise.

The only problem is, it takes several therapists initially to do this. Because you usually have one therapist on each leg. And then sometimes you also have a therapist controlling their trunk. So it's very labor intensive. And unless you're in an acute rehab facility it's sometimes hard to get this therapy, despite the fact that we know that if you get body weight treadmill training over a course of 12 weeks a lot of those patients are ambulating afterwards. Closer to that 80% that was on the earlier slide.

There have been three studies that have looked at high intensity interval training over the years. They still use a treadmill but they don't use any AFOs or braces. They basically have the patient walk at the highest speed that they can tolerate without any thought about whether or not that kinematics are correct, or the body mechanics are correct. And this is because they thought that most stroke patients aren't getting the cardiac, the work out that they should be getting. And it's leading to more risks for MIs after a stroke. And also recurrent strokes.

So they've done a few studies at RIC. They're doing one where they're coupling this with SSRIs or antidepressants to see if it actually improves recovery. But one of the biggest benefits is these patients are taking a lot more steps than conventional therapy. So in general sometimes regular PT sessions you'll walk 100, 300 steps.

But if you are on a treadmill and you're walking as fast as you can you're generally getting thousands of steps. And that's thought to increase neuromuscular recruitment. It also increases your cardio fitness. Gait speed has been shown to be improved with these studies and also endurance.

Last year I talked about this patient at RIC. He was enrolled in one of the studies and he spent about three months in acute rehab. And afterwards he was able to walk out. He had a large vessel stroke with complications and there's-- after three weeks there's no way he would have been walking out of any hospital.

But fortunately he was able to get three months of therapy, which a lot of our patients aren't able to get. But this was actually Senator Kirk. And I have permission from his office to use these pictures, so we're not violating any HIPAA regulations.

All right so the continuum of care. So this-- one of the barriers is after acute rehab the intensity of therapy just drops. Just because they're not getting the three hours, at least three hours of therapy a day. Generally they'll come back for two or three sessions a week.

The therapy sessions are usually limited by insurance caps or Medicare caps. So even the duration of therapy that they're allowed to get are limited. So OT-PT sessions are limited to 20 sessions per year depending on their diagnosis. So just getting two hours of therapy, three hours of therapy a week to work on ambulation isn't going to make significant difference. Unless you've got great therapists, which fortunately we do have here.

And day programs have sprung up across the country. Day programs in the outpatient setting is probably the best thing that we have as far as intensity for stroke recovery. So we're able to get patients back to a day program that's probably their best bet for not having a significant drop off in their function after they leave the acute hospital.

So there have been a few post acute rehab facility that I want to talk about. Because these actually provide a huge benefit for brain injury patients, young strokes who are physically able, but have a lot of cognitive deficits which make it difficult for them to return back to independent living.

But post acute rehab facilities, these are residence where patients have their own either apartment or unit. And they basically receive up to six hours of therapy a day and they work on a lot of things that the acute hospital doesn't have time to work on. Because they can focus on the vocational training and getting patients back into the community. So they can do a lot of community outings, getting them back on buses and practice doing things that they normally would do once they're discharged.

Outpatient therapies, like I mentioned, so day programs are great because usually we can get blocks of therapy. So for a whole morning stroke patients can come back. Their loved ones can drop them off for the day. They'll still get their PT, OT and speech and it's all blocked together. [INAUDIBLE] would have in acute rehab. [INAUDIBLE] is almost the same.

Unfortunately depending on their insurance these things can be capped. So ideally we'd be able to do it four, five times a week. But sometimes we have to space it out so they're able to get the therapies while they're still going through that natural recovery. Which can be up to six months. So you don't want to just kind of blow through all their therapies in the first two months, when they still have so much time to recover and benefit from the therapies.

Home health therapies. So for the patients who aren't able to actually get transportation to go home or go to the outpatient setting. There are a lot of home health agencies now that are developing programs for stroke survivors.

A lot of them can do speech therapy at home, they've got social workers they can obviously do the PT and OT they just don't have access to all the equipment that an outpatient facility would have. But some of them can do vital stimulation for dysplasia. And one of the benefits is they get to practice in their home environment. So it is functional. They're able to do things in their own bathroom. They can practice in their kitchen. They can practice doing things getting in and out of their bathtub or going up and down their stairs. So it has some benefit.

So more intensity is needed obviously. A lot of the high intensity modalities that we have that have been shown to improve function, so CIMT, which is Constrained Induced Movement Therapy. The initial studies, the Excite trial where they looked at stroke patients over a year out from their stroke. So this is well past the period of natural recovery. But they took patients and they basically did the same squirrel-monkey test on these patients. And they constrained their good arm and forced them to use their paretic arm for six to eight hours a day and coupled that with skilled therapy.

And the patients who actually made it through that study at the end of two weeks. So they were getting therapies five days a week for six to eight hours which was constrained, but they got skilled therapy for an hour or two where they focused on shaping and working on more difficult tasks.

At the end of two weeks the patients that made it through the study, completely regained their hand function. So this is a lot of the theories that we get about neuroplasticity happening well after six months comes from a lot of these studies.

Treadmill training. So we've got plenty of patients-- I've seen plenty of patients in the outpatient clinic who have been in a wheelchair. But they have five out of five knee extension, there's really no reason that they shouldn't be able to transfer, they shouldn't be able to advance their leg. But they've just been in a wheelchair for months, years. And several of these patients have been able to walk after coming back to our day program.

Intensive aphasia program. So at RIC there was a aphasia program that patients were enrolled in that usually lasts between somewhere between six to 12 weeks. And these were for patients who weren't globally aphasic but sometimes had various mixed aphasia's or expressive aphasia's and high intensity training, it also works for that as well as dysphagia.

So a lot of our high intensity dysphagia programs for our brain stem strokes who have difficulty swallowing if they just go through five days a week of therapies at the end of four weeks a lot of patients are going to be able to swallow. Even though the medullary strokes or the pontine strokes that typically take longer if you put them through high intensity training. Many of them are able to get rid of their peg tubes and swallow and drink normally again.

6,000 steps program is something that we started this year for our stroke survivors at Saint David's. And basically there have been studies in Japan and Canada that have looked at ambulation. So I talked about how stroke survivors are walking 80% less than sedentary adults. So many stroke survivors aren't walking anywhere near 6,000 steps.

But when they did studies in the Japanese and Canadians, for stroke patients who actually walked over to this 6,000 threshold they had reduced risk of recurrent strokes and MIs in these patients. So every single stroke patient I tell to get a pedometer, start walking and reduce their future risks of strokes.

So transitioning back to the community. A lot of times patients are lost to followup. Motivation is a huge issue. So once you're at home and you're sitting at home and you don't have the motivation, you don't have your great therapist pushing you every single day to therapies you need to have somebody to follow up with them. It's the same thing, CHF patients or anybody who just needs to be monitored. Daily weights, take your Lasik if you need it.

Same thing goes with stroke recovery. If you go home and you don't use it, you're going to lose it. But if you are able to follow up and do this on a regimen basis you are going to be able to recover at least some of your function. At least maintaining.

So as far as returning to work. So this is usually a huge goal for our young stroke survivors. About 20% of strokes survivors are of working age. And less than 40% of them are able to return to their previous job. 20% are able to return with some sort of job modification. And many times it's the physical, cognitive, communication impairments that keep them from doing this.

So as far as what we're able to do. Positive predictors of being able to return to work in our stroke patients. So how flexible are your employers to being able to modify your job description? Are they able to limit how much you're able to work? Are they OK with you coming back part time? And slowly working your way back into it.

Younger patients are able to get back to work compared to older patients. And then in the studies the patients that were higher educated and also white collar jobs were able to return. But a lot of that is a function of physically they can still sit at a computer and type or talk and go to meetings.

And then vocational rehab programs. These are beneficial for our young stroke patients. Vocational programs will be able to take their job description and our therapists OTs and PTs and speech therapists are able to work on the task that they were once able-- required to do. So if it's typing or lifting certain things, or climbing ladders a lot of vocational programs can do that.

Negative predictors of returning to work. So when they cited what kept patients from going to back to work. So even if they were physically able to, a lot of patients complain of cognitive memory issues that kept them from going back to work. Severity of stroke, obviously the more severe your stroke is the less likely you're going to recover enough to get back to work.

And then age. Over the age of 65. Patients that were already thinking about retiring are less likely to go back to work. And obviously if you've got a family to raise and bills to pay you're going to be more motivated.

As a caveat if you had disability insurance that also was a negative predictor of whether or not patients returned to work. So in countries when they did international studies in Europe where they don't have as much disability those patients there were higher return to work rates.

And this last slide. So as far as returning to work, a lot of times young stroke patients are eager to get out of the acute hospital. They're eager to get out of rehab, they want to get back home. But their full time job for the next months, years, is really just focusing on stroke recovery and investing all the time necessary to recover as much as possible so they don't have to deal with the deficits that they may incur if they decide to cut their rehab short.

So in summary, the incidence of our strokes in the younger population are increasing even though it's still a sliver of the overall stroke in America. There are huge impairments with high individual and economic costs.

Significant barriers exist limiting access to care and also duration and access to the skilled therapies that are required to maximize recovery. And obviously regardless of where they're going for rehab the highest intensity matters. Recovery is a full time job. And then long term followup is needed to maximize recovery.

[APPLAUSE]