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Fall Prevention, Part IV: Interventions

By Carol Marleigh Kline, JACA Online editor

In this final segment of our series on fall prevention, we look at devices that may help stimulate proprioception and encourage better balance in older adults. They range all the way from space-age technology to re-purposed household items.

Contributors to this segment include Dennis Enix, DC, MBA, assistant professor, research division, Logan College of Chiropractic, St. Louis; Ted Forcum, DC, DACBSP, president of the ACA Sports Council and in private practice in Portland, Ore.; Michael Rogers, PhD, CSCS, FACSM, professor in the department of human performance and research director at the Center for Physical Activity and Aging at Wichita State University in Kansas; Tom Hyde, DC, DACBSP, former president of the ACA Sports Council and co-author of *Conservative Management of Sports Injuries*, Asheville, N.C.; and Lisa Killinger, DC, professor and chair, diagnosis and radiology, Palmer College of Chiropractic, Davenport, Iowa.

Whole-Body Vibration

The Russian Space Institute, the European Space Agency, and NASA are all experimenting with whole-body vibration (WBV) to counteract the muscle atrophy and bone loss caused by lack of gravity on space flights—conditions commonly found not only in high-flying astronauts but also in sedentary, Earth-bound older adults. Researchers are looking at WBV for older adults to build bone mineral density, increase muscle power, and work with postural control and balance.¹⁻⁸ That said, the quality of WBV devices varies. Benefits described in the better studies are not universally available, in part because no industry-wide WBV rating system exists.

One WBV device is the Power Plate™ vibration platform, as described by Dr. Dennis Enix. “This form of mechanical vibration, typically in frequencies between 30 and 60 Hz, produces an involuntary reflexive muscle contraction, stimulating joint mechanoreceptors, Pacinian corpuscles, Meissner corpuscles, and free nerve endings. The muscle response occurs across a broad spectrum of vibrational frequencies; however, studies suggest that maximal contraction is at higher frequencies. There is evidence

that short, repeated bursts, such as 50 seconds on, 5 seconds off, result in larger muscle contractions than longer, sustained periods.⁹ While both Pacinian and Meissner corpuscles are rapidly adapting mechanoreceptors that are responsive to mechanical pressure, the Pacinian corpuscles are most sensitive to vibration, with a threshold of between 200 and 300 Hz.

“WBV has been used as a treatment for several conditions,” he adds. “In a study involving 12 multiple sclerosis patients, vibrational frequencies of 2.0 and 4.4 Hz showed improvement in their balance and in the Timed Get Up and Go Test. Effects were strongest one week after the intervention ($p < 0.05$) and showed a general increase in postural control and mobility.¹⁰ In another study that examined the effects of 30-Hz WBV on postural control in chronic stroke patients, the author reported an increase in balance, theorized to be an effect of cortical reorganization.”¹¹

Patients who undergo WBV therapy stand on a platform, sometimes while performing prescribed exercises. Some European researchers believe that the exact frequency used in WBV training is important to outcomes. Bosco states

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that each individual's musculature vibrates at a different frequency and that people should receive WBV at that rate for best results.¹²⁻¹⁴

But just as vascular and/or neurological vibration injuries to operators of pneumatic power tools and the risk of LBP in drivers of certain types of vibrating work machines have been documented, WBV equipment is not without risk potential. Legal limits on exposure to industrial vibration have been introduced in many countries to avoid such hazards, but Brooke-Wavell states, "European occupational exposure limits can be exceeded in less than five minutes on some commercially available whole-body vibration training platforms if used on their highest magnitude settings. It is important to balance the potential risks of adverse side effects on the neurological and vascular systems with potential benefits when designing a whole-body vibration training protocol." The author continues, "Vibration training may offer some potential musculoskeletal benefits, but further research is needed to evaluate the optimum vibration protocol in terms of safety and efficacy in older people and to evaluate its effectiveness at reducing fall incidence."¹⁵

Barefoot Shoes

Dr. Ted Forcum says "barefoot" shoes were designed for athletes,¹⁶⁻²¹ not older adults, but they may offer this population certain benefits. Because this country's typically smooth pavement and thick-soled shoes are considered at least partly to blame for faulty proprioception in older adults, doctors may want to consider this type of shoe, although barefoot shoes may not provide frail older adults' feet with sufficient stability and cushioning. Thinner, more elastic soles in most barefoot shoes increase the wearer's sense of connection with the walking surface. Some barefoot shoes look like ordinary athletic shoes. Others do not.

Nike "Eclipse" and "Free"

Both of these shoes pass the "twist test." In other words, the heel and toe can be twisted in

opposite directions and bent to touch each other. The Eclipse is less expensive, but the Free has several different levels of flexibility from 3.0 (more flexible) to 7.0 (less flexible). Built more for motion than for cushioning or stability, Nike bills the Free as a "weight room for the feet." Both types of shoe are conservative in style. See www.nike.com.

Terra Plana "Dopies" and "Vivo Barefoot"

Also based on the barefoot model, Dopies are split-toed sandals with a strap across the arch that may not appeal to more conservative older adults. The company's "Vivo Barefoot" model, however, is a lace-up style built along traditional lines. See www.terraplana.com.

Vibram "Five Fingers"

Vibram makes four styles of five-toed shoes: "Classic," "Sprint," "Flow," and "KSO." All are designed to give the walker's feet the sense of going barefoot. Snug to the toes and more like gloves for the feet than shoes, they provide the foot with rubberized protection but no cushioning or stability. The "Sprint" model won *Time Magazine's* award as one of the best inventions of 2007. All Five Fingers shoes are washable (www.vibramfivefingers.com). In cooler weather, Injinji can be worn with five-toed socks beneath their five-toed shoes (www.injinji.com). No conservative styles are available in Vibram's five-toed models.

MBT Shoes

Dr. Forcum added the MBT shoe to this list. The MBT (Masai Barefoot Training) shoe has a curved surface on the bottom of the sole that's meant to provide sensorimotor training, particularly for those with ankle instabilities. This shoe creates what MBT calls the "natural instability" that would be felt on soft ground—on sand or moss. The idea is to stimulate and strengthen the small supporting muscles of the foot and ankle (<http://us.mbt.com>). Studies are listed under "benefits."

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Reactive Neuromuscular Training for LBP

Older adults with balance problems often suffer from LBP, as well. “Low-back pain (LBP) is rarely explained by a single structural pathology,” says Dr. Enix. “It’s more likely a result of accumulated biomechanical and pain-related psychological variables.”^{22,23} Biomechanical factors that have been identified as playing a key role in the development and chronicity of LBP include poor proprioceptive input and poor muscular endurance of the lumbar and pelvic region.²⁴

“Rehabilitation protocols for LBP commonly include neuromuscular and proprioceptive training, which have clinically encouraging results but modest empirical support. Reactive neuromuscular training (RNT) is one form of therapy that is promising but not fully investigated,” adds Dr. Enix. A 2009 study by Enix et al., tested the SpineForce trainer (LPG, Inc., Cedex, France) as a method of increasing core stability. Exercises to isolate the core spinal muscles were performed on an oscillating platform (see Fig. 1) to place those muscles “in a lengthened state relative to their neutral position in the spine,”²⁵ says Dr. Enix. “The muscles reacted to perturbations while being taken through a series of active and resisted ranges of motion designed to isolate weak and imbalanced core muscles and strengthen and stabilize them.”



Fig. 1. SpineForce Reactive Neuromuscular Trainer. (Left to right): Dr. Dennis Enix, Logan graduate student, Dr. Kristian Giggey. (Photo courtesy of Dr. Enix.)

This study used the McGill side bridge test to study participants’ ability to perform sustained core muscle contraction over a period of time without undue fatigue, says Dr. Enix. “Sustained contraction tests have been shown to be an indicator of muscular endurance. Core muscle exercises, when performed properly, aid in the development of muscle tone important for spinal stabilization. Adequate strength and endurance of core body muscles have been shown to be an important element in the prevention and treatment of lower back injury.”^{26,27} In this study, participants who trained for 10 minutes three times a week for four weeks showed a significant increase in core muscle endurance.”

Stochastic Resonance

Feet

In a practical sense, as Dr. Stephen Perle points out, stochastic resonance (SR) refers to using unstable surfaces or other types of random neurological input to aid in training or rehabilitation. For years, researchers have been intrigued by the potential of SR as a treatment for balance problems. SR has been used as a kind of input noise that can be disseminated through gel-filled insoles. One such study concludes

with “Noise-based devices, such as randomly vibrating shoe insoles, might be effective in the enhancement of performance of dynamic balance activities (e.g., walking) and could enable older adults to overcome postural instability caused by age-related sensory loss.”^{28,29}

Ankles

A 2007 study with 30 subjects in a laboratory setting weighed stochastic resonance as a treatment for functional ankle instability.³⁰ It

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states that SR stimulation therapy as provided by subsensory electrical noise or mechanical noise applied to the skin has promise as a therapy to improve postural stability. The mechanism is believed to “enhance the detection of sensorimotor signals related to postural control” by causing “sub-threshold sensorimotor signals to exceed threshold, allowing weak sensorimotor signals related to joint motion to become detectable.” Ross et al. looked at the possibility that this type of stimulation “enhances monosynaptic reflex responses generated by muscle spindles.” The study states that, “Stochastic resonance stimulation therapy has been useful for improving postural stability in healthy young and elderly individuals when compared to postural stability tests without stimulation,” and recommends further research.

Knees

Another possible balance-related use for this technology was tested at the department of biomedical engineering at the University of Boston in Massachusetts. In that study, imperceptible electrical noise was applied to the knees of 13 healthy older volunteers to test whether this type of stimulation could enhance balance performance. The abstract concludes that the “findings suggest that electrical noise-based devices may be effective in improving balance control in elderly people.”³¹ Caution is advised, however, in interpreting the results of such a small study.

Investigational Devices

At least two devices are under investigation as aids to people with balance difficulties. One was designed at the Neurological Science Institute of Oregon Health Sciences University.³² This device, about the size of the palm of the hand, is hooked onto a patient’s clothing at the waist, and is connected to headphones. As patients walk in the lab, auditory cues tell them if they are leaning left, right, forward, or backward. More studies are underway to determine if a certain duration and/or frequency of train-

ing can help patients sense excessive postural sway even without the device.

Another investigational balance-training device is a small electrode array placed in the mouth on the tip of the tongue. A tilt sensor in the device warns the patient of excessive postural sway. Patients must focus on where the stimulus is felt on the tongue and adjust their bodily position to maintain the stimulus properly on the center of the tongue. This device is part of the BrainPort Technologies division of Wicab, Inc. See www.wicab.com.

Surfing on Dry Land

One of the more intriguing pieces of balance equipment is the iJoyBoard balance trainer by Human Touch. Weighing about 50 lbs., the iJoyBoard replicates the perturbation and many of the unstable position shifts found in board sports while exercising the hips, legs, abdominals, and lumbar muscles through an increasingly challenging series of modes that include three-axis motion. Working out while standing on the iJoyBoard requires good coordination—which could be a problem for older adults with degraded proprioception. Also, because much of the iJoyBoard’s motion is from side to side, its suitability for older adults with lower-back conditions would need to be weighed case by case.



Fig. 2. iJoyBoard
(Photo courtesy of Human Touch®)

For relatively fit older patients, however, the iJoyBoard has much to offer. Dr. Tom Hyde uses it for a wide range of activities that in-

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clude open- and closed-chain exercises and upper- and lower-extremity exercises. He adds, “Exercises can be done seated in both directions; that is, by straddling the board or sitting across the board, as well as while sitting, standing, squatting, doing pushups, planks, and more.” Dr. Hyde says the utility of the iJoy-Board as a balance trainer can be expanded through the use of “Thera-Band® tubing, light weights, soft weights (balls), stability trainers, and with exercise balls, kettle bells, body blades, and flex bars.”

The iJoyBoard’s motor is designed for people who weigh 250 lbs. or less. At least one study is underway, but nothing has been published at press time. About \$500. See www.humantouch.com

From High-Tech to Low-Tech

Patients with a tendency to fall rarely have access to the latest 21st-century technology, nor do they necessarily need it. For basic balance-practice equipment in the patient’s home or in the rehab corner of the clinic, doctors may wish to consider:

Thera-Band® Stability Trainers

These devices come with directions for exercises that can be performed at all challenge levels. Three types of stability trainers, from firm (about \$40 per pair) to extra-soft (about \$85 per pair), are available for patients who are ready for a progressive challenge.



Fig. 3. Thera-Band® Stability Trainer in Action
(Photo courtesy of Performance Health/Thera-Band®)

Thera-Band® rocker boards and wobble boards (about \$65 each) for the hardier older adult have a non-skid surface.



Fig. 4. Thera-Band® Rocker Boards and Wobble Boards. (Photo courtesy of Performance Health/Thera-Band®)

Stability Disc

This new device, also by Thera-Band®, is a 13-inch PVC air-filled cushion. It can be used in a chair to develop the core musculature, or it can be placed on the floor and used in conjunction with a number of included balance-related exercises. About \$30. For further information on Thera-Band® products, see www.thera-band.com.



Fig. 5. Thera-Band® Stability Discs.
(Photo courtesy of Performance Health/Thera-Band®)

BOSU® Balance Trainer

For those who are relatively fit, Dr. Hyde says that in addition to stability exercises that can be performed on the rounded side of the ball, patients can achieve a wobble-board effect by turning the ball over. He states that “BOSU” actually stands for “both sides up,” and adds,

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“This equipment can also be used with upper- and lower-extremity open- and closed-chain exercises,” which are among the many different types of exercises that can be performed with the versatile BOSU® Balance Trainer ball to provide the user with a range of stability challenges. About \$140. See www.bosu.com.

Stability Balls

See ACA’s Patient Education article on stability balls at www.acatoday.org/healthyliving.³³ \$20 and up. A base is available (www.performbetter.com) to hold the ball in place. About \$25.

BOSU® Ballast Ball

This stability ball includes 5 lbs. of ballast inside to keep the ball from migrating away from the user. About \$50.

Foam Rollers

Older adults may find foam rollers appealing because of their simplicity of design, as well as their flexibility and ease of use.

Free Equipment

Dr. Michael Rogers says that just about any unstable surface will do if a patient has reached a level of fitness that allows for practicing balance exercises on something with more “give” than a floor. For older adults no longer challenged by floor exercises alone, he suggests trying a few balance exercises on a folded-over towel or two. “Later,” he says, “older adults can graduate to working with a sofa cushion. You’d be surprised at what a good workout you can get with one of those.” He suggests that older adults who want to try performing floor balance exercises on unstable surfaces make sure they have something to grab onto as needed—a solid chair, a grab bar, or even another person—until they are completely comfortable with their workouts.

Balancing Nutrition and Lifestyle Choices

Dr. Lisa Killinger says that besides the strength, flexibility, and balance exercises she gives her older patients, she reminds them to keep their meals regular and avoid both alcohol and caffeine, which may increase fall risk.

Dr. Killinger is a chiropractic consultant to the U.S. Bone and Joint Decade. Bone health has long held special interest for her. “Caffeine and alcohol play a role in osteoporosis, as well as in fall risk, so avoiding them can help protect patients if they do fall.” And that’s not all. “The food pyramid for people over 65 is the only one that includes supplements. An older person with some bone risk should take vitamin D and a calcium-magnesium supplement. Vitamin D is the hot topic in bone health these days. I perceive that they will change the recommended daily allowance of vitamin D within the next year or so—doubling it from 400 to 800 I.U. Many researchers are saying that’s not even enough—that 2,000 I.U. can be useful not only for bone health but for some vascular health and cancer prevention and many other issues. I’m not saying any of this is proven yet, but there are signs that we’ll be thinking differently about vitamin D.” Dr. Killinger also advises her older patients to avoid tobacco. “The tobacco issue isn’t intuitive, but being around tobacco or second-hand smoke sets up an unhealthy situation for laying down healthy bone.”

The worst thing an older adult can do, says Dr. Killinger, is nothing. “A sedentary lifestyle leaves people’s bones at great risk. “That’s probably the most significant thing on the list of things people can do for themselves.” Like it or not—and many older people do not like it—moderate-intensity endurance activity on most or all days of the week for about 30 minutes a day is a must.³⁴ Doctors of chiropractic should remind older patients that too much time spent seated will lead to loss of bone, muscle, and independence—a hard price to pay for doing nothing. ■

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