

Lokomat Clinical Report

Where leaders in rehabilitation of neurological disease & trauma tell how they enhance care with the Hocoma Lokomat

Shepherd Center blends manual & robotic locomotor therapy for state-of-art SCI, TBI rehab

The Shepherd Center in Atlanta is the nation's largest catastrophic care hospital specializing in the treatment of people with spinal cord injury and disease, acquired brain injury, multiple sclerosis and other neuromuscular disorders and urological problems.

Shepherd Center, located in the Buckhead community of Atlanta, Georgia, is a private, not-for-profit hospital devoted to the medical care and rehabilitation of people with spinal cord injury and disease, acquired brain injury, multiple sclerosis and other neuromuscular problems.

One tool of Shepherd Center program is the Hocoma Lokomat[®], a driven gait orthosis used for robotic treadmill training of neurological patients with movement disorders.

In this issue of Lokomat Clinical Report, Shepherd therapists Candy Tefertiller, MPT and Leslie VanHiel, MSPT tell how they use the Lokomat in Shepherd Center's world-recognized rehabilitation programs.

Before Lokomat: Manual locomotor therapy

You received your Lokomat in December of 2005. Before then, how did you provide gait training for your SCI patients?

Tefertiller: Before we got the Lokomat, the patients in my program were trained on the manual bodyweight supported treadmill system.

Some of those patients were what I would consider more traditionally-appropriate patients for the modality, as in they were motor incomplete spinal cord injuries meaning that they had movement below their level of injury.

However, some of those patients had undergone stem cell surgeries or were only sensory incomplete spinal cord injuries and had no movement below their level of injury. Those patients





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were often very difficult to manage on a manual system because their legs were so flaccid.

Manual locomotor therapy works well for appropriate patients. Patients for whom it is not appropriate include those who are obese, those who have considerable spasticity, and those whose muscles are very flaccid. Manual locomotor therapy can be very demanding with those types of patients causing considerable physical stress on the staff providing this type of treatment.

The best Lokomat candidates: Those with at least some movement below their injury

You’ve described the patients who aren’t good candidates for manual locomotor therapy. Who are the best candidates for Lokomat therapy?

VanHiel: The best candidates for robotic locomotor therapy with the Lokomat are in the post-acute period and just starting to get small amounts of movement back in their legs. I work only with patients who have movement in their legs (motor incomplete injuries). These are the patients that have the highest probability of functional gains and walking.

Typically, they can’t yet support very much of their body weight. They have to be able to stand in a standing frame or tilt table without getting dizzy, for 15 or so minutes.

Tefertiller: I think one of the biggest contributions the Lokomat has made to our center is that it allows me to get almost any patient upright and mobilized soon after they are medically stable. I’ve had patients with

diaphragmatic pacers – patients who had once been vent dependent – up and walking in the Lokomat. I don’t think I could handle or manage those types of patients on a manual system.

Are there any notable contraindications to Lokomat therapy?

VanHiel: The factor you most have to consider is the loss of bone density that commonly affects very chronic spinal cord injuries.* But as long as a physician gives the go-ahead for full weight-bearing on their lower extremities, we’ll get them on.

Lokomat encourages more appropriate manual locomotor therapy

Now that you have a choice between manual locomotor and Lokomat therapy, how has that impacted the Shepherd protocol for gait training SCI patients?

Tefertiller: Having a Lokomat gives us options for providing locomotor therapy to a wide variety of patients who may not initially qualify for manual locomotor therapy due to their level of impairment.

When we only had access to the manual therapy system, we were using it four hours a day, three days a week. In order to successfully complete four straight hours of manual body weight supported treadmill training, we would need to have four to six people prepared to assist due to the physical demands resulting in therapist fatigue.

However, it doesn’t always have to be just certified physical therapists completing the training. Often, it’s two physical therapists, two techs, and two trained volunteers. That’s about the minimum staffing necessary to get through four hours of continuous training without being over-fatigued. Our goal is to get 30 minutes of stepping each session, for each patient.

The Lokomat assures that we can get that, no matter what our staff availability is on a particular day, or in the presence of patient conditions that can complicate manual locomotor therapy such as spasticity and/or hypertonicity.

**For a complete list of potential contraindications for Lokomat therapy, please visit www.hocoma.com.*



Abnormal tone, stiffness no obstacle to Lokomat therapy

You mentioned that patients with spasticity are difficult to manage with manual therapy. How does the Lokomat handle spasticity?

VanHiel: One of my main concerns about using the Lokomat was how it would handle spasticity, because our patients just seem to have so much spasticity. And so, when we were considering it, I sent emails to some of the experts in locomotor therapy – Dr. Field-Fote in Miami, Matt Elrod at NRH, and Dr. Hornby at RIC, asking, “How does the Lokomat handle spasticity?” – and all of them said, “No problem, it goes right through it.”

Nevertheless, I had to try it for myself. And sure enough, it stopped when it needed to, but even if I resisted it quite a bit, it went right through the movement. It didn’t bother me. It felt fine. It felt natural. Some of our patients with severe spasticity really fatigue the team on manual locomotor training, but they look beautiful on the Lokomat. You get a nice pattern while they’re on the Lokomat, and their active range will improve a little bit when they get off, because they’re looser.

Potentially useful for evaluating spastic, stiff patients

VanHiel: I would like to regularly use the evaluation tools on the Lokomat, especially for stiffness. Ideally, I would do some pretesting stiffness testing, have them do Lokomat every day for however long, and then do a post-exercise stiffness test.

I also would like to study how the Lokomat affects them by using functional tests in the regular environment and at home. Lokomat training does seem to loosen folks up. I believe that, if the Lokomat can have a positive effect on their spasticity, it predicts our potential to change their spasticity with either Lokomat or manual treadmill training. And that’s a great forecaster of what we can accomplish with patients.

Tefertiller: I see both acquired and traumatic brain injured patients. I have one patient right now who has an acquired brain injury that I keep on the Lokomat instead of the manual system because he is very, very hypertonic, and he has a

very slow and spastic gait pattern. I feel like I can get him a faster and more consistent gait pattern within the constraints of the Lokomat than I can on the manual system, just because his hypertonicity prevents us from really being able to give him a nice fast pattern with manual locomotor therapy.

Shepherd Center Facts

Shepherd Center has 100 beds, including an eight-bed intensive care unit and a 20-bed acquired brain injury unit. Each year it admits more than 850 patients, with a length of stay averaging 4-6 weeks. It averages nearly 30,000 outpatient clinic visits annually.

The Shepherd Spinal Cord Injury program provides a continuum of care to those who have sustained any level of spinal cord injury – paraplegia, quadriplegia (including those who are ventilator dependent) or dual diagnosis (spinal cord and brain injury). Its Acquired Brain Injury Rehabilitation Program includes an early-recovery unit that begins treating patients immediately after their injury. It also has a coma-stimulation program and a program for ventilator-dependent patients.

The Beyond Therapy Program at Shepherd Center focuses on promoting lifelong wellness and maximizing muscle and neural return, especially weaker muscles and nerve connections that may have been ignored in the initial phases of recovery. The Beyond Therapy engages the concepts of athletic training and neuroplasticity, which is the belief that the spinal cord can adjust itself functionally by reorganizing neural maps and allowing some recovery of lost abilities. For more information, visit Shepherd Center online at www.shepherd.org.



Candy Tefertiller, MPT

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Lokomat vs. manual locomotor training?

You’ve described some of the advantages of manual over Lokomat therapy, and Lokomat therapy over manual techniques. Is the choice obvious when you first encounter a new patient?

Tefertiller: The choice of using manual versus robotic Lokomat therapy on a specific patient isn’t always obvious.

The literature generally suggests that the EMG patterns patients can generate on the manual system are more similar to those in

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normal ambulation than the EMG patterns most patients will generate on a Lokomat. That would suggest that, if a patient can demonstrate return during manual locomotion, and I think that I can safely manage them on the manual system, I would prefer to put them on the manual system rather than the Lokomat system.

But it’s worth noting that, even though the EMG patterns are more similar to normal ambulation on a manual system, that’s not been uniformly correlated to greater improvement in function.

In fact, Patricia Winchester at the University of Texas Southwestern published the results of a study¹ in which she put ASIA Cs and Ds on the Lokomat, and she showed significant improvements in gait velocity – a main outcome measure that we look at – as well as decreased assistive devices needed for ambulation.

When we first received the Lokomat, my instinct was to put all of my patients who had undergone stem cell surgeries and those who were classified as ASIA B spinal cord injuries directly on the Lokomat system, because their flaccid leg muscles make them notoriously difficult to manage with manual locomotor therapy. And then I evaluated each ASIA C and D patient on a case-by-case basis, to determine which system was best for each.



If my ASIA C and D patients had significant spasticity or if they were obese and I didn’t feel like we could successfully manage them on the manual system, then I would put them on the Lokomat system.

Managing patients who are very obese on the manual system is physically too taxing for us, and sometimes raises safety considerations. I feel such patients are better handled on the Lokomat until they are strong enough to be transitioned to the manual system.

In conclusion, if a patient has a lot of voluntary control, and I believe our team can successfully manage them on the manual system, I’ll give them manual locomotor therapy. But if I’m struggling to manage a patient manually because of spasticity or obesity, or if I don’t have the staffing on a particular day to give an otherwise manual therapy patient their normal session, I will put that patient on the Lokomat and provide appropriate training parameters to facilitate all active voluntary-type movements and use the biofeedback display to monitor their effort.

Early locomotor training: More than gait benefits

Obviously, locomotor therapy, whether manual or via Lokomat, can enhance the gait of patients with SCI. But are there other, non-gait-related reasons for starting with whichever system can be employed first?

VanHiel: The Lokomat provides the opportunity for most patients with SCI to initiate locomotor therapy early because it provides the trunk and hip stability they usually need to get started.

Starting on Lokomat gets them upright. You can loosen the trunk straps so that you can start to challenge trunk stability, but they’re still safe. They’re not going to flop over. They’re getting that rhythmic motion and it’s very consistent. And they’re getting some weight-bearing through their legs.

By contrast, when we transition them to the manual system, they have to be prepared to handle suspension from a spreader bar on a single-axis cable, which has a rotational component. They need to maintain stability with trunk control and arm swing. They don’t hold onto anything. Just like with the Lokomat, we don’t like them to hold onto anything. The only time I support their arm is if they have a shoulder subluxation or for some reason, their shoulder is so weak that the gravity is actually detrimental to the joint, so that’s when I might put their arm on the rails.

But otherwise, everything has to be working through the trunk and legs.

That’s when and how we initiate therapy on the Lokomat. We transition to manual locomotor therapy when trunk control and movement in the legs increase to the point where we can work with the patient safely on the manual system and maintain a good stepping pattern.

Manual therapy: More challenging to patients, if they can handle it

How does a session on the Lokomat compare to a manual locomotor therapy session?

VanHiel: Manual therapy is different from Lokomat therapy because it makes the patient work harder – a *lot* harder. It almost always makes patients sweat, and I have only gotten a couple of people to sweat on the Lokomat.



The difference is mostly because the ones that start on the Lokomat are the ones that don't yet have a lot of movement. They're just starting to take advantage of that initial movement, whereas the ones who are on the manual version have a lot more movement that they can take advantage of. And we're making them really work much more. So they're more actively exercising their trunk, legs, coordination, and symmetry – everything that goes into gait at one time – whereas exercise on the Lokomat is more restricted in the hips and generally less active.

Remember, we put patients onto a Lokomat because they or their doctors have reported that “something is changing.” My goal with the Lokomat is to get his or her nervous system “woken up.” We want to see them get more recovery in their legs, and see if we can get anything else to fire...to strengthen what is firing, and hopefully, to enable them to support more of their body weight.

Ideally, we get them to the point on the Lokomat where they can stand on their own, and perhaps even take a step with one leg. It's more the amount of movement that they're getting rather than achieving a specific body-weight support

percentage. If they can hold up half of their body weight with fair to good trunk posture and be able to have some movement in their legs with about 25 to 50 percent supported, I usually judge them ready for transition.

That's when I really want to switch them to manual therapy, because that's when I need to work on trunk more. I need to work on their core stability via their trunk and hips, which can't be done well on the current models of Lokomats, which constrain hip motion in favor of encouraging step motion and improved weight support.

Once they're that much stronger in one or both legs, I want to really make them work harder.

To optimize Lokomat therapy, PTs must be very proactive

Clearly, in administering manual locomotor therapy, therapists are literally “hands on.” How active must the therapist be in Lokomat therapy?

VanHiel: To get patients most rapidly to the point where they can graduate to manual therapy, I believe the therapist has to be very actively, and perhaps, aggressively involved in therapy when a patient is on the Lokomat.

I'm very verbally encouraging. I wouldn't say I yell at patients, but other people in the gym tend to look over.

At the end of a session, when you get them off the Lokomat, they typically say, “Whew! I can really feel that!” And that's when I feel like they've really taken advantage of what Lokomat has to offer. As long as they're cognitively there, when they're on the Lokomat, and everything else is looking good, I'm barking at them the whole time. Of course, you have to be careful of spasticity.

Early post-acute Lokomat therapy: What impact?

You mentioned that one of the advantages of the Lokomat is that it enables you to begin locomotor therapy for many patients earlier in the post-acute period than possible with manual therapy. Have you seen any immediate benefits or impact on outcomes?

VanHiel: Probably no specific *immediate* clinical benefit. But for those patients to be upright and walking, and doing something that they used to do before their injury, is psychologically *huge* for them.

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I think the Lokomat also gives me so many more options to assure continuity of care. Say I have a patient who is very spastic. Perhaps, I might not have the staffing to assure I could get them up and on the manual system much more than once a week, because it is so taxing on the team. But with the Lokomat, I know that I can get them up as many times a week as I need to.

So I think the Lokomat allows me more room in my clinical decisionmaking, because it enables me to give patients more options for their care.

Patient case: Large ASIA C patient too big for manual therapy

Can you give me an example of a patient who you couldn't handle with manual therapy, but successfully managed with the Lokomat?

Tefertiller: One Lokomat patient I recall was injured about three years before he came to our program. He was an ASIA C, so he had a little bit of movement below his level of injury, but not a lot, and he was still in a power wheelchair, fulltime. He was completely dependent for transfers, so his wife was using a Hoyer Lift to get him in and out of his bed and wheelchair. He was a C-5 ASIA C, but he was completely dependent for all activities of daily living (ADLs) and mobility. He'd been in and out of our regular outpatient system for those first three years after his injury and had been unable to make any significant functional improvements.

One of his problems was that he was very large. He was six-foot-four and weighed about 280 pounds. Therefore, trying to manage somebody like that during manual locomotor therapy is very difficult. During the first two weeks in our program, I tried to stand him with four people. But even with four of us, we were not able to achieve full upright posture. Therefore, we instituted Lokomat therapy, three times a week. He also started working with the Functional Electrical Stimulation (FES) bike three times a week, and core strengthening including

aquatic therapy three times a week. So again he was getting nine hours of therapy a week, including these different modalities.

After about two months, he was able to stand using a walker with two of us, and then by the end of seven months, he was able to walk about 150 feet with the walker and just one of us, but it was a special walker that he could use his arms to bear some of his weight because the problem was that after being injured for so long, his Achilles' tendons had really shortened because he hadn't been standing. He then underwent surgery to lengthen both tendons, and now he's come back to work with us again. We've now started over again with the Lokomat, and will transition to the manual system once he gets stronger.

Now, he's not walking at home yet, but he is able to transfer independently there. He's able to get in and out of a tub bench at home – which, for somebody who's taken a bed-bath for three years, is a very big deal. I think if you asked him, he'd tell you he'd rather be able to take a shower than he would be able to walk during the day. So those things are pretty exciting. He's also just recently gotten back to driving and is independently driving to and from therapy on a daily basis, which he would have never dreamed of during the first three years of his injury.

Patient case: Managing a spastic patient on Lokomat

Both of you have mentioned spasticity and flaccidity being challenges to locomotor therapy. Can you recall patients who show how the Lokomat can handle them?

Tefertiller: One example of a very spastic patient is a 38-year-old man who was originally diagnosed with an ASIA B spinal cord injury, who, when I first met him, had no movement in his lower extremities. He had been seen as an inpatient at Shepherd, but when I met him, it was eight weeks after his injury.

Generally, if you don't see any movement below the level of injury during those first eight weeks, a lot of times the literature will tell you, you're not going to see any movement. This was before we had the Lokomat, and he wasn't appropriate for the manual system yet because he didn't have any movement. Therefore, we started him on the FES bike, and toes started wriggling on both feet, five sessions after we started.



But then, he got very, very, very spastic. We tried to initiate manual locomotor therapy, but we couldn't manage him because he was too spastic. Shortly after the Lokomat arrived, we began locomotor training with it — and after 16 sessions, we were able to transition him back to the manual system. Now he's a fulltime community ambulator. He walks with two straight canes all the time. He doesn't take his wheelchair with him anywhere anymore even when he travels out of the country.

VanHiel: You need to think of using Lokomat not only for folks who have spasticity and are hard to move, but also for those who are hypotonic — for example, some chronic patients. Their joints can be floppy, which makes them also very hard to control on the manual treadmill, especially if they're large because your hands can't control the whole aspect of a large knee, especially my hands — I'm tiny. But it can be tough for patients of any size.

I'm thinking of one particular patient — a younger, fairly small woman, whose joints were very hard to control. Her knees were extremely lax and would go into hyperextension during manual locomotor training. Despite her being very loosey-

goosey, she did have movement. But her joints were so loose that her movement wasn't strong enough to be able to control them.

So I put her on the Lokomat and the first thing she said was, "Oh, my joints feel like they're where they're supposed to be every step of the way." And she was right — in fact, her joints were in the perfect position for every step consistently. It wasn't like one step was good, and the next three were not so good. Every one was correct.

Patient case: 60 year old sheds KAFOs and walker

Most of the examples of Shepherd Center patients you've mentioned started Lokomat therapy in the early post-acute phase. Can you recall any chronic SCI patients who improved significantly after Lokomat therapy?

VanHiel: An example of such a Shepherd Center patient is a 60-year-old man classified as ASIA C, referred to us when he was an outpatient. When he came to us, he was walking on the ground with a walker and bilateral knee ankle foot orthoses (KAFOs).

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And so, he was blocked at his ankles and his knees. But he had movement in his legs, so his therapist wanted to get him up, wanted to try walking more independently. He had progressed to being able to unlock one of those KAFOs. So, one knee was getting stronger. Plus, he was developing good trunk strength.

Despite those assets, he still had to work hard, because he tended to lean forward – walkers tend to habituate that posture, and of course, you’re sitting all day. People in his state tend to walk flexed over.

And so, one of our first objectives of his Lokomat therapy was to improve his posture. He worked hard on getting those muscles firing and that rhythmic pattern, obviously very consistently. His therapy encouraged him to get lots of steps in, in a short amount of time.

This patient spent 12-15 sessions on the Lokomat. His biofeedback was stronger, he was getting more movement, and his posture looked good. He received ten more sessions in manual locomotor therapy, and continued in occupational therapy for about two more

months, working to improve his walking over ground. He slowly lost those braces, and now he walks with no braces.

Reference

¹ Winchester P. et al. Changes in supraspinal activation patterns following robotic locomotor therapy in motor-incomplete spinal cord injury. *Neurorehabil Neural Repair* 19: 313-24, 2005.



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