

Lower Extremity Review

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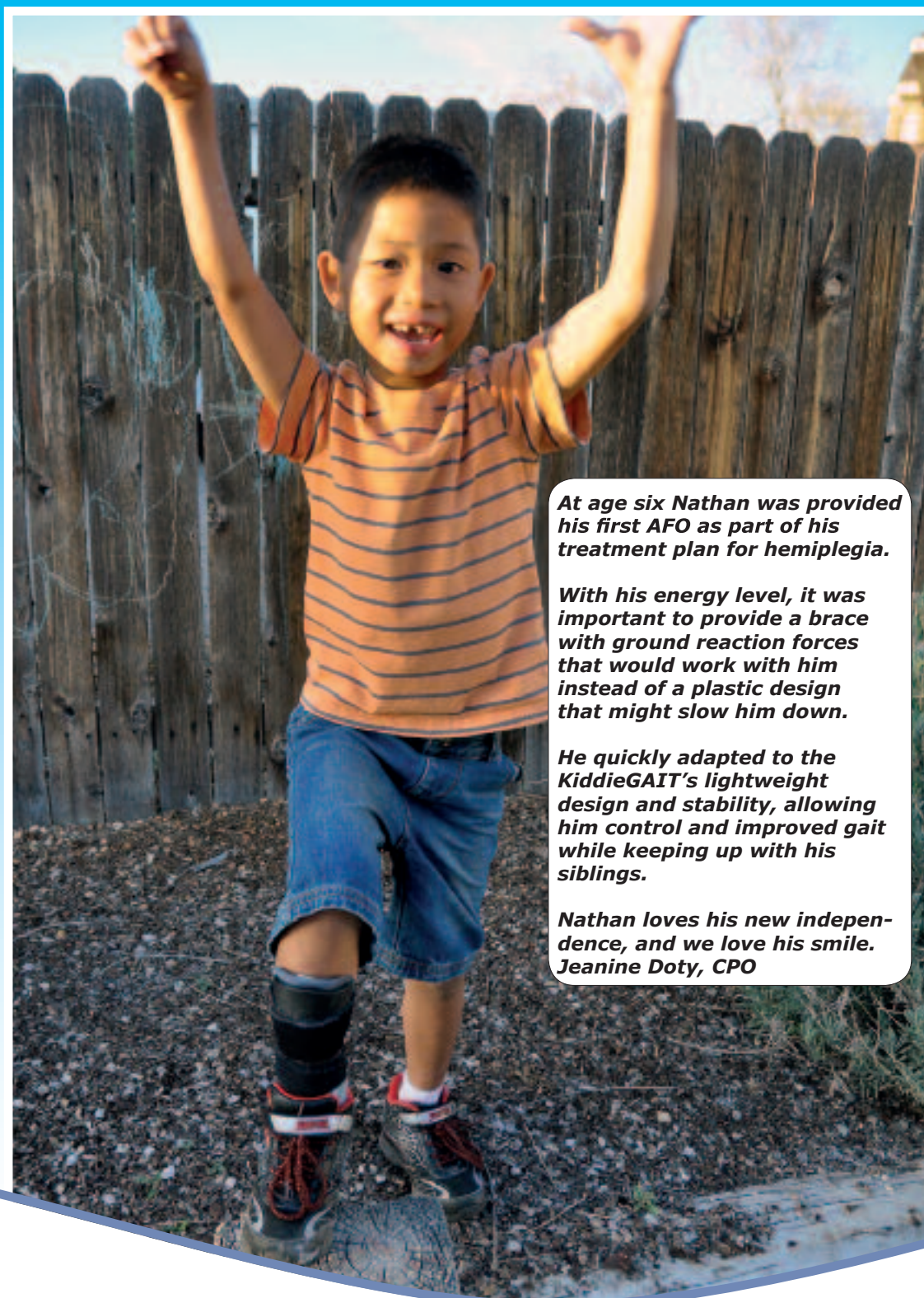
**Therapeutic play plus O&P
care is a win-win for kids**

**Path of least resistance:
Sequencing orthotic care**

PLUS:

- Autism and motor skills training
- AFOs, calf muscle length in CP
- Home-based ACL injury prevention

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17 Path of least resistance: Sequencing orthotic care

The higher profile the device, the more it perturbs movement, and sometimes kids reject such orthoses because of discomfort or unwieldiness. Starting with the least restrictive device and responding to subtle changes in children's orthotic needs may improve outcomes and compliance.

By Hank Black

From the editor: Making it personal



Personalized medicine, holistic care, and patient-centered management can all imply slightly different things, but beneath the differences one central tenet is the same—the importance of tailoring treatment to individual patients' unique conditions, needs, and goals.

In this issue several articles discuss some of the varied ways in which lower extremity practitioners are taking an individualized approach to orthotic management of young patients, who are undergoing rapid physical changes, developing interests, and facing other childhood challenges.

Karl Barner, CPO, LPO, for example, notes in "Therapeutic play plus O&P care is a win-win for kids" (page 11), that attending some of his patient's sports events and watching them in those environments helps him better understand their reality—and perhaps adapt their braces or orthoses for a better fit.

In "Path of least resistance: sequencing orthotic care" (page 17), experts note that how restrictive a device needs to be can depend on factors other than a child's specific diagnosis, such as how much follow-up or physical therapy their personal situation will allow. If compliance or follow-up is likely to be limited, for example, keeping that child safe might mean heavier bracing makes more sense.

And, in "AFO effects on gastrocnemius underscore heterogeneity of CP" (page 7), the author of the study reviewed says her research highlights a need for adjustable, adaptive devices that make use of flexible design, smart sensors, and machine learning algorithms so they can change as the needs of the wearer change.

Whether it's delving into a child's personality to discover why they aren't wearing their brace or getting parental feedback to understand how a child is functioning in a real-world setting, lower extremity practitioners have many opportunities to get to know their patients as individuals—and to adjust their care accordingly. Doing so can mean better outcomes—and happier, more active patients.

Emily Delzell, *Senior Editor*

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Early motor skills training in ASD improves locomotion, socialization

Intense therapy creates quick gains

By Peaches Scribner

Intense motor skills interventions in young children with autism spectrum disorder (ASD) can significantly improve locomotor and other lower extremity skills in addition to socialization behaviors, according to a recent pilot study.

Most evidence-based interventions for young children with ASD target core deficits in social and communication domains, but ASD-related motor delays emerge as early as age 6 months. Motor skills therapies can address these deficits before others emerge, said lead author Leah R. Ketcheson, PhD, director of operations at LightUp.Shine.Now, an organization in Ann Arbor, MI, providing research-informed programs to individuals with special needs.

"Motor skills interventions have cascading effects toward secondary domains and can result in a host of positive outcomes in communication and social skills," she said.

The study included 20 kids aged 4 to 6 years with ASD; 11 received an eight-week motor skill intervention four hours a day, five days a week, with a 1:1 instructor-to-child ratio. Nine children in the control group were instructed to continue typical activity and did not receive the intervention; both groups underwent speech, occupational, and social skills therapy.

Strategies from Classroom Pivotal Response Teaching (CPRT), an evidence-based therapeutic model designed for teachers and paraeducators, provided the framework. Investigators tested children in familiar places, such as playgrounds or fields. Allowing children to choose their favorite ball color and size and using fun games such as kicking a ball around cones and modified relay races appealed to the children and kept them engaged.

Ketcheson and colleagues used the Test of Gross Motor Development-2 (TGMD-2) biweekly to measure locomotor skills (eg, running, hopping, jumping) and object control skills (eg, striking a stationary ball, stationary dribble, catching, kicking, throwing).

After only two weeks, the children in the experimental group demonstrated a significant increase in locomotor and object control skills and in gross quotient (a composite measure of both skills categories). Participants' locomotor improvements plateaued

between weeks four and eight, and object control skills improved during the first two weeks but demonstrated nonsignificant changes between weeks two and four, four and six, and six and eight. A significant gain in locomotor skills also occurred between weeks four and eight.

The researchers assessed socialization changes in the experimental group every other week during the intervention. Significant improvements were achieved in proximity and peer-to-peer engagement, but not across all domains. Children spent significantly less time in solitary activities, and time effects approached significant changes in two domains.

Motor skills therapies can address ASD-related motor delays, which can begin at age 6 months, before others emerge.

Retention of improvements was high for motor skills and socialization skills one week postintervention, with only a slight drop when measured at four weeks. One week postintervention the control group demonstrated slightly improved motor outcomes, but these changes weren't sustained through the fourth week. Ketcheson attributed the temporary change to test and tester familiarity.

To describe physical activity (PA) for both groups, researchers used an accelerometer, capturing pre- and postintervention data at weeks one and four. Although PA changes were nonsignificant, both groups met or exceeded guidelines for moderate and vigorous PA recommendations of 60 minutes a day but were sedentary for at least eight hours a day.

Autism republished the results in June.

"Improvements took much less time than we thought," Ketcheson said. "Most changes occurred in the first four weeks, indicating that intensity is needed only as initial therapy, with maintenance therapy requiring an hour a week." Follow-up can be done




Children in the experimental group run through part of the motor skills intervention. (Photo courtesy of Leah Ketcheson, PhD.)

realistically in a variety of settings without being burdensome, she said.

"What is exciting about Dr. Ketcheson's findings is that, with the right support and instruction we can improve motor skills very early, and in a fun and playful atmosphere that will keep children engaged," said Megan MacDonald, PhD, assistant professor in Movement Studies of Disability at Oregon State University in Corvallis. MacDonald studies similar interventions for children with disabilities. (See "Early focus on gross motor skills may benefit children with autism," August 2014, page 6.)

This therapy can be delivered in a classroom setting or during summer sessions and vacation time, through community centers, in gym spaces, and on sports fields, making it widely accessible, said Ketcheson. She hopes to narrow the gap between ASD diagnosis and treatment, which can be as long as a year.

Children with ASD often have associated conditions such as hypotonia, or they may be diagnosed with other disabilities affecting muscle strength and coordination. Ketcheson said the CPRT framework can be effective as a foundation for other therapies or be implemented simultaneously.

Early childhood is a sensitive time in development, and motor researchers have an opportunity to improve motor skills very early—even as young as 2 years, said Ketcheson. Early intervention may give children with ASD the ability to play and interact in age-appropriate ways with their peers entering kindergarten. Early intense motor skills instruction within a CPRT framework can be a valuable addition to practitioners' intervention strategies aimed at improving social success for children with ASD, she said. 

Peaches Scribner is a freelance writer in Washington, DC.

Source:

Ketcheson L, Hauck J, Ulrich D. The effects of an early motor skill intervention on motor skills, levels of physical activity, and socialization in young children with autism spectrum disorder: a pilot study. *Autism* 2016 June 26. *Ipub ahead of print*



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AFO effects on gastrocnemius underscore heterogeneity of CP

Variations call for adjustable devices

By Greg Gargiulo

Outfitting pediatric cerebral palsy (CP) patients with two types of ankle foot orthoses (AFOs) elicited various effects, as the medial gastrocnemius operating length in some—but not all—participants was consequently stretched while walking, according to a recent study.

These changes may contribute to improving overall function, but the outcomes more directly highlight the need for adjustable and adaptable devices when managing such a heterogeneous population, said coauthor Katherine Steele, PhD, an assistant professor in the Department of Mechanical Engineering at the University of Washington in Seattle.

"This study is our first foray into understanding the effects of current clinical options and AFO prescriptions for kids with cerebral palsy, and it shows that these orthoses led to different responses in patients in terms of how they influence ankle plantar flexion function," said Steele.

The findings of this case series, which was a secondary analysis of data from a 2015 *Pediatric Physical Therapy* study conducted by Children's Hospital Los Angeles, were published in September 2016 by *Prosthetics and Orthotics International*.

In the original study, researchers investigated the gait-related effects of two different AFOs—a dynamic AFO and an adjustable dynamic response AFO—on 11 children with CP. Individuals wore each orthosis for four weeks, and several parameters of their gait were analyzed with an eight-camera infrared motion-capture system at baseline and after each interval (one participant was excluded from the first study's final analysis).

For the secondary analysis, Steele and her colleagues focused primarily on the operating length and velocity of the commonly impaired medial gastrocnemius in all 11 patients (six in Gross Motor Function Classification System Level I, five in Level III).

Both AFOs led to similar changes for Level I participants, with four of six experiencing increased peak medial gastrocnemius operating length during gait compared

with barefoot walking and no significant changes occurring in peak musculotendon velocity. Knee hyperextension was the only undesirable change detected, as one patient reported it with the dynamic AFO and two with the adjustable dynamic response AFO.

The dynamic AFO was associated with increased peak medial gastrocnemius operating length in all but one Level III participant, while the adjustable dynamic response AFO was in three of five. Both orthoses were associated with decreased peak medial gastrocnemius lengthening velocity (except for one participant's right side), and no

"We can hopefully create devices in the future that adapt, learn, and grow with each individual."

-Katherine Steele, PhD

Level III patients had knee hyperextension with either AFO.

"I don't think there are direct clinical recommendations that come out of our work, partially because at this point we really don't know what is good when it comes to ankle plantar flexor length in particular, and more generally, what the operative length of muscles should be in daily life," Steele said.

To Steele, the incidence of knee hyperextension in certain patients also underlines some of the potential kinematic consequences of focusing on medial gastrocnemius stretching during gait.


"I think that's a good example of some of the compensatory effects that you can see, because stretching the muscle may be helpful, but if it doesn't have enough length then something has to give," she said. "It's all these competing effects that make the orthotists' and therapists' jobs so challenging when it comes to treating these kids."

"The cerebral palsy patient population



is heterogeneous, so they have their own goals, and we're trying to drive their goals around what their needs are," said Christopher Joseph, DPT, director of physical therapy at the Kennedy Krieger Institute in Baltimore, MD. "Gastrocnemius length is definitely an important factor for us to focus on as physical therapists, but it's one of many, and I would say that it's probably lower on the priority list. We also want to focus on improving patients' function and ability to walk further and faster with better balance, and we evaluate each AFO to make sure it's energy efficient and not putting too much stress on their bodies."

Given their findings, Steele and her colleagues are continuing to investigate the effects of different AFO stiffnesses on medial gastrocnemius function, and to use ultrasound to better assess the relative stretching of muscle and tendon.

"We've used the ultrasound on unimpaired individuals and stroke patients, and our next goal is children with cerebral palsy, which we think will give us an even more in-depth answer of the impact on muscle function," she said. "For now, the most important thing is that our designs are adjustable and adaptable to meet the diverse needs of these patients. By using smart, wearable sensors, machine learning algorithms, and adaptive devices, we can hopefully create devices in the future that adapt, learn, and grow with each individual." 

Greg Gargiulo is a freelance medical writer based in San Francisco.

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Home-based ACL injury prevention program fails the compliance test

Oversight, feedback may up buy-in

By Chris Klingenberg

The idea of injury prevention training in the comfort of one's own home is appealing on many levels, and researchers at the University of Wisconsin-Madison are taking steps toward making that type of training feasible and effective for young athletes.

In a recent pilot study on home-based, DVD-delivered training to prevent anterior cruciate ligament (ACL) injuries in female high school athletes, compliance with the protocol fell far short of the researchers' expectations, but they have identified potential opportunities for improvement.

"Coaches could monitor compliance," said Jill Thein-Nissenbaum, PT, DSC, SCS, ATC, who is an associate professor in the Doctor of Physical Therapy Program at the university and first author of the study. "For the study, the coaches could not know who was involved in the actual study being done. But I think athletes would be more compliant if they thought it might affect playing time."

During the 2012-2013 school year, nine high schools in Wisconsin were selected by convenience for study participation. Sixty-six girls who planned to go out for basketball participated in the study, which was conducted in the weeks prior to the basketball season. The majority (40.90%) were in grade 9; the fewest were in grade 12 (13.64%).

The eight-week injury prevention program was designed by the authors, based on the Prevent Injury and Enhance Performance (PEP) supervised training program. Researchers from the Santa Monica Orthopaedic and Sports Medicine Foundation in California, who designed the supervised PEP program, have found it effectively reduces ACL injury incidence in female collegiate soccer players, and Korean researchers found it effective for improving ACL injury risk factors in female high school basketball players.

"PEP has been studied in adults as well as fifteen- to eighteen-year-olds," Thein-Nissenbaum said. "They used the same routine in all of their studies. We had the video designed such that the individual simply had to mirror the DVD (like an aerobics work-out), so

the cadence and repetitions did not have to be counted by the subject."

The DVD-based program was designed to progress the athletes' strength, balance, and jumping and landing technique with minimal risk of injury. Each training session was approximately 15 minutes in length and was composed of three components: strength training, plyometrics, and balance. The athletes were instructed to do the training three times a week for eight weeks.

After the eight weeks, 27 of the 66 athletes completed a compliance survey and

"Lack of education regarding the value of performing injury prevention programs is very common."

-Darin Padua, PhD, ATC

provided feedback on the program. About half (52%) of respondents said they did the training once a week or not at all over the eight weeks. The main reason for poor compliance was lack of time, followed by failing to remember to participate.

Seven respondents (27%) said they completed at least 12 training sessions during the eight weeks, meaning they received at least half the target dose. Most of those athletes said they thought the training would improve their strength and balance and would make them better basketball players.

The findings were published in February by the *Wisconsin Medical Journal*.

Although the athletes in the Wisconsin study were not given reminders to prompt them to do the training, the authors noted that a 2007 Canadian study of high school basketball players reported low compliance with home-based balance training despite regular face-to-face reminders.


Similarly, though the importance of the training for injury prevention was briefly addressed on the DVD, further education of the athletes and their coaches could help



improve compliance, said Darin Padua, PhD, ATC, professor and chair of the Department of Exercise & Sport Science and codirector of the Sports Medicine Research Laboratory at the University of North Carolina at Chapel Hill.

"Lack of education regarding the importance and value of performing an injury prevention program is very common and perhaps a weakness of much research in the area of ACL injury prevention," Padua said. "We need to do much more to understand how to effectively implement these programs to get more widespread adoption and long-term compliance."

Athletes might also be more compliant if their home-based training included feedback about whether they were performing the exercises correctly, he suggested.

"Utilization of technology to track movement quality, such as a camera or Kinect or other wearable technology, may be very helpful," Padua said. "Feedback on movement quality is a critical component to an effective prevention program, so the ability to automate feedback while doing a program at home could be very effective." 

Chris Klingenberg is a freelance writer based in Massachusetts.

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Therapeutic play plus O&P care is a win-win for kids

O&P practitioners are working with recreational therapists to open doors to leisure activities for kids with lower extremity issues and other disabilities. By expanding their playtime experiences and skills, kids can boost their physical activity, mobility, self-confidence, and social connections.

By Brigid Elsken Galloway

Mimi Miranda grins as she is helped into a bright red kayak. Nearby, Ashley Miranda watches with pride as her daughter grips the oar and begins to glide across the pool. The 10-year-old typically uses a device to communicate, but it's easy to understand that Mimi is thrilled with her accomplishment. She doesn't think of it as work, or therapy, but it is. Although she's moving toward the goal of building muscle and improving mobility, to Mimi, she's just doing what kids do best: having fun.

For children with lower extremity issues like Mimi, who was born with bilateral schizencephaly resulting in quadriplegic cerebral palsy (CP) and has dystonia and leg length discrepancy, the ability to participate in adaptive sports and other recreational activities is not just another play date. The activity provides them with a way to strengthen muscles, socialize with peers, and challenge themselves to reach beyond their mobility challenges.

Many pediatric O&P patients are interested activities that they and their parents aren't sure how to make possible; recreational therapists can help find solutions that help children feel more connected to their communities and become more physically active, said Michelle Hall, MS, CPO, a prosthetist-orthotist in the Department of Assistive Technology at Gillette Lifetime Specialty Healthcare in St. Paul, MN.

She and recreational therapist Kaitlin Lewis, CTRS, presented a talk last March on collaborative opportunities for O&P practitioners and recreational therapists at the American Academy of Orthotists and Prosthetists Annual Meeting and Scientific Symposium in Orlando, FL.

Therapeutic recreation (TR, also known as recreational therapy) helps challenge the patient to expand their mobility in ways that O&P specialists might not consider, said Hall. "[Often] when we think recreation, we think sports, but it's much more than that," she said, noting recreational therapists connect patients with community resources for all types of activities, including visual arts, dance, and hobbies.



Taking part in a variety of TR activities helps Mimi build muscle, mobility, and relationships. (Photos courtesy of Ashley Miranda.)

By focusing on the context in which a mobility device will be used, recreational therapists may help push patient abilities beyond orthotists' considerations.

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This child gets water-based TR to strengthen his lower extremities for greater mobility on land. (Photo courtesy of Robyn Winston Cohen, CTRS.)

Although they live an hour away in the suburbs, the Mirandas frequently drive to Washington, DC, for Health Services for Children (HSC) Kids in Action programs. Ashley Miranda believes it's well worth the commute. "Mimi gets the opportunity to be part of a team where she's involved, and everyone's skill level was around the same range," Miranda said. "It's helped her self-esteem, because now she knows she can do this activity. At school not everything can be adapted for one child. Being in a setting where things are adapted and she can take part helps with her confidence. When you're at a Kids in Action event, everyone is trying their best and no one stares at you. Mimi can be herself."

Holistic approach

Eight years ago, Robyn Winston Cohen, CTRS, founded Kids in Action after families expressed frustration with the lack of opportunities for kids with disabilities to play sports and participate in other recreational activities. Cohen funded the first adaptive T-ball and soccer sessions out of her own pocket. The kids—and their parents—loved it. Soon the program was formalized through HSC and sponsors came on board.

Today, Kids in Action provides a variety of adaptive sports and social activities for children and young adults with disabilities four years and older and their siblings. The events, supervised by recreational therapists, physical therapists, (PTs), occupational therapists (OTs), speech therapists, and assistive technology practitioners, aim to increase physical abilities, including gait, stamina, strength, and balance. The programs provide more than exercise, however.

"If you ask any of my kids if they are doing any sort of therapy they would say, 'No,'" Cohen said. "If you were to ask a patient in

PT, they might say they are having fun, but they know they're working on a therapeutic goal. With therapeutic recreation they're just having fun, enjoying themselves. We focus on similar goals to those of physical or occupational therapy, but in a fun way. A kid's job is to have fun and play—no matter what their disability is."

Last year, more than 200 children participated in the Kids in Action programs, which include adaptive sports such as tennis, archery, lacrosse, basketball, kayaking, and bocce ball, as well as other recreational activities, such as Teen Night with dancing, cooking, karaoke, and movies. For Cohen, the goals of therapeutic recreation are far reaching.

"I'm focusing on the big picture, which includes socialization, self-esteem, fine motor skills, and mobility," Cohen said. "Yes, we're playing basketball, but I'm also thinking about how else will it benefit the child when they get home. What life skills are they learning? I look at their entire picture to see how they will function in all areas of their lives. It is more than simply adapting action sports; it's about being a part of a community, creating opportunity, and opening the doors of possibility for the future."

"You have to treat the whole child," echoed Dana Dempsey, MS, CTRS. "We want to make sure kids with amputations or other lower extremity issues get involved in meaningful play, recreation, and leisure," she said. "Therapeutic recreation helps give children back their childhoods."

As director of therapeutic recreation at Texas Scottish Rite Hospital for Children in Dallas, Dempsey develops and oversees programs that serve 400 to 500 children a year from across the state and around the country.

Scottish Rite's activities aim to improve balance, coordination, and stamina. But they also serve an important role in helping to provide an environment for socialization for children with ambulatory issues. In addition, recreational therapists serve as a touchstone for TR resources and information, educating parents about programs that may benefit their child after they leave the hospital or clinic.

"In therapeutic recreation at Scottish Rite, we focus on the social model approach," Dempsey said. "While the individual has a medical condition that negatively impacts his or her functioning, large barriers to participation lie in the environment that doesn't accommodate the individual, or the attitudes or beliefs about the individual with the disabilities."

This child gets into a walker and orthoses to try new sports, which recently included lacrosse. (Photo courtesy of Robyn Winston Cohen, CTRS.)



Continued on page 14

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To break down barriers and maximize a child's participation, recreational therapists may work with orthotists and prosthetists after a child expresses interest in participating in specific sport or activity and parents need to locate adaptive programs. Likewise, the recreational therapist may contact an O&P specialist when a patient experiences difficulty participating in an activity with his or her existing brace or prosthesis.

"For example, if a child is an amputee and wants to ride a bike, we might contact his prosthetist to see what type of foot components to use for the child's prosthetic so it can clip into the bike pedal," said Dempsey. "We can also help the family connect with recreational activities once the child has a brace or prosthetic device, so it's a matter of using recreational activities to improve functional skills."

Likewise, if a child expresses an interest in participating in a particular activity, an orthotist or prosthetist may refer patients to TR to help them locate adaptive sports activities that will be appropriate for the patient and help accomplish his or her goals. Together, TR and O&P practitioners often find creative solutions that allow their young patients to overcome challenges.

"As clinicians, we try to encourage our patients and figure out ways to help our patients meet their goals, whether that's being active in community or at camps or making a device that's adaptive to their needs," said Karl Barner, CPO, LPO, NCOPE (National Commission on Orthotic and Prosthetic Education) residency director at Children's Healthcare of Atlanta.

Beyond fitting them for lower extremity devices, Barner often takes a personal interest in his young patients by attending their sports events and encouraging them to reach their adaptive sports goals. He said watching his patients perform activities in the sports environment helps him better understand their reality.

"Many clinicians become involved in TR camps where we can see how the kids are involved in activities," Barner said. "That allows us to come up with different designs. If a child is struggling doing an activity, we might have to adapt their braces or orthoses for a better fit, or find a company that makes a device that specifically meets the need. For example, we source a company who makes shoes and a prosthetic foot designed specifically for rock wall climbing."

Team work

A growing number of O&P clinicians are connecting the dots between the practical application of the devices they fit with how their young patients participate in typical leisure activities. Some health-care systems are encouraging the team approach between O&P and TR.

At Gillette Lifetime Specialty Healthcare Kaitlin Lewis and Michelle Hall find practicing under the same roof—literally right down the hall from one another—has great advantages for their patients. "Our scope of practice overlaps with therapeutic recreation," Hall said. "Before we had recreational therapists, if a patient came to us wanting to go horseback riding, we would have to search for outlets in the community. Now the recreational therapist keeps up with those resources and fields those questions."

Because they are focused on the context in which a mobility device will be used, the recreational therapist may also help push



AFOs and a walker allow this child to cover long distances on the playground and in the community. (Photo courtesy of Robyn Winston Cohen, CTRS.)

the limits of the patient's abilities beyond the orthotist's considerations. "We look for red flags, such as if the patient says, 'The device fits great but I'm struggling when I play soccer in it,'" Lewis explained. "If it's not a fit issue, we would look at their technique. The patient might just need more practice using the device. Or there also may be stigma using the new device. If a patient isn't compliant, often a recreational therapist can dig deeper to find out what's going on and come up with ideas for how the patient might be able to reduce the stigma."

Lewis and Hall appreciate the ability to work together in close collaboration, which allows both prosthetist-orthotist and recreational therapist to meet the needs of the patient on a practical level. "Now I think about things differently," Hall said. "I ask questions about what the patient likes to do in their free time and if they're having any difficulties. It makes me more aware of the global needs of the patient and helps me address those needs. It also helps the patient advocate for themselves."

Hall, who also conducts research and serves as Gillette's prosthetics residency director, developed this list of questions to help her colleagues assess their patients with an eye toward recreational needs. These questions may include:

- What do you do in your spare time?
- Are there things you can't do that you'd like to do?
- Are you having difficulties with those activities?
- Is it some activity we can help you accomplish by making adjustments?

Measuring success: The fun factor

Although it's part of many pediatric patients' regimens, measuring success from therapeutic recreation can be complicated. "You can't just measure muscle strength and see if there's improvement," Dempsey said. "But we have other tools."

Dempsey cites a postparticipation survey among parents of kids who participate in Scottish Rite's Learn to Golf program. Approximately 70% of the kids who participated in the program have continued playing golf. Parents reported their children's coordination improved and they were more confident and more willing to try new activities (unpublished data).

"Others report their child shows physical improvement or improved social skills, or better concentration," Dempsey said. "Plus, there's the added benefit in that they feel more connected to something bigger than themselves because they are part of a team."


At Kids in Action, Robyn Cohen and colleagues measured outcomes of adaptive swimming participants through before and after surveys that tracked the child's water safety awareness and swimming skills. The recreational therapists tracked the progress of eight participants with CP and spina bifida in three 10-week courses. Overall, participants showed an average of 31% improvement in swimming skill scores and 49% improvement in water safety awareness (unpublished data). Cohen attributes the success of TR to two important factors. "If you want a kid to succeed they have to have buy-in and have fun," said Cohen.

Ultimately, the TR approach may not only help young patients have more fun, but also provide them with motivation for compliance with the use of their orthosis or prosthesis. It also allows kids



Seeing other kids wearing braces in RT activities made Mimi more willing to wear hers. (Photo courtesy of Ashley Miranda.)

to have social interaction with their peers who have mobility challenges. For Mimi Miranda, who attends a mainstream school, the opportunity to interact with children with mobility disabilities similar to her own inspires confidence.

"It's helped her become a stronger person," said her mother. "For example, Mimi used to hate wearing her braces, but when she saw other kids wearing them at Kids in Action, she changed her mind. Knowing that other children wear braces—not just her—is significant. When you face limitations every day, it's important to be part of a group where accommodations aren't even an issue. When Mimi is at Kids in Action, she doesn't have to think about it, she just has fun." 

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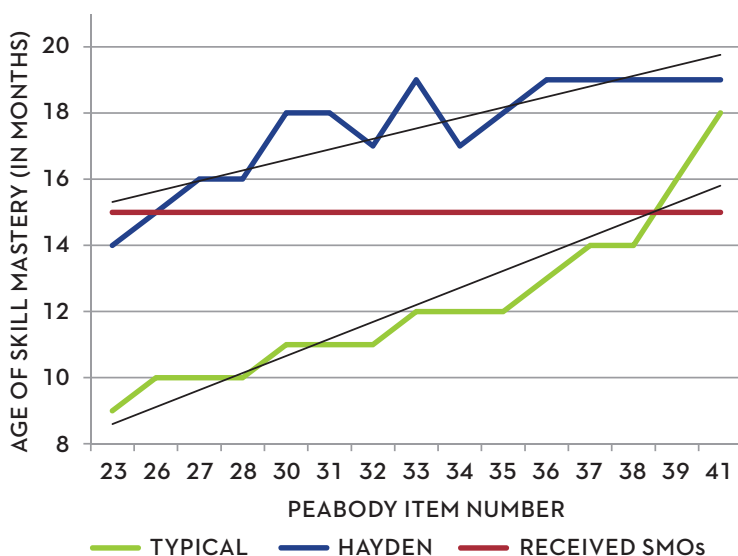
Hayden was prescribed SMOs at 15 months old. At the time, she demonstrated pronation and hypotonia. She could pull to stand but not was yet taking independent steps.

In addition to SMOs, she received physical therapy once a week for the duration of the study. Her parents reported Hayden wore her SMOs an average of 12 hours a day, seven days a week.

Four months after receiving her Surestep SMOs, she was walking independently and mastered eight to nine months of gross motor skills.



Gross Motor Skill Mastery Over Time



PEABODY ITEM DEFINITIONS

- | | |
|--|---|
| 23 Pull to stand with support | 35 Walking 5 steps with no hands held (independent) |
| 26 Cruising - 4 steps | 36 Standing, picks up toy from ground, stands up and takes 3 steps |
| 27 Lowering to sitting without falling | 37 Creeps up 2 steps |
| 28 Takes 4 steps with trunk held | 38 Walks 10 feet with narrow base of support, has heel-toe gait for half the distance |
| 30 Standing - child will let go of table and stand for 5 seconds | 39 Creeps down 3 steps backward, without support |
| 31 Standing - away from table, child will stand for 3 seconds | 41 Walking fast |
| 32 Stepping - 4 steps with one hand held | |
| 33 Standing up from ground without turning more than 20° | |
| 34 Walking 8 feet with one hand held | |
- Source: Folio MK, Fewell R. Peabody developmental motor scales and activity cards. Chicago: Riverside Publishing; 1983.

Background: Each child in the case series was assessed every other week for 16 weeks to determine mastery of items 23, 26-28, 30-39, and 40 (ranging from "pull to stand" to "walk fast") on the Peabody Developmental Motor Scale. Test instructions were modified as needed for children to understand them. Parents were included in each session and encouraged to play with the child in order to demonstrate the targeted skills. Graphs illustrate age of mastery for each item number for the hypotonic child compared to a "typical" child, with linear trend lines illustrating rate of change, and demonstrate the improved mastery of skills after prescription of supramalleolar orthoses (SMOs).



Photo courtesy of Surestep.

Path of least resistance: Sequencing orthotic care

The higher profile the device, the more it perturbs movement, and sometimes kids reject such orthoses because of discomfort or unwieldiness. Starting with the least restrictive device and responding to subtle changes in children's orthotic needs may improve outcomes and compliance.

By Hank Black

"Sequential orthotic management" is a relatively new term, but most lower extremity clinicians who treat children are very familiar with the philosophy it describes. The approach may go by other names, but at its root, it is the belief that a patient should be fit with the least cumbersome orthotic device possible, such as a low-profile in-shoe foot orthosis, and then gradually progressed to higher-profile or more supportive orthoses if more stability or durability is needed.

"Essentially, it's 'less is more,'" said Faye McNerney, PT, DPT, C/NDT, a pediatric physical therapist in Troy, OH. "If you use an orthosis that is too high on the leg, it weakens muscles from disuse, and you're just harming the normal gait cycle. I tend to start with the least possible orthotic support."

There is scant scientific literature on this topic, but researchers from the Georgia Institute of Technology in Atlanta used the term "sequential orthotic treatment" to describe treatments for idiopathic toe walking (ITW) in their recently published randomized controlled trial.¹

In that study, nine children wore foot orthoses with an attached carbon fiber footplate, and an equal number wore articulated ankle foot orthoses (AFOs). They were evaluated before treatment and after six weeks, when they stopped wearing the orthoses. Both groups showed significant improvement in kinematics compared with baseline, with the AFO group exhibiting better control at initial contact than the foot orthosis group. Once the devices were removed, however, the AFO group did not immediately maintain the improvement, while the foot orthosis group did. In addition, parents preferred the foot orthoses for ease of use and appearance.

The authors suggested that, because both devices produced benefits, treatment might begin with the less restrictive device. If the foot orthosis proved unsuccessful after a time (eg, six weeks), the patient could be advanced to an articulated AFO.

The timing of the switch from a foot orthosis to a higher-profile device is primarily based on whether the child is progressing functionally, said Kinsey Herrin, CPO, who was a coauthor of the study

The predictable nature of many pediatric conditions leads some practitioners to use orthoses proactively, further extending the scope of sequential orthotic management.

while a student at Georgia Tech, and who now practices with Ortho Pro Associates in Miami.

“Close monitoring of the clinical presentation, such a maintenance of range of motion and strength, are important factors that help determine the course of orthotic treatment,” Herrin said.

Parental feedback on how the child is walking in a nonclinic environment is also helpful, she said. And of course, she said, sequential orthotic treatment exists beyond the diagnoses of idiopathic toe walking and other lower extremity impairments. “We sequentially treat plagio/brachycephaly by recommending repositioning first and then later using a cranial remolding orthosis,” Herrin said.

Cylie Williams, BAppSc(Pod), MHLthEd(HlthProm & Ed), PhD, an adjunct research fellow in physiotherapy at Monash University in Victoria, Australia, has studied the use of orthotic devices for ITW as well as calcaneal apophysitis.^{2,3}

“When there are smaller, less-clunky options on offer, it is always preferable to keep a kid out of an AFO. Once they are in an AFO, it’s hard to take them out,” Williams said. “I often will consider a carbon fiber plate or even a foot-up, which is a soft, modified AFO that connects to the shoe. Basically I’m a big fan of progressing to AFOs as slowly as possible with kids because those devices are just so hard for them to play in.”

Predicting progression

Awareness of the possibility of sequencing orthoses to achieve more management options requires continual assessment and reassessment of the patient when observing mild-to-moderate gait-related impairments and disability, McNerney said. Such issues can emerge even when a child’s care is consistent with published foot care guidelines,⁴ and might warrant graduated, sequential orthotic treatment.

Some practitioners will also use orthoses proactively, further extending the scope of sequential orthotic management. Assessment technologies such as magnetic resonance imaging, ultrasound, and electromyography can help to identify early anatomical damage caused by inflammatory or other processes and allow clinicians to intervene with an orthosis to prevent or minimize pain or deformity.⁵⁻⁷ Fairburn et al demonstrated that the use of ultrasonography and instrumented gait analysis in patients with juvenile idiopathic arthritis (JIA) allows both specific lesions and functional deficits to be detected and targeted with customized orthoses in addition to physical therapies and steroid injections.⁷

The predictable, progressive nature of the pathogenesis of some pediatric conditions also can help the practitioner look for opportunities to make subtle changes in orthoses.

Children with Charcot-Marie-Tooth (CMT) disease, for example, experience a very specific sequence of muscle loss that leads to predictable deformities, said Ken Cornell, CO, who practices with Cornell Orthotics and Prosthetics in the Boston area.

“Because we can predict how the disease is going to progress, we can brace the immature skeleton to prevent the deformity from happening or at least slow it down,” Cornell said. “We can predict, for example, the development of a plantar-flexed first ray in CMT. It’s going to happen, so we can brace to mitigate that deformity, at least in magnitude. Someone who is just beginning to get into problems with the disease and still has plenty of strength and normal sensation, might be started with something simple inside the shoe, like a little SMO, to put forces in place to prevent deformity from progressing.”

Although practitioners can draw on a growing body of research to help guide sequential orthotic management in children with progressive conditions like CMT (see “Orthotic management: A symptom-based, dynamic approach,” in *Orthotic management of CMT: Dynamic solutions for active lifestyles*, *LER* May 2015 supplement, page 8), clinical experience remains a key part of the process.

“Experience and expertise help a lot, over time, to enable us to actually get better at predicting progression of disease,” Cornell said. “Basically, if you recognize that the patient has a muscle imbalance or weakness in a certain direction, you know which way that’s going to go and you can brace for it, hopefully before it is too late.”



Photo courtesy of Surestep.

McNerney, who has almost 40 years of experience in her field, agreed that a high level of clinical knowledge can help with decisions about when to transition a patient to another device.

“It’s not easy, until you’ve developed the experience, to just know when things need to be modified,” she said.

Over-bracing

One of the most common reasons for starting pediatric patients with the least restrictive orthosis and proceeding in a reasoned, incremental manner is to avoid over-bracing the child.

“Over-bracing is much more prevalent than under-bracing,” said Louis DeCaro, DPM, who practices with DeCaro Total Foot Care Center in West Hatfield, MA. “I believe most patients are way over-braced because practitioners do not pay enough attention to the specific needs of the foot position. I see children aged one to three come in with a diagnosis of ankle collapse where the previous treating practitioner simply makes an AFO or SMO, either because their

knowledge of the foot contribution is weak or, frankly, because reimbursement is greater with an orthotic above the ankle.”

Correcting calcaneal valgus and limiting abduction goes a long way in such cases, DeCaro said. For initial bracing, he employs a prefabricated 30-mm depth UCBL (University of California Biomechanics Laboratory) with lateral flanges and medial skive that he designed.

“Nine times out of ten this allows the ankle to recreate itself, and the leg will stand up erect without the need to intervene above the ankle,” he said. “When a device is correctly posted, everything else falls into place.”

Children often find above-ankle devices uncomfortable to wear and in need of frequent adjustment, DeCaro said.

“No joking, probably eighty percent of patients who come to me with a brace end up in a UCBL, because they’ll have more comfort, better range of motion [because their ankle is freer], and better subtalar joint motion, and they and their parents are much happier,” he said.

Many clinicians also try to avoid over-bracing within the AFO category. Cornell called carbon fiber bracing a “game changer” in delaying or eliminating the need for a solid AFO in some patients.

“You literally can restore all three stance phase rockers, eliminate foot drop in swing phase, and control the proper amount of transverse plane rotation. So with all that, you basically are normalizing the motion of the foot and ankle,” he said.



Compliance and collaboration

How heavily to brace a patient may also depend on factors outside the evaluation and diagnosis, according to Karl Barner, CPO, LPO, and NCOPE (National Commission on Orthotic and Prosthetic Education) residency director at Children’s Healthcare of Atlanta (CHOA).

“If the patient is getting good, regular therapy with a lot of follow-up, we can go with less of a brace than if the patient has minimal or no therapy and follow-up,” Barner said. “Otherwise, for the child’s safety, we might need to be a little more conservative and give them a more supportive brace.”

Even then, if the more conservatively treated child improves, the brace can be adjusted to make it less rigid or supportive, he said.

“In addition, if there is a really compliant parent, compliant patient, and compliant therapist, the orthotist has more options in treating,” he said. “If we have very minimal compliance, we put in a little more conservative treatment, and, again, mainly for safety.”

CHOA therapists work with some ITW patients week in and week out to help them maintain range of motion in the foot and ankle, Barner said.

“If we can get good results that way, sometimes we can make a less-invasive type of device, such as a foot orthosis with a carbon plate under it and, obviously, a good pair of shoes,” he said.

McNerney echoed Barner’s emphasis on collaboration between therapists and orthotists, especially with regard to children whose orthotic needs may change over time.

“That interaction is really important. We need to trust each other as professionals and be open to discussion about what’s best for an individual patient,” she said. “We all have to keep our eyes on the child’s functional status and how they are changing. For example, if a child needs stability and is fitted with an AFO, then later gains stability, I will discuss the issue with the orthotist. The orthotist typically can trim it down to the level of an SMO.”

Anticipating change

Sequential orthotic management is well served by the idea that devices are designed with anticipation of change in mind, Herrin said.

“For example, this allows a patient who needs the stability of a solid-ankle AFO to start with a blocked articulated AFO and later progress to an articulated AFO with a simple cut of the posterior aspect of the orthosis,” she said.

Adjustability has long been a cornerstone of prosthetic device design, and similar features can be incorporated into orthotic devices for patients whose needs may change, Barner said.

“We consider those from the get-go if we clearly anticipate the patient either improving or worsening,” he said.


Modifying an orthotic device to make it smaller, more flexible, or less supportive is usually easier than trying to make a device larger or more rigid, Barner said.

“If a patient’s condition worsens even with the orthosis and they begin to need something more substantial, we either need to add to the brace or make an entirely different one to give support,” he said.

That might mean, for example, transitioning from an AFO to a KAFO (knee ankle foot orthosis) to improve stability during standing and walking despite weakened muscles.

Research needed

Clinical support for sequential orthotic management so far is outpacing the publication of scientific evidence on which to base decisions related to device progression. But there are also signs that this may be starting to change.

A recent meta-analysis⁸ of foot care interventions for patients with JIA called for more well-designed clinical trials to suss out the relative benefits of various orthotic interventions for pediatric patients and help develop clinical standards. Specifically, the panel suggested investigation of how use of foot care management options can be improved to increase therapeutic effect—findings that could potentially help shape the future of sequential orthotic management. 

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References are available at lerpediatrics.com.

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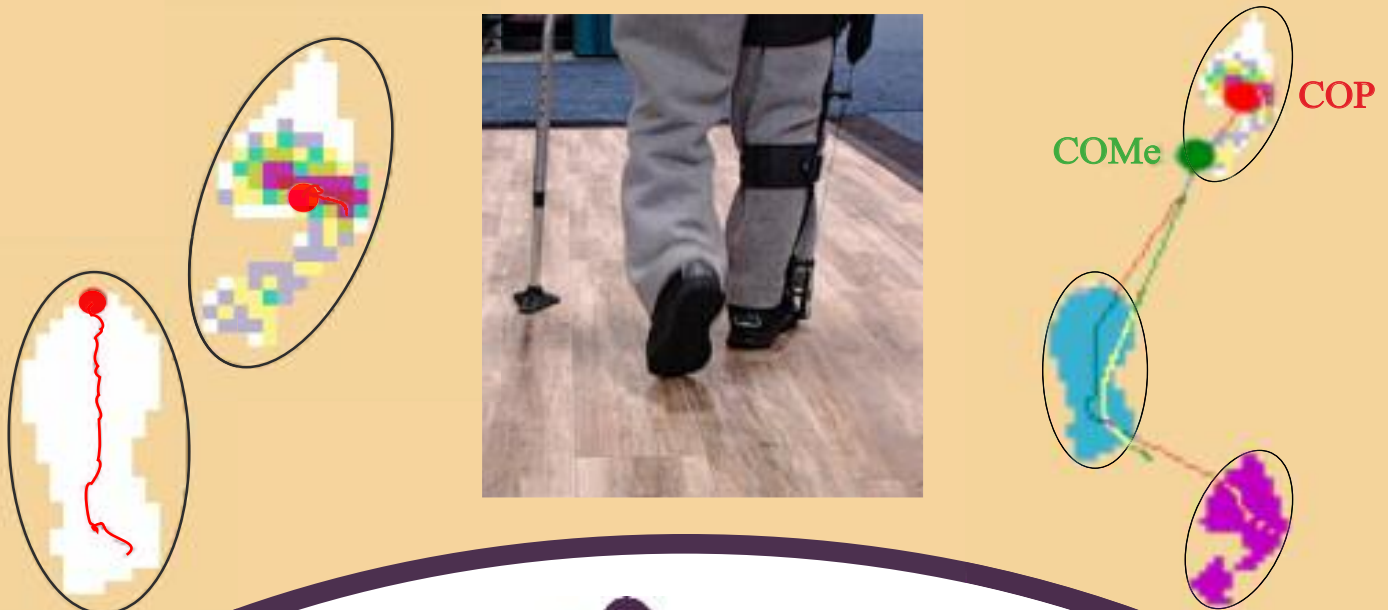
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