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Physical Therapy

Clinical Policy Bulletins | Medical Clinical Policy Bulletins

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06/17/2025

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Scope of Policy

This Clinical Policy Bulletin addresses physical therapy.

I. Medical Necessity

A. Aetna considers physical therapy (PT) medically necessary to significantly improve, develop or restore physical functions lost or impaired as a result of a disease, injury or surgical procedure, and the following criteria are met:

1. The member's licensed health care practitioner has determined that the member's condition can improve significantly based on physical measures (eg, active range of motion (AROM), strength, function or subjective report of pain level) within one month of the date that therapy begins or the therapy services proposed must be necessary for the establishment of a safe and effective maintenance program that will be performed by the member without ongoing skilled therapy services. These services must be proposed for the treatment of a specific illness or injury; *and*
2. The PT services provided are intended to cover only episodes of therapy for situations where there must be a reasonable expectation that a member's condition will improve significantly in a reasonable and generally predictable period of time; *and*
3. PT services must be performed by a duly licensed and certified, if applicable, PT provider. All services provided must be within the applicable scope of practice for the provider in their licensed jurisdiction where the services are provided; *and*
4. The services provided must be of the complexity and nature to require that they are performed by a licensed professional therapist or provided under their direct supervision by a licensed ancillary person as permitted under state laws. Services may be provided personally by physicians and performed by personnel under their direct supervision as permitted under state laws. As physicians are not licensed as physical therapists, they may not directly supervise physical therapy assistants; *and*
5. PT must be provided in accordance with an ongoing, written plan of care. The PT plan of care should be of such sufficient detail and include appropriate objective and subjective data to demonstrate the medical necessity of the proposed treatment (see Appendixfor documentation requirements);

B. Physical therapy in asymptomatic persons or in persons without an identifiable clinical condition is considered *not* medically necessary;
C. Physical therapy in persons whose condition is neither regressing nor improving is considered *not* medically

necessary;

D. Once therapeutic benefit has been achieved, or a home exercise program could be used for further gains, continuing supervised physical therapy is *not* considered medically necessary;

E. Home-based physical therapy is considered medically necessary in selected cases based upon the member's needs (i.e., the member must be homebound). This may be considered medically necessary in the transition of the member from hospital to home, and may be an extension of case management services.

   Note: In Aetna HMO, QPOS, Health Network Only, and Health Network Option plans, such short-term physical therapy accumulates towards the 60-day limit or other applicable rehabilitation benefit limits. Please check benefit plan descriptions for details.

F. There are no reliable data demonstrating that the following methods of physical therapy are superior to standard methods of physical therapy:

   1. McKenzie Method of Mechanical Diagnosis and Therapy
   2. Muldowney Method of Physical Therapy
   3. Muscle Activation Techniques (MAT)
   4. Postural Restoration Form of Physical Therapy

   Thus, it is not medically necessary to go out of network for these specific methods of physical therapy when standard methods of physical therapy are available in-network.

G. There are no reliable data that outcomes of soft tissue mobilization (myofascial release) are improved with the use of hand-held tools (so-called "augmented soft tissue mobilization"; e.g., the Dynatronics ThermoStim probe). Thus, augmented soft tissue mobilization is considered medically necessary and covered as standard myofascial release modality. Notes: No additional reimbursement is provided for

use of hand-held tools for performing myofascial release. The ThermoStim probe also allows delivery of electrical stimulation, and would be covered for electrical stimulation as a modality.

II. **Experimental, Investigational, or Unproven**

The following physical therapy interventions are considered experimental, investigational, or unproven because the effectiveness of these approaches has not been established (not an all-inclusive list):

A. Adhesion removal physical therapy for bowel obstructions
B. Applied Functional Science
C. Blood flow restriction therapy
D. Dynamic Movement Intervention
E. Kinesio Taping/McConnell Taping/Taping:

- Kinesio taping/taping for back pain, radicular pain syndromes, and other back-related conditions
- Kinesio taping for lower extremity spasticity, meralgia paresthetica, post-operative subacromial decompression, wrist injury, prevention of ankle sprains, and all other indications
- McConnell taping for knee pain, low back pain, and all other indications

F. "Hands-free" ultrasound and low-frequency sound (infrasound)
G. Hivamat therapy (deep oscillation therapy)
H. Interactive Metronome program
I. Low-dye strapping for the treatment of stress fracture of the ankle
J. MEDEK therapy
K. RomTech PortableConnect
L. Strapping of the chest and/or hip for the treatment of pain and improvement of posture
M. Ultrasound therapy for the treatment of Dupuytren's contracture
N. Virtual reality facilitated gait training.

III. Policy Limitations and Exclusions

A. Typically, in Aetna HMO plans, the physical therapy benefit is limited to a 60-day treatment period. When this is the case, the treatment period of 60 days applies to a specific condition. In some plan designs this limitation is applied on a calendar year or on a contract-year basis. In others it is a lifetime limitation. Please check benefit plan descriptions for details. Regardless, it is possible for a member to receive more than one 60-day treatment course of physical therapy as treatment of separate conditions. For example, a surgical procedure causing the need for physical therapy is considered to be the initiation of a new or separate condition in a person who previously received physical therapy for another indication, and so qualifies the member to receive coverage for an additional course of physical therapy as outlined above. An exacerbation or flare-up of a chronic illness is not considered a new incident of illness.

B. In some plans, the available physical therapy benefit is defined by a number of treatment sessions covered per year regardless of the condition or number of courses of therapy indicated.

C. Standard Aetna policies exclude coverage for educational training or services. Under plans with this exclusion, physical therapy is not covered when provided in educational settings. Please check benefit plan descriptions for details.

D. Sports rehabilitation refers to continued treatment for sports related injuries in an effort to improve above and beyond normal ability to perform activities of daily living (ADLs). Sports-related rehabilitation or other similar avocational activities is not covered because it is not considered treatment of disease. This includes, but is not limited to: baseball pitching/throwing, cheerleading, golfing, martial arts of all types, organized football, baseball, basketball, soccer, lacrosse, swimming, track and field, etc. at a college, high school, other school or community setting, professional and amateur tennis, professional and amateur/hobby/academic dance, and competitive weightlifting and similar activities.

E. For clinical policy on physical therapy for persons with a diagnosis of autistic spectrum disorder, see CPB 0648 - Autism Spectrum Disorder (../600_699/0648.html).

IV. **Related Policies**

- CPB 0648 - Autism Spectrum Disorder (../600_699/0648.html)

CPT Codes / HCPCS Codes / ICD-10 Codes

CPT codes covered if selection criteria are met:

Code	Code Description
Muldowney Method of Physical Therapy – no specific code	
97010	Application of a modality to 1 or more areas; hot or cold packs
97012	traction, mechanical
97014	electrical stimulation (unattended)
97016	vasopneumatic devices
97018	paraffin bath
97022	whirlpool
97024	diathermy (eg, microwave)
97026	infrared
97028	ultraviolet
97032	Application of a modality to one or more areas; electrical stimulation (manual), each 15 minutes
97033	iontophoresis, each 15 minutes
97034	contrast baths, each 15 minutes
97035	ultrasound, each 15 minutes
97036	Hubbard tank, each 15 minutes

Code	Code Description
97110	Therapeutic procedure, one or more areas, each 15 minutes; therapeutic exercises to develop strength and endurance, range of motion and flexibility
97112	neuromuscular reeducation of movement, balance, coordination, kinesthetic sense, posture, and/or proprioception for sitting and/or standing activities
97113	aquatic therapy with therapeutic exercise
97116	gait training (includes stair climbing)
97124	massage, including effleurage, petrissage and/or tapotement (stroking, compression, percussion)
97129	Therapeutic interventions that focus on cognitive function (eg, attention, memory, reasoning, executive function, problem solving, and/or pragmatic functioning) and compensatory strategies to manage the performance of an activity (eg, managing time or schedules, initiating, organizing, and sequencing tasks), direct (one-on-one) patient contact; initial 15 minutes
+97130	each additional 15 minutes (List separately in addition to code for primary procedure)
97140	Manual therapy techniques (e.g., mobilization/manipulation, manual lymphatic drainage, manual traction), one or more regions, each 15 minutes
97161 - 97164	Physical therapy evaluation or reevaluation
97530	Therapeutic activities, direct (one on one) patient contact (use of dynamic activities to improve functional performance), each 15 minutes [not covered for Dynamic Movement Intervention]
97535	Self care/home management training (e.g., activities of daily living [ADL] and compensatory training, meal preparation, safety procedures, and instructions in use of assistive technology devices/adaptive equipment) direct one-on-one contact by provider, each 15 minutes

Code	Code Description
97537	Community/work reintegration training (e.g., shopping, transportation, money management, avocational activities and/or work environment/modification analysis, work task analysis, use of assistive technology device/adaptive equipment), direct one-on-one contact by provider, each 15 minutes
97542	Wheelchair management (e.g., assessment, fitting, training), each 15 minutes
97760	Orthotic(s) management and training (including assessment and fitting when not otherwise reported), upper extremity(s), lower extremity(s), and/or trunk, each 15 minutes
97761	Prosthetic training, upper and/or lower extremity(s), each 15 minutes
97762	Checkout for orthotic/prosthetic use, established patient, each 15 minutes
97763	Orthotic(s)/prosthetic(s) management and/or training, upper extremity(ies), lower extremity(ies), and/or trunk, subsequent orthotic(s)/prosthetic(s) encounter, each 15 minutes
99509	Home visit for assistance with activities of daily living and personal care
CPT codes not covered for indications listed in the CPB:	
Sports Rehabilitation, The Interactive Metronome Program, MEDEK Therapy, Hands-Free Ultrasound and Low-Frequency Sound (Infrasound), Hivamat Therapy (Deep Oscillation Therapy), Applied Functional Science, McKenzie Method of Mechanical Diagnosis and Therapy, Postural Restoration Form of Physical Therapy, Muscle Activation Techniques, Adhesion Removal Physical Therapy, Blood flow restriction therapy, Muldowney Method of Physical Therapy, RomTech PortableConnect, Blood flow restriction therapy - no specific code	
+0791T	Motor-cognitive, semi-immersive virtual reality–facilitated gait training, each 15 minutes (List separately in addition to code for primary procedure)
Other CPT codes related to the CPB:	
97039	Unlisted modality (specify type and time if constant attendance)

Code	Code Description
97139	Unlisted therapeutic procedure (specify)
97150	Therapeutic procedure(s), group (2 or more individuals)
HCPCS codes covered if selection criteria are met:	
G0151	Services performed by a qualified physical therapist in the home health or hospice setting, each 15 minutes
G0159	Services performed by a qualified physical therapist, in the home health setting, in the establishment or delivery of a safe and effective therapy maintenance program, each 15 minutes
S9131	Physical therapy; in the home, per diem
HCPCS codes not covered for indications listed in the CPB:	
Dynatronics ThermoStim probe - no specific code	
Other HCPCS codes related to the CPB:	
G0152	Services performed by a qualified occupational therapist in the home health or hospice setting, each 15 minutes
G0153	Services performed by a qualified speech-language pathologist in the home health or hospice setting, each 15 minutes
G0157	Services performed by a qualified physical therapist assistant in the home health or hospice setting, each 15 minutes
G2168	Services performed by a physical therapist assistant in the home health setting in the delivery of a safe and effective physical therapy maintenance program, each 15 minutes
S9128	Speech therapy, in the home, per diem
S9129	Occupational therapy, in the home, per diem
Kinesio taping, McConnell taping:	
No specific code	
Other HCPCS codes related to the CPB:	
A4450	Tape, non-waterproof, per 18 square inches
A4452	Tape, waterproof, per 18 square inches
Low dye strapping/strapping of the chest:	
CPT codes not covered for indications listed in the CPB:	
Low dye strapping/strapping of the chest –no specific code	

Background

Physical therapy (PT) treatment consists of a prescribed program to relieve symptoms, improve function and prevent further disability for individuals disabled by chronic or acute disease or injury. Treatment may include various forms of heat and cold, electrical stimulation, therapeutic exercises. For medical necessity criteria, see, ambulation training and training in functional activities.

Physical therapy is the treatment of disorders or injuries using physical methods or modalities. A PT modality is often defined as any physical agent applied to produce therapeutic changes to biologic tissues. Modalities that are generally accepted for use include exercises, thermal, cold, ultrasonic or electric energy devices. Due to the passive nature of therapeutic modalities, they are generally used to enable the patient to take part in active aspects of therapy.

Physical therapy may be indicated for treatment of muscle weakness, limitations in the range of motion, neuromuscular conditions, musculoskeletal conditions, lymphedema and for selected training of patients in specific techniques and exercises for their own continued use at home.

Therapeutic procedures are intended as a means of effecting change using clinical skills and/or techniques and/or services whose goal is the improvement of function. PT procedures in general include therapeutic exercises and joint mobilization. These have generally been shown to be one set of effective means of treating aspects of many musculoskeletal conditions.

Medically necessary physical therapy services must be restorative or for the purpose of designing and teaching a maintenance program for the patient to carry out at home. The services must also relate to a written treatment plan and be of a level of complexity that requires the judgment, knowledge and skills of a physical therapist (or a medical doctor/doctor of osteopathy) to perform and/or supervise the services. The amount, frequency and duration of the physical therapy services must be

reasonable, the services must be considered appropriate and needed for the treatment of the disabling condition and must not be palliative in nature.

A qualified physical therapist for benefit coverage purposes is a person who is licensed as a physical therapist by the state in which he or she is practicing. A physical therapy assistant (PTA) is a person who is licensed as a PTA, if applicable, by the state in which he or she is practicing. The services of a PTA must be supervised by a licensed physical therapist at a level of supervision determined by state law or regulation. The services of a PTA cannot be provided incidental to a physician/appropriately licensed other practitioner as they are not specifically qualified as licensed physical therapists

Physical therapy is generally covered for members with eligible conditions that require improvement in the activities of daily living (ADLs). These include, but may not be limited to : bathing, communication, dressing, feeding, grooming, mobility, personal hygiene, self maintenance, skin management, and toileting.

Treatments and/or therapies that are intended to specifically improve what are known as Instrumental Activities of Daily Living (IADL) are not covered because they are not considered treatment of disease. These include, but are not limited to: community living skills including balancing a checkbook, use of public transportation; home management skills including meal preparation, laundry; leisure activities including hobbies, sports or recreation of all types even if suggested as part of a PT treatment plan; motor vehicle driving evaluations and driving instruction - this includes automobiles, trucks, motorcycles and bicycles; or personal safety preparedness.

Physical therapy for members whose condition is neither regressing nor improving, is not medically necessary. An exacerbation or flare-up of a chronic condition or illness is not considered a new illness or condition. It is the intent of the PT coverage to have the member receive those services that are medically necessary, who show demonstrated improvement over a reasonable period of time, consistent with the condition under treatment and to achieve the stated treatment goals.

Non-skilled services are certain types of treatment that do not generally require the skills of a qualified physical therapist. Non-skilled services include, but are not limited to, (1) passive range of motion (PROM) treatment which is not specifically part of a restorative program related to a loss of function and (2) services which maintain function by using routine, repetitive and reinforced procedures after initial teaching of the patient has taken place. These also include most situations where general conditioning, recovery from an acute medical/surgical illness that caused deconditioning or increased general ability to exercise or walk are undertaken. Services that can be safely and effectively furnished by non-skilled (non-licensed physical therapists or their assistants under appropriate supervision) personnel are non-skilled services.

Maintenance care consists of activities that generally are intended to preserve the patient's present level of function and/or prevent regression of that level of function. Maintenance begins when the therapeutic goals of the treatment program are achieved or when no further significant progress is made or reasonably seen as occurring. Specifically, these include continued activities for patients who have achieved generally accepted levels of function and/or muscle strength and are at a plateau or have reached "normal" levels. A plateau is a period of four weeks or dependent on the specific condition and/or patient situation, a lesser period of time that is seen as generally accepted.

Below is a description and medical necessity criteria for different treatment modalities and therapeutic procedures.

1. Activities of Daily Living (ADL) Training

   Training of severely impaired individuals in essential ADL, including bathing; feeding; preparing meals; toileting; walking; making bed; and transferring from bed to chair, wheelchair or walker. This procedure is considered medically necessary to enable the member to perform essential ADL related to the patient's health and hygiene, within or outside the home, with minimal or no assistance from others. This procedure is considered medically necessary only when it requires the

professional skills of a provider, is designed to address specific needs of the member, and must be part of an active treatment plan directed at a specific outcome. The member must have the capacity to learn from instructions. Standard medical treatment may generally require up to 12 visits in 4 weeks. Services provided concurrently by physicians, physical therapists and occupational therapists may be considered medically necessary if there are separate and distinct functional goals.

2. Aquatic Therapy/Hydrotherapy/Hubbard Tank

   Hubbard tank involves a full-body immersion tank for treating severely burned, debilitated and/or neurologically impaired individuals. Pool therapy (aquatic therapy, hydrotherapy) is provided individually, in a pool, to severely debilitated or neurologically impaired individuals. (The term is not intended to refer to relatively normal individuals who exercise, swim laps or relax in a hot tub or Jacuzzi). Develops and/or maintains muscle strength including range of motion by eliminating forces of gravity through total body immersion (except for head) – requires constant attention. It is not considered medically necessary to provide more than 1 type of hydrotherapy on the same day (e.g., whirlpool, Hubbard tank, hydrotherapy). For medical necessity criteria, see CPB 0174 - Pool Therapy, Aquatic Therapy or Hydrotherapy (../100_199/0174.html).

3. Cognitive skills development

   This procedure is considered medically necessary for persons with acquired cognitive defects resulting from head trauma, or acute neurologic events including cerebrovascular accidents. It is not appropriate for persons with chronic progressive brain conditions with no potential for restoration. Occupational/speech therapists or clinical psychologists with specific training in these skills are typically the providers. This procedure should be aimed at improving or restoring specific functions which were impaired by an identified illness or injury. The goals of therapy, expected outcomes and expected duration of therapy should be specified.

4. Contrast Baths

Blood vessel stimulation with alternate hot and cold baths – constant attendance is needed. This modality may be considered medically necessary to treat extremities affected by reflex sympathetic dystrophy, acute edema resulting from trauma, or synovitis/tenosynovitis. It is generally used as an adjunct to a therapeutic procedure. Standard treatment is 3 to 4 treatments per week for 1 month.

5. Crutch/Cane Ambulation

   Ambulation training ad re-education with the use of assistive devices such as cane or crutches. Considered medically necessary for persons who meet medical necessity criteria for ambulatory assist devices. See CPB 0505 - Ambulatory Assist Devices: Walkers, Canes and Crutches (../500_599/0505.html).

6. Diathermy (e.g., microwave)

   Deep, dry heat with high frequency current or microwave to relieve pain and increase movement – supervised. The objective of diathermy is to cause vasodilatation and relieve pain from muscle spasm. Diathermy using deep dry heat with high-frequency achieves a greater rise in deep tissue temperature than does microwave. Considered medically necessary as a heat modality for painful musculoskeletal conditions. Considered experimental, investigational, or unproven as a treatment for asthma, bronchitis or other pulmonary conditions.

7. Dynamic Movement Intervention

   Dynamic Movement Intervention (DMI) is an intervention used by physical therapists as well as occupational therapists for the treatment of children with gross motor impairments by improving automatic postural responses and promoting progress towards developmental milestones. The objective of DMI therapy is to provoke a specified active motor response from the child in response to defined dynamic exercises prescribed by the therapist. This intervention incorporates current research on neurorehabilitation, technologies, and methodologies. DMI therapy stimulates neuroplasticity to facilitate new neuronal

connections and development of motor milestones. During a treatment session the child will complete various exercises that provide novel and different sensory and motor challenges; and each exercise is repeated approximately 5 times. Exercises may be repeated from session to session until the movements become automatic, which results in improved balance and function. Exercises are performed on a tabletop or the floor based on the child's abilities. DMI therapy works well in conjunction with other therapeutic techniques and therapy equipment. These are often combined in a treatment session to provide better alignment and enhance optimal outcomes. There is a lack of evidence regarding the effectiveness of DMI therapy.

8. Electrical Stimulation

   For medical necessity criteria, see CPB 0011 - Electrical Stimulation for Pain (../1_99/0011.html); CPB 0677 - Functional Electrical Stimulation and Neuromuscular Electrical Stimulation (../600_699/0677.html); and CPB 0680 - Electrical Stimulation for Chronic Ulcers (../600_699/0680.html).

9. Gait Training

   Teaching individuals with severe neurological or musculoskeletal disorders to ambulate in the face of their handicap or to ambulate with an assistive device. Gait training is considered medically necessary for training individuals whose walking abilities have been impaired by neurological, muscular or skeletal abnormalities or trauma. Gait training is not considered medically necessary when the individual's walking ability is not expected to improve. Provider supervision of repetitive walk-strengthening exercise for feeble or unstable patients is not considered medically necessary. Gait training is not considered medically necessary for relatively normal individuals with minor or transient abnormalities of gait who do not require an assistive device; these minor or transient gait abnormalities may be remedied by simple instructions to the individual.

10. Hot/Cold Packs

Hot packs increases blood flow, relieves pain and increases movement; cold packs decreases blood flow to an area to reduce pain and swelling immediately after an injury. These are used in Contrast Therapy under supervision. Considered medically necessary as thermal modalities (hot or cold) for painful musculoskeletal conditions and for acute injuries. See also CPB 0297 - Cryoanalgesia and Therapeutic Cold (../200_299/0297.html).

11. Infrared Light Therapy

    Dry heat with a special lamp to increase circulation to an area under supervision. The objective is to cause vasodilatation and relieve pain from muscle spasm. Considered medically necessary as a heat modality for musculoskeletal indications. See also CPB 0540 - Heating Devices (../500_599/0540.html); and CPB 0604 - Infrared Therapy (../600_699/0604.html).

12. Iontophoresis

    Electric current used to transfer certain chemicals (medications) into body tissues. For medical necessity criteria, see CPB 0229 - Iontophoresis (../200_299/0229.html).

13. Kinetic Therapy

    Use of dynamic activities to improve functional performance. Considered medically necessary when there are major impairments or disabilities which preclude the individual performing the activities and exercises that are ordinarily prescribed. In kinetic therapy, considerable time is spent developing specific, individualized therapeutic exercises and instructing the patient in how to perform them. The term kinetic therapy is not intended to apply to instructions in routine exercises.

14. Massage Therapy

    Massage involves manual techniques that include applying fixed or movable pressure, holding and/or causing movement of or to the body, using primarily the hands. These techniques affect the

musculoskeletal, circulatory-lymphatic, nervous, and other systems of the body with the intent of improving a person's well-being or health. The most widely used forms of massage therapy include Swedish massage, deep-tissue massage, sports massage, neuromuscular massage, and manual lymph drainage. Massage therapy is considered medically necessary as adjunctive treatment to another therapeutic procedure on the same day, which is designed to restore muscle function, reduce edema, improve joint motion, or for relief of muscle spasm. Massage therapy is not considered medically necessary for prolonged periods and should be limited to the initial or acute phase of an injury or illness (i.e., an initial 2-week period).

15. Myofascial Release

    Soft tissue mobilization through manipulation. Skilled manual techniques (active and/or passive) are applied to soft tissue to effect changes in the soft tissues, articular structures, neural or vascular systems. Examples are facilitation of fluid exchange, restoration of movement in acutely edematous muscles, or stretching of shortened connective tissue. This procedure is considered medically necessary for treatment of restricted motion of soft tissues in involved extremities, neck, and trunk.

16. Neuromuscular Reeducation

    This therapeutic procedure is provided to improve balance, coordination, kinesthetic sense, posture, and proprioception to a person who has had muscle paralysis and is undergoing recovery or regeneration. Goal is to develop conscious control of individual muscles and awareness of position of extremities. The procedure may be considered medically necessary for impairments which affect the body's neuromuscular system (e.g., poor static or dynamic sitting/standing balance, loss of gross and fine motor coordination, hypo/hypertonicity) that may result from disease or injury such as severe trauma to nervous system, cerebral vascular accident and systemic neurological disease. Standard treatment is 12 to 18 visits within a 4- to 6-week period.

17. Orthotic Training

Training and re-education with braces and/or splints (orthotics). Considered medically necessary for persons who meet criteria for a brace or splint. See CPB 0009 - Orthopedic Casts, Braces and Splints (../1_99/0009.html). There should be distinct treatments rendered when orthotic training for a lower extremity is done during the same visit as gait training, or self-care/home management training. It is unusual to require more than 30 mins of static orthotics training. In some cases, dynamic training may require additional time.

18. Paraffin Bath

    Also known as hot wax treatment, this involves supervised application of heat (via hot wax) to an extremity to relieve pain and facilitate movement. This is considered medically necessary for pain relief in chronic joint problems of the wrists, hands or feet. One or 2 visits is usually sufficient to educate the individual in home use and to evaluate effectiveness. See also CPB 0540 - Heating Devices (../500_599/0540.html).

19. Prosthetic checkout

    These assessments are considered medically necessary when a device is newly issued or there is a modification or re-issue of the device. These assessments are considered medically necessary when member experiences loss of function directly related to the orthotic or prosthetic device (e.g., pain, skin breakdown, or falls. Usually, no more than 30 mins of time is necessary.

20. Prosthetic Training

    Training and re-education with artificial devices (prosthetics). Considered medically necessary for persons with a medically necessary prosthetic. There should be distinct goals and services rendered when prosthetic training for a lower extremity is done during the same visit as gait training or self care/home management training. Periodic revisits beyond the 3rd month may be reviewed for medical necessity. It is unusual to require more than 30 mins of prosthetic training on a given date.

21. Therapeutic activities

    This procedure involves using functional activities (e.g., bending, lifting, carrying, reaching, pushing, pulling, stooping, catching and overhead activities) to improve functional performance in a progressive manner. The activities are usually directed at a loss or restriction of mobility, strength, balance or coordination. They require the professional skills of a provider and are designed to address a specific functional need of the member. This intervention may be appropriate after a patient has completed exercises focused on strengthening and range of motion but need to be progressed to more function-based activities. These dynamic activities must be part of an active treatment plan and directed at a specific outcome.

22. Therapeutic Exercise

    Instructing a person in exercises and directly supervising the exercises. Purpose is to develop and/or maintain muscle strength and flexibility including range of motion, stretching and postural drainage. Therapeutic exercise is performed with a patient either actively, active-assisted, or passively (e.g., treadmill, isokinetic exercise lumbar stabilization, stretching, strengthening). Therapeutic exercise is considered medically necessary for loss or restriction of joint motion, strength, functional capacity or mobility which has resulted from disease or injury. Standard treatment is 12 to 18 visits within a 4- to 6-week period. Note: Exercising done subsequently by the member without a physician or therapist present and supervising would not be covered.

23. Traction

    Manual or mechanical pull on extremities or spine to relieve spasm and pain – supervised. Considered medically necessary for chronic back or neck pain. This modality, when provided by physicians or physical therapists, is typically used in conjunction with therapeutic procedures, not as an isolated treatment. Standard treatment is to provide supervised mechanical traction up to 4 sessions per week. For cervical radiculopathy, treatment

beyond 1 month can usually be accomplished by self-administered mechanical traction in the home. See also CPB 0453 - Cervical Traction Devices (../400_499/0453.html), and CPB 0569 - Lumbar Traction Devices (../500_599/0569.html).

24. Ultrasound

    Deep heat by high frequency sound waves to relieve pain, improve healing – constant attendance. This modality is considered medically necessary to treat arthritis, inflammation of periarticular structures, neuromas, and to soften adhesive scars. Standard treatment is 3 to 4 treatments per week for 1 month. Considered experimental, investigational, or unproven as a treatment for asthma, bronchitis or other pulmonary conditions, and Dupuytren's contracture. An UpToDate review on "Dupuytren's contracture" (Aggarwal and Blazar, 2022) states that "Other interventions, including continuous slow skeletal traction, dimethyl sulfoxide, vitamin E, allopurinol, physical therapy, ultrasound therapy, glucocorticoid injections, interferon, and splinting, have generally not been successful".

25. Vasopneumatic Device

    Pressure application by special equipment to reduce swelling – supervised. It may be considered necessary to reduce edema after acute injury. Education for use of lymphedema pump in the home usually requires 1 or 2 sessions. Further treatment of lymphedema by the provider after the educational visits are generally not considered medically necessary. See also CPB 0062 - Burn Garments (../1_99/0062.html), and CPB 0069 - Lymphedema (../1_99/0069.html).

26. Wheelchair management training

    This procedure is considered medically necessary only when it requires the professional skills of a provider, is designed to address specific needs of the member, and must be part of an active treatment plan directed at a specific goal. The member must have the capacity to learn from instructions. Typically, 3 to 4 total sessions are sufficient.

27. Whirlpool

    These modalities involve supervised use of agitated water in order to relieve muscle spasm, improve circulation, or cleanse wounds e.g., ulcers, exfoliative skin conditions. Considered medically necessary to relieve pain and promote relaxation to facilitate movement in persons with musculoskeletal conditions. Also considered medically necessary for wound cleansing. It is not considered medically necessary to provide more than 1 hydrotherapy modality (e.g., whirlpool, Hubbard tank, aquatic therapy) performed on the same day. See also CPB 0450 - Fluidized Therapy (Fluidotherapy) (../400_499/0450.html); CPB 0429 - Bathroom and Toilet Equipment and Supplies (../400_499/0429.html); and CPB 0699 - Dry Hydrotherapy (Hydromassage, Aquamassage, Water Massage) (../600_699/0699.html).

Certain physical medicine modalities and therapeutic are considered duplicative in nature and it would be inappropriate to perform or bill for these services during the same session, such as:

1. Functional activities and ADL
2. Infrared and ultraviolet
3. Massage therapy and myofascial release
4. Microwave and infrared
5. Orthotics training and prosthetic training
6. Whirlpool and Hubbard tank.

The medical necessity of neuromuscular re-education, therapeutic exercises, kinetic activities, and/or therapeutic activities, performed on the same day, must be documented in the medical record.

Only 1 heat modality would be considered medically necessary during the same treatment session. An exception to this is ultrasound (a deep heat), which may be considered medically necessary with 1 superficial heat modality but is not considered medically necessary with other deep heat modalities.

The Interactive Metronome Program

The Interactive Metronome (IM) program is designed for processing speed, focus, as well as coordination. Trainees wear headphones and hear a fixed, repeating reference beat; they press against a hand or foot sensor to try to match it, while receiving visual and auditory feedback. The IM program has been promoted as a treatment for children with attention-deficit hyperactivity disorder (ADHD) and for other special needs children to increase concentration, focus, and coordination. It has also been promoted to improve athletic performance, to assess and improve academic performance of normal children, and to improve children's performance in the arts (e.g., dance, music, theater, creative arts). Furthermore, the IM program has also been implemented as part of a therapy program for patients with balance disorders, cerebrovascular accident, limb amputation, multiple sclerosis, Parkinson's disease, and traumatic brain injury.

Schaffer et al (2001) examined the effects of the IM program on selected aspects of motor and cognitive skills in a group of children with ADHD. The study included 56 boys who were 6 years to 12 years of age and diagnosed before they entered the study as having ADHD. The participants were pre-tested and randomly assigned to one of three matched groups. A group of 19 participants receiving 15 hours of IM training exercises were compared with a group receiving no intervention and a group receiving training on selected computer video games. A significant pattern of improvement across 53 of 58 variables favoring the IM program was found. Additionally, several significant differences were found among the treatment groups and between pre-treatment and post-treatment factors on performance in areas of attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior. The authors concluded that the IM program appears to facilitate a number of capacities, including attention, motor control, and selected academic skills, in boys with ADHD.

In a case report, Bartscherer and Dole (2005) described the use of the IM program for improving timing and coordination in a 9-year old boy who had difficulties in attention and developmental delay of unspecified origin. The subject underwent a 7-week training with the program. Before, during, and after training, timing accuracy was evaluated with testing

procedures consistent with the IM training protocol. Before and after training, the subject's gross and fine motor skills were examined with the Bruininiks-Oseretsky Test of Motor Proficiency (BOTMP). The child exhibited marked change in scores on both timing accuracy and several BOTMP subtests. Additionally his mother relayed anecdotal reports of changes in behavior at home. This child's participation in a new intervention for improving timing and coordination was associated with changes in timing accuracy, gross and fine motor abilities, and parent reported behaviors. The authors noted that these findings warrant further study.

Cosper et al (2009) examined the effectiveness of IM (Interactive Metronome, Sunrise, FL) training in a group of children with mixed attentional and motor coordination disorders to further explore which subcomponents of attentional control and motor functioning the training influences. A total of 12 children who had been diagnosed with ADHD, in conjunction with either developmental coordination disorder (n = 10) or pervasive developmental disorder (n = 2), underwent 15 1-hr sessions of IM training over a 15-week period. Each child was assessed before and after the treatment using measures of attention, coordination, and motor control to determine the effectiveness of training on these cognitive and behavioral realms. As a group, the children made significant improvements in complex visual choice reaction time and visuomotor control after the training. There were, however, no significant changes in sustained attention or inhibitory control over inappropriate motor responses after treatment. These results suggested IM training may address deficits in visuomotor control and speed, but appears to have little effect on sustained attention or motor inhibition.

In a review on autism, Levy and colleagues (2009) stated that popular biologically based treatments include anti-infectives, chelation medications, gastrointestinal medications, hyperbaric oxygen therapy, and intravenous immunoglobulins. Non-biologically based treatments include auditory integration therapy, chiropractic therapy, cranio-sacral manipulation, facilitated communication, IM, and transcranial stimulation. However, few studies have addressed the safety and effectiveness of most of these treatments.

Currently, there is insufficient evidence in the peer-reviewed medical literature to support the effectiveness of the IM program. Randomized controlled studies are needed to establish the clinical value of this program.

Augmented Soft Tissue Mobilization

Augmented soft tissue mobilization (ASTM), a non-invasive mobilization technique, is used by chiropractors as well as massage, occupational, and physical therapists to treat chronic musculoskeletal disorders that result from scarring and fibrosis. It entails the use of hand-held tools made from bone or stone or metal and a lubricant on the skin to scrape and mobilize scar tissue. Scraping is done to promote circulation, thus, promoting healing. Manual and other treatments may also be used with exercise to guide the healing process. Treatments with ASTM are often administered on non-consecutive days, 1 to 2 times per week. A typical 30-min session usually includes 15 mins of treatment and 15 mins of exercise and assessment. Less severe conditions reportedly can respond well in 2 to 4 sessions whereas difficult chronic cases may require 8 to16 sessions. However, there is insufficient evidence to support the effectiveness of ASTM.

In a case report, Melham et al (1998) described their finding on the use of ASTM in the treatment of excessive scar tissue around an athlete's injured ankle. Surgery and several months of conventional physical therapy failed to alleviate the athlete's symptoms. As a final resort, ASTM was administered. It used ergonomically designed instruments that assist therapists in the rapid localization and effective treatment of areas exhibiting excessive soft tissue fibrosis; followed by a stretching and strengthening program. Upon the completion of 6 weeks of ASTM, the athlete had no pain and had regained full range of motion and function.

The Dynatronics ThermoStim probe is a hand-held device intended to deliver soft tissue mobilization and electrical stimulation. There are no data demonstrating that such a hand-held device provides effective soft tissue mobilization. The ThermoStim probe also allows delivery of electrical stimulation, and would be covered for electrical stimulation as a modality.

Ostrowski and colleagues (2019) noted that the ThermoStim Probe (TSP) has recently joined the market as a superficial heating modality. Although there is limited research into the intra-muscular (IM) heating capability of superficial heating modalities in general (moist hot pack [MHP], paraffin, warm whirlpool), no previous research has examined IM heating capability of TSP. In a repeated-measures, counter-balanced, multi-center study, these investigators examined rate and magnitude of IM heating via TSP compared with hydrocollator MHP, and examined if TSP could increase tissue temperature 3°C to 4°C (vigorous heating range). Participants included 18 healthy college-aged subjects (11 females and 7 males, age of 23.0 [2.1] years, weight of 74.64 [18.64] kg, height of 168.42 [9.66] cm, subcutaneous adipose: 0.71 [0.17] cm) with calf subcutaneous adipose of less than 1.2 cm. MHP and TSP were applied to the posterior aspect of the non-dominant calf for 20 mins; participants underwent each treatment in a counter-balanced order. Muscle temperature at a depth of 1.5 cm was measured via 21-G catheter thermocouple. Temperatures were recorded at baseline and during the 20-min treatment. There was a significant treatment-by-time interaction during the treatment period ($F_{5,85} = 14.149$, $p < 0.001$), as well as significant main effects for treatment ($F_{1,17} = 7.264$, $p = 0.02$) and for time ($F_{5,85} = 34.028$, $p < 0.001$). Muscle temperature increased an average of 1.7° (0.9°) for the MHP and 0.6° (1.0°) for the TSP. Pair-wise comparisons of the interaction (using least significant difference adjustment for multiple comparisons) indicated that MHP heated faster than TSP at 12-min ($p = 0.02$), 16-min ($p = 0.002$), and 20-min ($p = 0.001$). There was no significant correlation between subcutaneous adipose thickness and maximum temperature increase obtained with either MHP ($r = -0.033$, $p = 0.90$) or TSP ($r = -0.080$, $p = 0.75$). The authors concluded that MHP increased IM temperature significantly more than TSP; however, neither modality was capable of producing a 3°C to 4°C temperature increase associated with increased tissue extensibility.

Kinesio Taping / McConnell Taping / Taping

Kinesio taping is a method of taping utilizing a specialized type of tape. It differs from traditional white athletic tape in the sense that it is elastic and can be stretched to 140 % of its original length before being applied to the skin. It subsequently provides a constant pulling (shear) force to the skin over which it is applied unlike traditional white athletic tape. The fabric of

this specialized tape is air permeable and water resistant and can be worn for repetitive days. Kinesio tape is being used immediately following injury and during the rehabilitation process. However, its effectiveness has yet to be established.

Halseth et al (2004) examined if Kinesio taping the anterior and lateral portion of the ankle would enhance ankle proprioception compared to the untaped ankle. A total of 30 subjects (15 men, 15 women, aged 18 to 30 years) participated in this study. Exclusion criteria: included ankle injury less than 6 months prior to testing, significant ligament laxity as determined through clinical evaluation, or any severe foot abnormality. Experiment utilized a single group, pre-test and post-test. Plantar flexion and inversion with 20° of plantar flexion reproduction of joint position sense (RJPS) was determined using an ankle RJPS apparatus. Subjects were bare-footed, blind-folded, and equipped with headphones playing white noise to eliminate auditory cues. They had 5 trials in both plantar flexion and inversion with 20° plantar flexion before and after application of the Kinesio tape to the anterior/lateral portion of the ankle. Constant error and absolute error were determined from the difference between the target angle and the trial angle produced by the subject. The treatment group (Kinesio taped subjects) showed no change in constant and absolute error for ankle RJPS in plantar flexion and 20º of plantar flexion with inversion when compared to the untaped results using the same motions. The application of Kinesio tape does not appear to enhance proprioception (in terms of RJPS) in healthy individuals as determined by measures of RJPS at the ankle in the motions of plantar flexion and 20º of plantar flexion with inversion. The authors stated that in order to fully understand the effect of Kinesio tape on proprioception, further research needs to be conducted on other joints, on the method of application of Kinesio tape, and the health of the subject to whom it is applied. In addition, further research may provide vital information about a possible benefit of Kinesio taping during the acute and sub-acute phases of rehabilitation, thus facilitating earlier return to activity participation.

In a pilot study, Yasukawa and colleagues (2006) described the use of the Kinesio taping method for the upper extremity in enhancing functional motor skills in children admitted into an acute rehabilitation program. A total of 15 children (10 females and 5 males; 4 to 16 years of age), who were receiving rehabilitation services at the Rehabilitation Institute of

Chicago participated in this study. For 13 of the inpatients, this was the initial rehabilitation following an acquired disability, which included encephalitis, brain tumor, cerebral vascular accident, traumatic brain injury, and spinal cord injury. The Melbourne Assessment of Unilateral Upper Limb Function (Melbourne Assessment) was used to measure upper-limb functional change prior to use of Kinesio tape, immediately after application of the tape, and 3 days after wearing tape. Children's upper-limb function was compared over the three assessments using analysis of variance. The improvement from pre- to post-taping was statistically significant, $F(1, 14) = 18.9$; $p < 0.02$. The authors concluded that these results suggested that Kinesio tape may be associated with improvement in upper-extremity control and function in the acute pediatric rehabilitation setting. The use of Kinesio Tape as an adjunct to treatment may assist with the goal-focused occupational therapy treatment during the child's inpatient stay. Moreover, they stated that further study is recommended to test the effectiveness of this method and to determine the lasting effects on motor skills and functional performance once the tape is removed.

In a pilot study, Fu and associates (2008) examined the possible immediate and delayed effects of Kinesio taping on muscle strength in quadriceps and hamstring when taping is applied to the anterior thigh of healthy young athletes. A total of 14 healthy young athletes (7 males and 7 females) free of knee problems were enrolled in this study. Muscle strength of the subject was assessed by the isokinetic dynamometer under three conditions: (i) without taping; (ii) immediately after taping; (iii) 12 hours after taping with the tape remaining in situ. The result revealed no significant difference in muscle power among the three conditions. Kinesio taping on the anterior thigh neither decreased nor increased muscle strength in healthy non-injured young athletes.

In a prospective, randomized, double-blinded, clinical study using a repeated-measures design, Thelen et al (2008) determined the short-term clinical efficacy of Kinesio tape when applied to college students with shoulder pain, as compared to a sham tape application. A total of 42 subjects with clinically diagnosed rotator cuff tendonitis and/or impingement were randomly assigned to 1 of 2 groups: therapeutic Kinesio tape group or sham Kinesio tape group. Subjects wore the tape

for 2 consecutive 3-day intervals. Self-reported pain and disability and pain-free active ranges of motion (ROM) were measured at multiple intervals to evaluate for differences between groups. The therapeutic Kinesio tape group showed immediate improvement in pain-free shoulder abduction (mean +/- SD increase, 16.9 degrees +/- 23.2 degrees ; p = 0.005) after tape application. No other differences between groups regarding ROM, pain, or disability scores at any time interval were found. The authors concluded that Kinesio tape may be of some assistance to clinicians in improving pain-free active ROM immediately after tape application for patients with shoulder pain. Utilization of Kinesio tape for decreasing pain intensity or disability for young patients with suspected shoulder tendonitis/impingement is not supported.

McConnell (2002) noted that the management of chronic low back pain (LBP) and leg pain has always provided a challenge for therapists. This researcher examined the influence of a repetitive movement such as walking as a possible causative factor of chronic LBP. Diminished shock absorption as well as limited hip extension and external rotation are hypothesized to affect the mobility of the lumbar spine resulting in lumbar spine dysfunction. Treatment must therefore be directed not only at increasing the mobility of the hips and thoracic spine, but also the stability of the lumbar spine. However, the symptoms can sometimes be exacerbated by treatment, so the neural tissue needs to unloaded to optimize the treatment outcome. This can be achieved by taping the buttock and down the leg following the dermatome to shorten the inflamed tissue.

While taping has a role in the management of musculoskeletal pain and injuries, its use in the management of LBP has not been established. In a review of LBP in athletes, Baker and Patel (2005) stated that most of the adult population experiences LBP at some time in life. Athletes may be at increased risk, but outcomes are good. The majority of LBP in adult athletes is mechanical in nature. Herniated discs, spinal stenosis, sacoilitis, and sacral stress fractures can also cause LBP in these individuals. Low back conditions mentioned above may be treated with rest, medication, as well as specific exercise programs. Surgery is indicated for severe spinal stenosis, pain with evidence of neurological compromise, and some painful deformities. Newer treatments for back pain are emerging, but few controlled clinical trials are available. Taping

was not mentioned as an option for managing individuals with LBP. Additionally, in a review of current concepts in the diagnosis and treatment of spondylolysis, McCleary and Congeni (2007) noted that treatment usually consists of rest and/or bracing to allow healing to occur, followed by rehabilitation that includes core strengthening. They stated that more large-scale controlled studies are needed to clarify the most effective diagnostic and therapeutic protocols. Furthermore, in reviews of treatment for subacute and chronic LBP (Chou, 2009) and occupational LBP (Kraeciw and Atlas, 2009), as well as review of rehabilitation program for the low back (Sheon andDuncombe, 2009), taping is not mentioned as an option.

Greig et al (2008) noted that greater thoracic kyphosis is associated with increased biomechanical loading of the spine which is potentially problematic in individuals with osteoporotic vertebral fractures. Conservative interventions that reduce thoracic kyphosis warrant further investigation. These researchers examined the effects of therapeutic postural taping on thoracic posture. Secondary aims explored the effects of taping on trunk muscle activity and balance. A total of 15 women with osteoporotic vertebral fractures participated in this within-participant design study. Three taping conditions were randomly applied: (i) therapeutic taping, (ii) control taping, and (iii) no taping. Angle of thoracic kyphosis was measured after each condition. Force plate-derived balance parameters and trunk muscle electromyographic activity (EMG) were recorded during 3 static standing tasks of 40-second duration. There was a significant main effect of postural taping on thoracic kyphosis ($p = 0.026$), with a greater reduction in thoracic kyphosis after taping compared with both control tape and no tape. There were no effects of taping on EMG or balance parameters. The authors concluded that these findings showed that the application of postural therapeutic tape in a population with osteoporotic vertebral fractures induced an immediate reduction in thoracic kyphosis. They stated that further research is needed to investigate the underlying mechanisms associated with this decrease in kyphosis.

The American College of Occupational and Environmental Medicine's practice guidelines on "Evaluation and management of common health problems and functional recovery in workers" (Hegmann, 2007) did not

recommend taping or kinesiotaping for acute, subacute, or chronic LBP, radicular pain syndromes or other back-related conditions.

González-Iglesias et al (2009) examined the short-term effects of Kinesio taping, applied to the cervical spine, on neck pain and cervical ROM in individuals with acute whiplash-associated disorders (WADs). A total of 41 patients (21 females) were randomly assigned to 1 of 2 groups: (i) the experimental group received Kinesio taping to the cervical spine (applied with tension) and (ii) the placebo group received a sham Kinesio taping application (applied without tension). Both neck pain (11-point numerical pain rating scale) and cervical ROM data were collected at baseline, immediately after the Kinesio tape application, and at a 24-hr follow-up by an assessor blinded to the treatment allocation of the patients. Mixed-model analyses of variance (ANOVAs) were used to examine the effects of the treatment on each outcome variable, with group as the between-subjects variable and time as the within-subjects variable. The primary analysis was the group-by-time interaction. The group-by-time interaction for the 2-by-3 mixed-model ANOVA was statistically significant for pain as the dependent variable ($F = 64.8$; $p < 0.001$), indicating that patients receiving Kinesio taping experienced a greater decrease in pain immediately post-application and at the 24-hr follow-up (both, $p < 0.001$). The group-by-time interaction was also significant for all directions of cervical ROM: flexion ($F = 50.8$; $p < 0.001$), extension ($F = 50.7$; $p < 0.001$), right ($F = 39.5$; $p < 0.001$) and left ($F = 3.8$, $p < 0.05$) lateral flexion, and right ($F = 33.9$, $p < 0.001$) and left ($F = 39.5$, $p < 0.001$) rotation. Patients in the experimental group obtained a greater improvement in ROM than those in the control group (all, $p < 0.001$). The authors concluded that patients with acute WAD receiving an application of Kinesio taping, applied with proper tension, exhibited statistically significant improvements immediately following application of the Kinesio tape and at a 24-hr follow-up. However, the improvements in pain and cervical ROM were small and may not be clinically meaningful. They stated that future studies should investigate if Kinesio taping provides enhanced outcomes when added to physical therapy interventions with proven efficacy or when applied over a longer period.

In a single-center, randomized, and double-blind study, Karadag-Saygi and colleagues (2010) evaluated the effect of kinesiotaping as an adjuvant therapy to botulinum toxin A (BTX-A) injection in lower extremity spasticity. A total of 20 hemiplegic patients with spastic equinus foot were enrolled into the study and randomized into 2 groups. The first group (n = 10) received BTX-A injection and kinesiotaping, and the second group (n = 10) received BTX-A injection and sham-taping. Clinical assessment was done before injection and at 2 weeks and 1, 3, and 6 months. Outcome measures were modified Ashworth scale (MAS), passive ankle dorsiflexion, gait velocity, and step length. Improvement was recorded in both kinesiotaping and sham groups for all outcome variables. No significant difference was found between groups other than passive range of motion (ROM), which was found to have increased more in the kinesiotaping group at 2 weeks. The authors concluded that there is no clear benefit in adjuvant kinesiotaping application with botulinum toxin for correction of spastic equinus in stroke.

In a pilot, feasibility study, Kalichman and colleagues (2010) evaluated the effect of Kinesio taping treatment approach on meralgia paresthetica (MP) symptoms. Men (n = 6) and women (n = 4) with clinically and electromyographically diagnosed MP received application of Kinesio tape, twice-weekly for 4 weeks (8 treatment sessions in total). Main outcome measures were visual analog scale (VAS) of MP symptoms (pain/burning sensation/paresthesia), VAS global quality of life (QOL); and the longest and broadest parts of the symptom area were measured. All outcome measures significantly improved after 4 weeks of treatment. Mean VAS QOL +/- SD decreased from 69.0 +/- 23.4 to 35.3 +/- 25.2 ($t = 4.3$; $p = 0.002$). Mean VAS of MP symptoms +/- SD decreased from 60.5 +/- 20.8 to 31.4 +/- 26.6 ($t = 5.9$; $p > 0.001$). Length and width of affected area decreased from 25.5 +/- 5.5 to 13.7 +/- 6.7 ($t = 5.1$; $p > 0.001$) and 15.3 +/- 2.1 to 7.4 +/- 4.3 ($t = 5.3$; $p > .001$), respectively. The authors concluded that Kinesio taping can be used in the treatment of MP. Moreover, they stated that future randomized, placebo-controlled trials should be designed with patients and assessors blind to the type of intervention.

Kaya et al (2011) compared the effectiveness of Kinesio tape and physical therapy modalities in patients with shoulder impingement syndrome. Patients (n = 55) were treated with Kinesio tape (n = 30) 3

times by intervals of 3 days or a daily program of local modalities (n = 25) for 2 weeks. Response to treatment was evaluated with the Disability of Arm, Shoulder, and Hand scale. Patients were questioned for the night pain, daily pain, and pain with motion. Outcome measures except for the Disability of Arm, Shoulder, and Hand scale were assessed at baseline, first, and second weeks of the treatment. Disability of Arm, Shoulder, and Hand scale was evaluated only before and after the treatment. Disability of Arm, Shoulder, and Hand scale and VAS scores decreased significantly in both treatment groups as compared with the baseline levels. The rest, night, and movement median pain scores of the Kinesio taping (20, 40, and 50, respectively) group were statistically significantly lower (p values were 0.001, 0.01, and 0.001, respectively) at the first week examination as compared with the physical therapy group (50, 70, and 70, respectively). However, there was no significant difference in the same parameters between the two groups at the second week (0.109, 0.07, and 0.218 for rest, night, and movement median pain scores, respectively). Disability of Arm, Shoulder, and Hand scale scores of the Kinesio taping group were significantly lower at the second week as compared with the physical therapy group. No side effects were observed. Kinesio tape has been found to be more effective than the local modalities at the first week and was similarly effective at the second week of the treatment. The authors stated that Kinesio taping may be an alternative treatment option in the treatment of shoulder impingement syndrome especially when an immediate effect is needed. The findings of this small study need to be validated by well-designed studies.

Ankle sprains are common in sports and the fibularis muscles play a role in providing functional stability of the ankle. Prophylactic ankle taping with non-elastic sports tape has been used to restrict ankle inversion, while Kinesio tape is elastic and has not been studied for that purpose. In a controlled study, Briem and colleagues (2011) examined the effect of 2 adhesive tape conditions compared to a no tape condition on muscle activity of the fibularis longus during a sudden inversion perturbation in male athletes (soccer, team handball, basketball). A total of 51 male premier-league athletes were tested for functional stability of both ankles with the Star Excursion Balance Test. Based on the results, those with the 15 highest and those with the 15 lowest stability scores were selected for further testing. Muscle activity of the fibularis longus was recorded with surface electromyography during a sudden inversion perturbation.

Each participant was tested under 3 conditions: (i) with the ankle taped with non-elastic, white sports tape, (ii) Kinesio tape, and (iii) with no tape. Differences in mean muscle activity were evaluated with a 3-way mixed model ANOVA for the 3 conditions across four 500-ms time-frames (within subject factors) and between the 2 groups of stable versus unstable participants (between subjects factor). Differences in peak muscle activity and in the time to peak muscle activity were evaluated with a 2-way mixed model ANOVA for the 3 conditions (within subjects factor), between the 2 groups (between subjects factor). Significantly greater mean muscle activity was found when ankles were taped with non-elastic tape compared to no tape, while Kinesio tape had no significant effect on mean or maximum muscle activity compared to the no tape condition. Neither stability level nor taping condition had a significant effect on the amount of time from perturbation to maximum activity of the fibularis longus muscle. The authors concluded that non-elastic sports tape may enhance dynamic muscle support of the ankle. The efficacy of Kinesio tape in preventing ankle sprains via the same mechanism is unlikely as it had no effect on muscle activation of the fibularis longus.

Pfeiffer et al (2004) evaluated the effectiveness of McConnell medial glide taping after exercise using an MRI extremity scanner. A total of 18 healthy women (mean age of 22.28 +/- 2.02 years) participated in the study. The patello-femoral joint was imaged at 4 knee flexion angles (0 degrees, 12 degrees, 24 degrees, and 36 degrees) in 3 conditions (no tape, with McConnell taping-medial glide, and with tape after exercise). Effectiveness was determined by measuring lateral patellar displacement. ANOVA and post-hoc paired t tests were used to test for changes in lateral patellar displacement at each knee angle and condition. Statistical analysis revealed significant differences in lateral patellar displacement at all test angles, between the tape and no tape and between tape and tape after exercise conditions. The authors concluded that McConnell medial glide taping resulted in significant medial glide of the patello-femoral joint at all 4 knee angles before but not after exercise. However, McConnell medial glide taping may be effective under controlled rehabilitation conditions in which exercise is less intense.

Aminaka and Gribble (2005) examined the effectiveness of patellar taping on pain control, patellar alignment, and neuromuscular control (i.e., vastus medialis oblique activation, knee extensor moment, etc.,) in subjects with patello-femoral pain syndrome (PFPS). These investigators searched MEDLINE, SPORT Discus, PEDro, and CINAHL through December 2004, using the key words patellar taping, therapeutic taping, McConnell taping, taping, chronic injury, patello-femoral pain, and knee. Criteria for inclusion criteria were studies that exclusively recruited patients diagnosed with PFPS or anterior knee pain and outcome measures specific to pain reduction, neuromuscular control, and patellar positioning. These researchers identified and reviewed 16 studies with an average PEDro score of 4.25/10. Articles were divided into 3 categories based on primary outcome measures: 4 randomized controlled trials on treatment methods and pain, 9 studies on neuromuscular control, and 3 on patellar positioning. The authors concluded that although patellar taping seems to reduce pain and improve function in people with PFPS during activities of daily living and rehabilitation exercise, strong evidence to identify the underlying mechanisms is still not available.

Derasari et al (2010) quantified the changes in the 6-degrees-of-freedom patello-femoral kinematics due to taping in patients with PFPS. A within-subject design and a sample of convenience were used. A total of 14 volunteers (19 knees) who were diagnosed with patello-femoral pain that was present for 1 year or longer were included in this study. Each knee had to meet at least 1 of the following inclusion criteria: Q-angle of greater than or equal to 15 degrees, a positive apprehension test, patellar lateral hypermobility (greater than or equal to 10 mm), or a positive "J sign". Each knee underwent 2 randomly ordered testing conditions (un-taped and taped). A full fast-phase contrast (PC) magnetic resonance image set was acquired for each condition while the participants volitionally extended and flexed their knee. Three-dimensional displacements and rotations were calculated through integration of the fast-PC velocity data. Statistical comparisons between baseline patello-femoral kinematics and the change in kinematics due to taping were performed using a 2-tailed paired Student t test. Correlations between baseline patello-femoral kinematics and the change in kinematics due to taping also were quantified. Patellar taping resulted in a significant patello-femoral inferior shift. The strongest correlation existed between the change in lateral-medial displacement with taping and baseline (r =

-0.60). The authors concluded that the inferior shift in patellar displacement with taping partially explains the previously documented decrease in pain due to increases in contact area. The lack of alteration in 5 of the 6 kinematic variables with taping may have been due to the fact that post-taping kinematic alterations are sensitive to the baseline kinematic values.

Chang and colleagues (2015) performed a systematic review comparing the effects of Kinesio taping with McConnell taping as a method of conservative management of patients with PFPS. Medline, PubMed, Embase, AMED, and the Cochrane Central Register of Control Trials electronic databases were searched through July 2014. Controlled studies evaluating the effects of Kinesio or McConnell taping in PFPS patients were retrieved. A total of 91 articles were selected from the articles that were retrieved from the databases, and 11 articles were included in the analysis. The methods, evaluations, and results of the articles were collected, and the outcomes of patellar tapings were analyzed. Kinesio taping can reduce pain and increase the muscular flexibility of PFPS patients, and McConnell taping also had effect in pain relief and patellar alignment. Meta-analysis showed small effect in pain reduction and motor function improvement and moderate effect in muscle activity change among PFPS patients using Kinesio taping. The authors concluded that Kinesio taping and McConnell taping are 2 types of patellar taping used to treat patients with PFPS. Kinesio taping could be applied to muscles to relieve pain, but there was a lack of evidence on effect of the effects of taping on patellar alignment correction. McConnell taping could adjust patellar alignment and tracking but did not improve proprioception and motor function for PFPS. Based on the current review study, both types of taping significantly improved muscle activity, motor function, and QOL, benefits which are possibly facilitated by pain relief. Moreover, they stated that further research examining the mechanism of pain relief is needed.

Leibbrandt and Louw (2015) reviewed the available evidence for the effect of McConnell taping on knee biomechanics in individuals with anterior knee pain. The PubMed, Medline, Cinahl, SPORTDiscus, PEDro and ScienceDirect electronic databases were searched from inception until September 2014. Experimental research on knee biomechanical or EMG outcomes of McConnell taping compared with no tape or placebo

tape were included. Two reviewers completed the searches, selected the full text articles, and assessed the risk of bias of eligible studies. Authors were contacted for missing data. A total of 8 heterogeneous studies with a total sample of 220 were included in this review. All of the studies had a moderate-to-low risk of bias. Pooling of data was possible for 3 outcomes: average knee extensor moment, average VMO/VL ratio and average VMO-VL onset timing. None of these outcomes revealed significant differences. The authors concluded that the evidence is currently insufficient to justify routine use of the McConnell taping technique in the treatment of anterior knee pain. They stated that there is a need for more evidence on the etiological pathways of anterior knee pain, level I evidence, and studies investigating other potential mechanisms of McConnell taping.

The 2016 Patellofemoral pain consensus statement from the 4th International Patellofemoral Pain Research Retreat, Manchester (Crossley et al, 2016) stated that “Whether patellar taping should be first-line treatment for patellofemoral pain was unclear to this expert panel. This conclusion was consistent with the ‘Best Practice Guide’13 findings. Patellar taping approaches vary considerably with respect to the type and duration of taping, and the systematic reviews that synthesize these studies have dealt with the variability inconsistently. Lack of clarity from systematic reviews may partially explain the uncertainty around the consensus voting and associated recommendations to support patellar taping. Uncertainty around the recommendations for taping might also reflect that greater consideration of individual patient needs may be required. For example, in Barton et al (2015)’s synthesis, the experts described that targeting the taping to suit individual patient presentations was an important consideration. Patellar taping and bracing could play a role in patellofemoral pain management in combination with other treatments (i.e., as part of a combined intervention as described above), but their role in isolation is yet to be fully determined. Other adjunctive treatments, such as joint mobilizations (patella, knee, lumbar), and electrophysical agents were not recommended for use in patellofemoral pain”.

Ho and co-workers (2017) examined the effects of 2 taping approaches (Kinesio and McConnell) on patellofemoral joint (PFJ) alignment and contact area. A total of 14 female subjects with patello-femoral pain and

PFJ mal-alignment participated. Each subject underwent a pre-taping magnetic resonance imaging (MRI) scan session and 2 MRI scan sessions after the application of the 2 taping techniques, which aimed to correct lateral patellar displacement. Subjects were asked to report their pain level prior to each scan session. During MRI assessment, subjects were loaded with 25 % of body weight on their involved/more symptomatic leg at 0°, 20°, and 40° of knee flexion. The outcome measures included patellar lateral displacement (bisect-offset [BSO] index), medio-lateral patellar tilt angle, patellar height (Insall-Salvati ratio), contact area, and pain. Patello-femoral joint alignment and contact area were compared among the 3 conditions (no tape, Kinesio, and McConnell) at 3 knee angles using a 2-factor, repeated-measures analysis of variance. Pain was compared among the 3 conditions using the Friedman test and post-hoc Wilcoxon signed-rank tests. The results did not reveal any significant effects of either McConnell or Kinesio taping on the BSO index, patellar tilt angle, Insall-Salvati ratio, or contact area across the 3 knee angles, whereas knee angle had a significant effect on the BSO index and contact area. A reduction in pain was observed after the application of the Kinesio taping technique. The authors concluded that in a weight-bearing condition, this preliminary study did not support the use of PFJ taping as a medial correction technique to alter the PFJ contact area or alignment of the patella.

MEDEK Therapy

MEDEK, a form of physiotherapy, refers to Metodo Dinamico de Estimulacion Kinesica or Dynamic Method for Kinetic Stimulation. It was developed by a Chilean physical therapist in the 1970s. MEDEK is used for developing gross motor skills in children with physical disabilities and movement disorders (e.g., cerebral palsy, Down syndrome, hypotonia, muscular dystrophy, and developmental motor delay). It does not focus on modifying muscle tone, primitive reflexes or abnormal patterns of movement. It focuses on training movements leading to sitting, standing, and walking. Muscles are trained in postural and functional tasks rather than in isolation. Tight muscles are stretched in dynamic situations. The motor developmental sequence is not used. MeDEK assumes that different skills require different movement strategies. Unlike other interventions, tasks are performed without the child's attention, conscious thought or co-operation. It is assumed that motivation will increase

temporary performance only but will not create a permanent change. The therapist's task is to provoke automatic postural reactions that contribute to the postural control needed for functional tasks. Well-designed clinical studies are needed to ascertain the effectiveness of MEDEK.

Hands-Free Ultrasound

Gulick (2010) noted that a "hands-free" ultrasound (US) device was recently introduced by Rich-Ma, Inc. This unit allows the clinician to choose the mode of US delivery, using either a hand-held (manual) transducer or a hands-free device that pulses the US beam through the transducer. However, the Center for Medicare and Medicaid Services has deemed delivery of US via a hands-free unit to be investigational. This investigator examined the effectiveness of tissue heating with a hands-free US technique compared to a hand-held US transducer using the Rich-Mar AutoSound unit. A total of 40 volunteers over 18 years of age participated. Treatment was provided at a 3-MHz US frequency. Muscle temperature was measured with 26-gauge, 4-cm Physiotemp thermistors placed in the triceps surae muscle. The depth of thermistor placement was at 1-cm and 2-cm deep. One calf was treated with a manual transducer (5-cm(2) US head at 3 times the effective radiating area [ERA]), and one calf was treated with the hands-free transducer (14-cm(2) [ERA]). Both methods used a 1.5 W/cm(2) intensity for 10 mins. The manual technique used an overlapping circular method at 4 cm/sec, and the hands-free method used a sequential pulsing at 4 cm/sec. Tissue temperatures were recorded at baseline and every 30 seconds. The hands-free technique resulted in a tissue temperature increase from 33.68 to 38.7 degrees C and an increase from 33.45 to 40.1 degrees C using the manual technique at 1-cm depth. The tissue temperature increase at the 2-cm depth was from 34.95 to 35.44 degrees C for the hands-free device and 34.44 to 38.42 degrees C for the manual device. Thus, there was a significant difference between the hands-free and the manual mode of US delivery for the 3-MHz frequency (5.02 degrees C versus 6.65 degrees C at 1 cm and 1.49 degrees C versus 3.98 degrees C at 2 cm). In this study, the "hands-free" device did not result in the same level of tissue heating as the manual technique. The hands-free device has the advantage of not needing a clinician present to deliver the

modality but a therapeutic level of heating was not achieved at the 2-cm tissue depth. Thus, the effectiveness of the "hands-free" treatment is in question.

Hivamat Therapy (Deep Oscillation Therapy)

Hivamat therapy (deep oscillation therapy) utilizes an intermittent electrostatic field via a Hivamat machine. It supposedly penetrates deeper into the body tissue than manual methods, allowing previously “untreatable” injuries to be manipulated with a minimum of physical pressure. Electrostatic waves create a kneading effect deep within the damaged tissues, restoring flexibility and blood supply to the affected area.

Aliyev (2009) noted that in Germany approximately 2 million sports injuries occur per year. Most common are distortions and ligamentous injury going along with post-traumatic lymphedema. Deep oscillation therapy provided very good results in lymph drainage and in other indications. The purpose of this experimental study was the evaluation of the effects of deep oscillation therapy in immediate therapy and after-care of different sports injuries in addition to usual care (complex physical and medical therapy). Two soccer teams were supported by a sports medicine section of a rehabilitation hospital. In 14 people (mean age of 23.9 years), 49 sports injuries of different kind were treated. Subjective rating of the symptoms by VAS improved significant ($p = 0.001$) from 8.7 (baseline) to 2.1 points (post-treatment). Objective rating by the attending physician according to different clinically relevant parameters lead to "very good" or "good" results in 90 % of the patients. The authors concluded that deep oscillation therapy is an easy to use and comparably cost-effective adjuvant therapy option. These investigators already had good experience with it in other indications concerning re-absorption of edema, reducing pain, anti-inflammatory effect, promotion of motoricity, promotion of wound healing, anti-fibrotic effect and improvement in trophicity and quality of the tissue. All these mentioned effects can be confirmed in the treatment of patients with acute sports injury and trauma. The soft mode of action is the reason that in contrast to other electric and mechanical therapies it is no contraindication in immediate therapy. In general the authors noted no side effects; patients were

highly compliant and rated this therapy as very good. Limitations of this small study (n = 14) were its retrospective and uncontrolled nature; findings were also confounded by the concomitant use of usual care.

Applied Functional Science

Applied Functional Science (AFS) combines physical sciences, biological sciences, and behavioral sciences to create a system for functional assessment, rehabilitation, training and conditioning, as well as injury prevention. The advocates of AFS note that these principles, integrated with neuromusculoskeletal Chain Reaction™ biomechanics, lead to strategies that guide the decision-making process. However, there is a lack of evidence regarding the clinical value of this approach.

Myofascial Physical Therapy for Pelvic Pain Syndromes

Fitzgerald et al (2013) determined the feasibility of conducting a randomized clinical trial designed to compare 2 methods of manual therapy (myofascial physical therapy and global therapeutic massage) in patients with urological chronic pelvic pain syndromes. They recruited 48 subjects with chronic prostatitis/chronic pelvic pain syndrome or interstitial cystitis/painful bladder syndrome at 6 clinical centers. Eligible patients were randomized to myofascial physical therapy or global therapeutic massage and were scheduled to receive up to 10 weekly treatments of 1-hour each. Criteria to assess feasibility included adherence of therapists to prescribed therapeutic protocol as determined by records of treatment, adverse events during study treatment and rate of response to therapy as assessed by the patient global response assessment. Primary outcome analysis compared response rates between treatment arms using Mantel-Haenszel methods. There were 23 (49 %) men and 24 (51 %) women randomized during a 6-month period. Of the patients 24 (51 %) were randomized to global therapeutic massage, 23 (49 %) to myofascial physical therapy and 44 (94 %) completed the study. Therapist adherence to the treatment protocols was excellent. The global response assessment response rate of 57 % in the myofascial physical therapy group was significantly higher than the rate of 21 % in the global therapeutic massage treatment group ($p = 0.03$). The authors concluded the preliminary findings of a beneficial effect of myofascial physical

therapy warrants further study. They stated that they are conducting a second small study comparing myofascial physical therapy and global therapeutic massage (with a sample size of approximately 90 at 11 sites.

Pontari and Giusto (2013) described new developments in the diagnosis and treatment of chronic prostatitis/chronic pelvic pain syndrome (CPPS). Symptoms in men with chronic prostatitis/CPPS appear to cluster into a group with primarily pelvic or localized disease, and a group with more systemic symptoms. Several other chronic pain conditions can be associated with chronic prostatitis/CPPS, including irritable bowel syndrome, fibromyalgia, and chronic fatigue syndrome. Markers of neurologic inflammation and autoimmune disease parallel changes in symptoms after treatment. Treatment options include new alpha-blockers, psychological intervention, and prostate-directed therapy. The areas of acupuncture and pelvic floor physical therapy/myofascial release have received increased recent attention and appear to be good options in these patients. Future therapy may include antibodies to mediators of neurogenic inflammation and even treatment of bacteria in the bowel. The authors concluded that the diagnosis of chronic prostatitis/CPPS must include conditions traditionally outside the scope of urologic practice but important for the care of men with chronic pelvic pain. The treatment is best done using multiple simultaneous therapies aimed at the different aspects of the condition.

Fitzgerald et al (2013) determined the feasibility of conducting a randomized clinical trial designed to compare 2 methods of manual therapy (myofascial physical therapy and global therapeutic massage) in patients with urological CPPS. These researchers recruited 48 subjects with chronic prostatitis/CPPS or interstitial cystitis/painful bladder syndrome at 6 clinical centers. Eligible patients were randomized to myofascial physical therapy or global therapeutic massage and were scheduled to receive up to 10 weekly treatments of 1 hour each. Criteria to assess feasibility included adherence of therapists to prescribed therapeutic protocol as determined by records of treatment, adverse events during study treatment and rate of response to therapy as assessed by the patient global response assessment. Primary outcome analysis compared response rates between treatment arms using Mantel-Haenszel methods. There were 23 (49 %) men and 24 (51 %) women randomized during a 6-month period. Of the patients 24 (51 %) were

randomized to global therapeutic massage, 23 (49 %) to myofascial physical therapy and 44 (94 %) completed the study. Therapist adherence to the treatment protocols was excellent. The global response assessment response rate of 57 % in the myofascial physical therapy group was significantly higher than the rate of 21 % in the global therapeutic massage treatment group (p = 0.03). The authors concluded that they judged the feasibility of conducting a full-scale trial of physical therapy methods and the preliminary findings of a beneficial effect of myofascial physical therapy warrants further study.

The European Association of Urology's guidelines on chronic pelvic pain (Engeler et al, 2012) stated that "There are insufficient data on the effectiveness of myofascial physical therapy for the treatment of PPS (prostate pain syndrome)".

Krauss et al (2011) stated that hip osteoarthritis (OA) is a disease with a major impact on both national economy and the patients themselves. Patients suffer from pain and functional impairment in ADL that are associated with a decrease in QOL. Conservative therapeutic interventions such as physical exercises aim at reducing pain and increasing function and health-related QOL. However, there is only silver level evidence for efficacy of land-based physical exercise in the treatment of hip OA. The purpose of this randomized controlled trial (RCT) is to examine if the specific 12-week exercise regime "Hip School" can decrease bodily pain and improve physical function and QOL in subjects with hip OA. A total of 217 participants with hip OA, confirmed using the clinical score of the American College of Rheumatology, are recruited from the community and randomly allocated to one of the following groups: (i) exercise regime "Hip School", n = 70; (ii) non-intervention control group, n = 70; (iii) "sham" ultrasound group, n = 70; and (iv) ultrasound group, n = 7. The exercise regime combines group exercises (1/week, 60 to 90 mins) and home-based exercises (2/week, 30 to 40 mins). Sham ultrasound and ultrasound are given once-weekly (15 mins). Measures were taken directly prior to (M1) and after (M2) the 12-week intervention period. Two follow-ups are conducted by phone 16 and 40 weeks after the intervention period. The primary outcome measure is the change in the subscale bodily pain of the SF36 from M1 to M2. Secondary outcomes comprise the Western Ontario and

McMaster Universities Osteoarthritis Index (WOMAC) score, SF36, isometric strength of hip muscles, spatial-temporal and discrete measures derived from clinical gait analysis, and the length of the center of force path in different standing tasks. An intension-to-treat analysis will be performed using multi-variate statistics (group × time). The authors concluded that results from this trial will contribute to the evidence regarding the effect of a hip-specific exercise regime on physical function, pain, and health-related QOL in patients with hip OA.

French et al (2013) determined the effectiveness of exercise therapy (ET) compared with ET with adjunctive manual therapy (MT) for people with hip OA; and identified if immediate commencement of treatment (ET or ET+MT) was more beneficial than a 9-week waiting period for either intervention. Patients (n = 131) with hip OA recruited from general practitioners, rheumatologists, orthopedic surgeons, and other hospital consultants were randomized to 1 of 3 groups: ET (n = 45), ET+MT (n = 43), and wait-list controls (n = 43). Participants in both the ET and ET+MT groups received up to 8 treatments over 8 weeks. Control group participants were re-randomized into either ET or ET+MT groups after 9 week follow-up. Their data were pooled with original treatment group data: ET (n = 66) and ET+MT (n = 65). The primary outcome was the WOMAC physical function (PF) subscale. Secondary outcomes included physical performance, pain severity, hip ROM, anxiety/depression, QOL, medication usage, patient-perceived change, and patient satisfaction. There was no significant difference in WOMAC PF between the ET (n = 66) and ET+MT (n = 65) groups at 9 weeks (mean difference of 0.09; 95 % confidence interval [CI]: -2.93 to 3.11) or 18 weeks (mean difference of 9.42; 95 % CI: -4.41 to 5.25), or between other outcomes, except patient satisfaction with outcomes, which was higher in the ET+MT group (p = 0.02). Improvements in WOMAC, hip ROM, and patient-perceived change occurred in both treatment groups compared with the control group. The authors concluded that self-reported function, hip ROM, and patient-perceived improvement occurred after an 8-week program of ET for patients with OA of the hip; MT as an adjunct to exercise provided no further benefit, except for higher patient satisfaction with outcome.

Bennell et al (2014) stated that there is limited evidence supporting use of physical therapy for hip OA. These investigators examined the effectiveness of physical therapy on pain and physical function in patients

with hip OA. Randomized, placebo-controlled, participant- and assessor-blinded trial involving 102 community volunteers with hip pain levels of 40 or higher on a VAS of 100 mm (range of 0 to 100 mm; 100 indicates worst pain possible) and hip OA confirmed by radiograph were included for analysis. A total of 49 patients in the active group and 53 in the sham group underwent 12 weeks of intervention and 24 weeks of follow-up (May 2010 to February 2013). Participants attended 10 treatment sessions over 12 weeks. Active treatment included education and advice, manual therapy, home exercise, and gait aid if appropriate. Sham treatment included inactive ultrasound and inert gel. For 24 weeks after treatment, the active group continued unsupervised home exercise while the sham group self-applied gel 3 times weekly. Primary outcomes were average pain (0 mm, no pain; 100 mm, worst pain possible) and physical function (WOMAC, 0 no difficulty to 68 extreme difficulty) at week 13. Secondary outcomes were these measures at week 36 and impairments, physical performance, global change, psychological status, and QOL at weeks 13 and 36. A total of 96 patients (94 %) completed week 13 measurements and 83 (81 %) completed week 36 measurements. The between-group differences for improvements in pain were not significant. For the active group, the baseline mean (SD) VAS score was 58.8 mm (13.3) and the week-13 score was 40.1 mm (24.6); for the sham group, the baseline score was 58.0 mm (11.6) and the week-13 score was 35.2 mm (21.4). The mean difference was 6.9 mm favoring sham treatment (95 % CI: -3.9 to 17.7). The function scores were not significantly different between groups. The baseline mean (SD) physical function score for the active group was 32.3 (9.2) and the week-13 score was 27.5 (12.9) units, whereas the baseline score for the sham treatment group was 32.4 (8.4) units and the week-13 score was 26.4 (11.3) units, for a mean difference of 1.4 units favoring sham (95 % CI: -3.8 to 6.5) at week 13. There were no between-group differences in secondary outcomes (except greater week-13 improvement in the balance step test in the active group); 19 of 46 patients (41 %) in the active group reported 26 mild adverse effects and 7 of 49 (14 %) in the sham group reported 9 mild adverse events ($p = 0.003$). The authors concluded that among adults with painful hip OA, physical therapy did not result in greater improvement in pain or function compared with sham treatment, raising questions about its value for these patients.

Yim et al (2015) reviewed the current literature on the effect of physical therapy on healing and QOL outcomes in patients with venous leg ulcers (VLUs) and identified research gaps that warrant further investigation. PubMed (MEDLINE), CINHAHL, and Cochrane databases were searched in April 2014. These researchers found 10 articles, consisting of RCTs and single-arm cohort studies with small sample sizes that used physical therapy or exercise for patients with open or healed VLUs. Although there is evidence that exercise strengthens the calf muscle pump and improves ankle ROM, few studies have investigated the effect of these interventions on QOL and healing, and few involved the supervision of a physical therapist. The authors concluded that the lack of evidence and RCTs suggested the need for further investigation on physical therapy-oriented exercise on wound healing and QOL. In addition, more studies are needed to investigate sustainability of the increased ankle ROM after physical therapy has ended or if VLU reoccurrences are prevented.

De Groef et al (2015) reviewed the effectiveness of various post-operative physical therapy modalities and timing of physical therapy following treatment of breast cancer on pain and impaired ROM of the upper limb. These modalities include passive mobilizations, manual stretching, myofascial therapy and active exercises. These investigators searched the following databases: PubMed/MEDLINE, CINAHL, EMBASE, PEDro and Cochrane; articles published until October 2012 were included. Only (pseudo-) RCTs and non-randomized experimental trials investigating the effectiveness of passive mobilizations, manual stretching, myofascial therapy and/or exercise therapy and timing of physical therapy, following treatment for breast cancer, were reviewed. Primary outcomes were pain of the upper limb and/or ROM of the shoulder. Secondary outcomes are decreased shoulder strength, arm lymphedema, limitations in ADL, decreased quality of life and wound drainage volume. Physical therapy modalities had to be started in the first 6 weeks following surgery. Articles were selected by 2 independent researchers in 3 phases and compared for consensus. First the titles were analyzed, then the selected abstracts and finally the full texts. A total of 18 RCTs were included in the review. Three studies investigated the effect of multi-factorial therapy: 2 studies proved that the combination of general exercises and stretching is effective for the treatment of impaired ROM; another study showed that passive mobilizations combined with massage had no beneficial effects on pain and impaired

ROM. Fifteen studies investigated the effectiveness of a single physical therapy modality. One study of poor quality found evidence supporting the beneficial effects of passive mobilizations. The only study investigating the effect of stretching did not find any beneficial effects. No studies were found about the effectiveness of myofascial therapy in the post-operative phase. Five studies found that active exercises were more effective compared to no therapy or compared to information on the treatment of impairments of the upper limb. Three studies supported the early start of exercises for recovery of shoulder ROM, while 4 studies supported the delay of exercises to avoid prolonged wound healing. The authors concluded that multi-factorial physical therapy (i.e. stretching and exercises) and active exercises were effective to treat post-operative pain and impaired ROM following treatment for breast cancer. Moreover, they stated that high-quality studies are needed to prove the effectiveness of passive mobilizations, stretching and myofascial therapy as part of the multi-factorial treatment. In addition, the appropriate timing and content of the exercise programs need to be further investigated.

Michaleff et al (2014) examined the effectiveness of a comprehensive exercise program delivered by physiotherapists compared with advice in people with a chronic whiplash-associated disorder. PROMISE was a 2-group, pragmatic RCT in patients with chronic (greater than 3 months and less than 5 years) grade 1 or 2 whiplash-associated disorder. Participants were randomly assigned by a computer-generated randomization schedule to receive either the comprehensive exercise program (20 sessions) or advice (1 session and telephone support). Sealed opaque envelopes were used to conceal allocation. The primary outcome was pain intensity measured on a 0 to 10 scale. Outcomes were measured at baseline, 14 weeks, 6 months, and 12 months by a masked assessor. Analysis was by intention-to-treat, and treatment effects were calculated with linear mixed models. A total of 172 participants were allocated to either the comprehensive exercise program (n = 86) or advice group (n = 86); 157 (91 %) were followed up at 14 weeks, 145 (84 %) at 6 months, and 150 (87 %) at 12 months. A comprehensive exercise program was not more effective than advice alone for pain reduction in the participants. At 14 weeks the treatment effect on a 0 to 10 pain scale was 0.0 (95 % CI: -0.7 to 0.7), at 6 months 0.2 (-0.5 to 1.0), and at 12 months -0.1 (-0.8 to 0.6). Central nervous system hyper-excitability and symptoms of post-traumatic stress did not

modify the effect of treatment. These researchers recorded no serious adverse events. The authors concluded that simple advice is equally as effective as a more intense and comprehensive physiotherapy exercise program in the treatment of whiplash-associated disorder. They stated that the need to identify effective and affordable strategies to prevent and treat acute through to chronic whiplash associated disorders is an important health priority; future avenues of research might include improving understanding of the mechanisms responsible for persistent pain and disability, investigating the effectiveness and timing of drugs, and study of content and delivery of education and advice.

Miscellaneous Information

Zhou et al (2015) noted that management of chronic wounds remains unsatisfactory in terms of treatment cost and time required for complete wound closure (CWC). These investigators calculated the healing rates, estimated cost, and time required for CWC in wounds; compare estimated wound care costs between healing and non-healing wounds; and compared cost effectiveness between venous leg ulcer (VLU) and non-VLU. This was a retrospective cohort study performed at a physical therapy (PT) wound care clinic. De-identified patient data in the electronic medical database from September 10, 2012 to January 23, 2015 were extracted. Among 159 included patients with wounds, 119 (74.84 %) patients were healed with CWC. The included patients were treated for 109.70 ±95.70 days, 29.71±25.66 visits, and at the costs per treatment episode of $1,629.65±1,378.82 per reimbursement rate and $2,711.42±2,356.81 per breakeven rate. For patients with CWC (healing group), the treatment duration was 98.01±76.12 days with the time for CWC as 72.45±64.21 days; the cost per treatment episode was $1,327.24±1,143.53 for reimbursement rate and $2,492.58±2,106.88 for breakeven cost. For patients with non-healing wounds, treatment duration was found to be longer with costs significantly higher ($p<0.01$ for all). In the healing group, no differences were found between VLU and non-VLU in treatment duration (95.46 days versus 100.88 days, $p=0.698$), time for CWC (68.06 days versus 77.38 days, $p=0.431$), and cost ($2,756.78 versus 2,397.84 for break-even rate, $p=0.640$) with the exception of wound dressing costs ($329.19 versus 146.47, $p=0.001$). Healing rates may be affected with patient exclusions. Costs at physicians' offices were not included. Incorporation of PT in wound care

appeared to be cost-effective. The authors concluded that PT may thus be a good referral option for patients with wounds; however, these findings should be interpreted cautiously and further studies are needed.

Moss and colleagues (2016) stated that early PT interventions may benefit patients with acute respiratory failure by preventing or attenuating neuromuscular weakness. However, the optimal dosage of these interventions is currently unknown. These researchers examined if an intensive PT program significantly improves long-term physical functional performance when compared to a standard of care PT program. Patients who required mechanical ventilation for at least 4 days were eligible. Enrolled patients were randomized to receive PT for up to 4 weeks delivered in an intensive or standard of care manner. Physical functional performance was assessed at 1, 3, and 6 months in survivors who were not currently in an acute or long-term care facility. The primary outcome was the Physical Functional Performance Test score at 1 month. A total of 120 patients were enrolled from 5 hospitals. Patients in the intensive PT group received 12.4 ± 6.5 sessions for a total of 408 ± 261 minutes compared to only 6.1 ± 3.8 sessions for 86 ± 63 minutes in the standard of care group ($p < 0.001$ for both analyses). Physical function assessments were available for 86 % of patients at 1 month, 76 % at 3 months, and 60 % at 6 months. In both groups, physical function was reduced yet significantly improved over time between 1, 3, and 6 months. When comparing the 2 interventions, there were no differences in the total PFP-10 scores at all 3 time-points ($p = 0.73$, 0.29, and 0.43 respectively), or the total PFP-10 score trajectory ($p = 0.71$). The authors concluded that an intensive PT program did not improve long term physical functional performance when compared to a standard of care program.

McKenzie Method of Mechanical Diagnosis and Therapy

Flavell et al (2016) noted that physiotherapists use musculo-skeletal classification systems for patient assessment. Since its early development, the McKenzie lumbar spine assessment (MK) has been incorporated into examination algorithms and combined with a series of patho-anatomical diagnostic tests. No previous studies have used a MK and a combined examination (MK-C) to provide a detailed profile of patients, report and compare the classification characteristics of a chronic

LBP (CLBP) population. In a prospective, cross-sectional study, these investigators reported the classification characteristics of a CLBP population using MK and MK-C examinations, and conducted inter-classification comparison of the MK-C for demographics, the Oswestry Disability Index (ODI), Roland Morris Disability Index (RM), Modified Somatic Perceptions Questionnaire (MSPQ), symptom duration and intensity. Results were obtained in 150 patients. Using MK, 31 % (n = 47) of participants were classified as inconclusive. Following MK-C only 6 % of participants remained inconclusive (n = 9). The most frequent MK-C classification was facet joint syndrome (FJS) (49 %). Participants with FJS were significantly older than those classified as discogenic ($p < 0.001$; 95 % CI: 3.96–to 19.74), or mixed ($p < 0.001$; 95 % CI: 5.98–to 36.41). Participants classified as discogenic had significantly higher RM ($p = 0.022$) and MSPQ ($p = 0.005$) scores than FJS. The authors concluded that results indicated that 94 % of CLBP patients could be classified using a MK-C. The most common presentation in CLBP was facet joint syndrome. Age, RM and MSPQ appeared to be distinguishing characteristics of this population. Moreover, they stated that future studies should be conducted to establish the validity and reliability of the MK-C.

Clare et al (2004) performed a systematic review of randomized clinical trials to investigate the effectiveness of McKenzie therapy in the treatment of spinal pain. Databases searched included DARE, CINAHL, CENTRAL, Embase, Medline and PEDro. To be eligible for inclusion trials had to provide treatment according to McKenzie principles and reported on 1 of the following outcomes: pain, disability, quality of life, work status, global perceived effect, medication use, health care contacts, or recurrence. A total of 6 trials were found to be eligible, all comparing McKenzie therapy to a comparison treatment. These included NSAIDS, educational booklet, back massage and back care advice, strength training, and spinal mobilization and general exercises. The data from 5 lumbar trials were pooled at short-term (less than 3 months) and from 3 at intermediate (3 to 12 months) follow-up. At short term follow-up the McKenzie therapy provided a mean 8.6 point greater pain reduction on a 0 to 100 point scale (95 % confidence interval [CI]: 3.5 to 13.7) and a 5.4 point greater reduction in disability on a 0 to 100 point scale (95 % CI: 2.4 to 8.4) than comparison. At intermediate follow-up, relative risk of work absence was 0.81 (0.46 to 1.44) favoring McKenzie,

however the comparison treatments provided a 1.2 point greater disability reduction (95 % CI: -2.0 to 4.5). In the 1 cervical trial, McKenzie therapy provided similar benefits to an exercise program. The results of this review showed that for low back pain (LBP) patients McKenzie therapy resulted in a greater decrease in pain and disability in the short-term than other standard therapies. The authors concluded that making a firm conclusion on LBP treatment effectiveness is difficult because there are insufficient data on long-term effects on outcomes other than pain and disability, and no trial has yet compared McKenzie to placebo or no treatment. They stated that there are also insufficient data available on neck pain patients.

In a meta-analysis of randomized controlled trials (RCTs), Machado et al (2006) evaluated the effectiveness of the McKenzie method for LBP. Medline, Embase, PEDro, and LILACS were searched up to August 2003. Two independent reviewers extracted the data and assessed methodological quality. Pooled effects were calculated among homogeneous trials using the random effects model. A sensitivity analysis excluded trials reporting on generic McKenzie. A total of 11 trials of mostly high quality were included. McKenzie reduced pain (weighted mean difference [WMD] on a 0- to 100-point scale, -4.16 points; 95 % CI: -7.12 to -1.20) and disability (WMD on a 0- to 100-point scale, -5.22 points; 95 % CI: -8.28 to -2.16) at 1 week follow-up when compared with passive therapy for acute LBP. When McKenzie was compared with advice to stay active, a reduction in disability favored advice (WMD on a 0- to 100-point scale, 3.85 points; 95 % CI: 0.30 to 7.39) at 12 weeks of follow-up. Heterogeneity prevented pooling of studies on chronic LBP as well as pooling of studies included in the sensitivity analysis. The authors concluded that there is some evidence that the McKenzie method is more effective than passive therapy for acute LBP; however, the magnitude of the difference suggested the absence of clinically worthwhile effects. They stated that there is limited evidence for the use of McKenzie method in chronic LBP; and the effectiveness of classification-based McKenzie is yet to be established.

Hosseinifar et al (2013) compared the effectiveness of stabilization and McKenzie exercises on pain, disability, and thickness of the transverse abdominis and multifidus muscles in patients with non-specific chronic

LBP. A total of 30 patients were randomly assigned into 2 groups: (i) the McKenzie and (ii) stabilization exercise groups. Before and after intervention, pain, disability, and thickness of the transverse abdominis and multifidus muscles were evaluated by visual analog scale (VAS), functional rating index, and sonography, respectively. The training program was 18 scheduled sessions of individual training for both groups. After interventions, the pain score decreased in both groups. The disability score decreased only in the stabilization group. The thickness of the left multifidus was significantly increased during resting and contracting states in the stabilization group. The thickness of the right transverse abdominis during the abdominal draw-in maneuver, and thickness of the left transverse abdominis during the active straight leg raising maneuver were significantly increased in the stabilization group. The intensity of pain, disability score, thickness of the right transverse abdominis during the abdominal draw-in maneuver, and thickness of the left transverse abdominis during active straight leg raising in the stabilization group were greater than those on the Mackenzie. The authors concluded that stabilization exercises were more effective than McKenzie exercises in improving the intensity of pain and function score and in increasing the thickness of the transverse abdominis muscle.

Werneke et al (2014) examined the association between therapists' level of formal pre-credential McKenzie post-graduate training and agreement on the following McKenzie classification variables for patients with LBP: main McKenzie syndromes, presence of lateral shift, derangement reducibility, directional preference, and centralization. Raters (n = 47) completed multiple sets of 2 independent successive examinations at 3 different stages of McKenzie post-graduate training (levels parts A and B, part C, and part D). Agreement was assessed with κ coefficients and associated 95 % CIs. A minimum κ threshold of 0.60 was used as a pre-determined criterion for level of agreement acceptable for clinical use. Raters examined 1,662 patients (mean age of 51 ± 15; range of 18 to 91; females, 57 %). Data distributions were not even and were highly skewed for all classification variables. No training level studied had acceptable agreement for any McKenzie classification variable. Agreements for all levels of McKenzie post-graduate training were higher than expected by chance for most of the classification variables except parts A and B training level for judging lateral shift and centralization and

part D training level for judging reducibility. Agreement between training levels parts A and B, part C, and part D were similar with overlapping 95 % CIs. The authors concluded that results indicated that level of inter-rater chance-corrected agreement of McKenzie classification system was not acceptable for therapists at any level of formal McKenzie post-graduate training. They stated that this finding raised concerns about the clinical utility of the McKenzie classification system at these training levels. They stated that additional studies are needed to assess agreement levels for therapists who receive additional training or experience at the McKenzie credentialed or diploma levels.

Hahn et al (2014) analyzed which tests, measures, and interventions are most commonly selected by physical therapists (PTs) holding a credential from the McKenzie Institute and those holding the McKenzie credential plus the credential of Fellow of the American Academy of Orthopaedic Manual Physical Therapy (FAAOMPT). Their responses were based on a simulated case vignette involving a patient with a presentation of cervical spine disk derangement. A survey administered through Survey Monkey was sent to 714 members of the McKenzie Institute who are certified or hold a diploma in mechanical diagnosis and therapy (MDT) or these credentials with the addition of Fellowship credentialing (MDT+FAAOMPT). Of the 714 surveyed PTs, 83 completed the survey for a response rate of 11.6 %. As the PTs were given further information regarding the patient, they were asked to progress through a clinical decision-making process by indicating their sequence of examination techniques, and then indicating which interventions would be performed based on the results of the examination. A descriptive analysis was conducted to determine the most common sequences chosen by the PTs based on their training. To perform the analysis, only respondents who completed the survey were included: clinicians with MDT credentials, (n= 77), and clinicians with both the MDT and FAAOMPT credentials (MDT+FAAOMPT), (n=6). Initially, the most common examination chosen regardless of credential was postural analysis. After receiving additional information regarding the patient's posture, the majority of clinicians in each of the 3 groups then chose active range of motion (AROM). However, after additional information was given, the majority of the MDT group chose repeated end range cervical movements as their next examination measure, and the FAAOMPT group varied. The majority of the FAAOMPT group continued to assess the patient through

an entire examination sequence, while the majority of the MDT group discontinued testing. A descriptive analysis of the intervention sequences depicted a trend toward direction of preference (DP) exercises for the MDT group (80.3 %), and passive movements or mobilization exercises for the FAAOMPT group. The authors concluded that the results of this study suggested that PTs with post-graduate training through the McKenzie Institute or through Orthopaedic Manual Physical Therapy (OMPT) Fellowship training may demonstrate an inherent bias toward their advanced training in the assessment and treatment of acute cervical derangement. They stated that although no significant findings can be reported secondary to sample size limitations, future studies may be performed to further explore this topic.

Garcia et al (2015) noted that although the McKenzie method has been compared with several other interventions, it is not yet known whether this method is superior to placebo in patients with chronic LBP. This proposed trial will evaluate the effectiveness of the McKenzie method in patients with chronic non-specific LBP. It is an assessor-blinded, 2-arm, randomized, placebo-controlled trial. The participants will be 148 patients seeking care for chronic non-specific LBP. Participants will be randomly allocated to 1 of 2 treatment groups: (i) McKenzie method, or (ii) placebo therapy (detuned ultrasound and shortwave therapy). Each group will receive 10 sessions of 30 minutes each (2 sessions per week over 5 weeks). The clinical outcomes will be obtained at the completion of treatment (5 weeks) and at 3, 6, and 12 months after randomization. The primary outcomes will be pain intensity (measured with the Pain Numerical Rating Scale) and disability (measured with the Roland-Morris Disability Questionnaire) at the completion of treatment. The secondary outcomes will be pain intensity; disability and function; kinesiophobia and global perceived effect at 3, 6, and 12 months after randomization; and kinesiophobia and global perceived effect at completion of treatment. The data will be collected by a blinded assessor. The authors stated that this will be the 1st trial to compare the McKenzie method with placebo therapy in patients with chronic non-specific LBP.

In a randomized, blinded trial with a 12-month follow-up, Halliday et al (2015) will examine if McKenzie exercises when applied to a cohort of patients with chronic LBP who have a directional preference demonstrate

improved recruitment of the transversus abdominis compared to motor control exercises when measurements were assessed from ultrasound images. A total of 70 adults with greater than 3-month history of LBP who have a directional preference will be included in this study. Interventions are McKenzie techniques or motor control exercises for 12-sessions over 8 weeks. Main outcome measures are transversus abdominus thickness measured from real time ultrasound images, pain, global perceived effect and capacity to self-manage. This study will be the 1st to investigate the possible mechanism of action that McKenzie therapy and motor control exercises have on the recruitment of the transversus abdominus in a cohort of LBP patients sub-classified with a directional preference. Patients receiving matched exercises according to their directional preference are believed to have better outcomes than those receiving unmatched exercises. A better understanding of the mechanism of action that specific treatments such as motor control exercises or McKenzie exercises have on patients classified with a directional preference will allow therapist to make a more informed choice about treatment options.

Petersen et al (2015) identified characteristics of patients with a changeable lumbar condition, i.e., presenting with centralization or peripheralization, that were likely to benefit the most from either the McKenzie method or spinal manipulation. A total of 350 patients with chronic LBP were randomized to either the McKenzie method or manipulation. The possible effect modifiers were age, severity of leg pain, pain-distribution, nerve root involvement, duration of symptoms, and centralization of symptoms. The primary outcome was the number of patients reporting success at two months follow-up. The values of the dichotomized predictors were tested according to the pre-specified analysis plan. No predictors were found to produce a statistically significant interaction effect. The McKenzie method was superior to manipulation across all subgroups, thus the probability of success was consistently in favor of this treatment independent of predictor observed. When the 2 strongest predictors, nerve root involvement and peripheralization, were combined, the chance of success was relative risk 10.5 (95 % CI: 0.71 to 155.43) for the McKenzie method and 1.23 (95 % CI: 1.03 to 1.46) for manipulation ($p = 0.11$ for interaction effect). The authors concluded that they did not find any baseline variables which were statistically significant effect modifiers in predicting different response to either McKenzie treatment or spinal manipulation when

compared to each other. However, they did identify nerve root involvement and peripheralization to produce differences in response to McKenzie treatment compared to manipulation that appear to be clinically important. They stated that these findings need testing in larger studies.

Kim et al (2015) examined the effect of a pelvis-concentrated exercise program and walking on the changes in body shape and foot base pressure. A total of 30 adults were randomly divided into the Swiss-ball exercise group and McKenzie exercise group, and they conducted exercise for 40 minutes 3 times a week for 6 weeks. Global postural system results and foot base pressure significantly decreased in both groups. A comparison of foot base pressure after the intervention between the 2 groups revealed that the Swiss-ball exercise group exhibited a greater reduction than the McKenzie exercise group. The authors concluded that the findings of this study indicated that the Swiss-ball exercise may improve posture and foot base pressure in male adults.

In a case report, Bowser and Swanson (2016) demonstrated the assessment, intervention, and clinical outcomes of a subject classified as having a shoulder derangement syndrome using the McKenzie Method of mechanical diagnosis and therapy (MDT) methodology. The subject was a 52-year old female with a 4-week history of insidious onset left shoulder pain, referred to physical therapy with a medical diagnosis of adhesive capsulitis. She presented with pain (4 to 7/10 on the VAS) and decreased shoulder ROM that limited her ADL and work capabilities (Upper Extremity Functional Index (UEFI) score: 55/80); AROM/PROM) were limited in all planes. Repeated motion testing was performed, with an immediate reduction in pain and increased shoulder motion in all planes following repeated shoulder extension. As a consequence, her MDT classification was determined to be derangement syndrome. Treatment involved specific exercises, primarily repeated motions, identified as symptom alleviating during the evaluation process. The author noted that the subject demonstrated significant improvements in the UEFI (66/80), VAS (0 to 2/10), and ROM within 6 visits over 8 weeks. At the conclusion of treatment, AROM/PROM was observed to be equal to the right shoulder without pain. The authors concluded that the patent demonstrated improved symptoms and functional abilities following evaluation and treatment using MDT methodology. Moreover, they stated that while a cause-effect relationship cannot be determined with a single

case, MDT methodology may be a useful approach to the examination, and potentially management, of patients with shoulder pain. These researchers stated that more research is needed to compare the outcomes of individuals treated with MDT methodology versus those treated with traditional therapy methods, and to determine if this is a valid approach for treatment of the extremities.

In a RCT, Waqqar et al (2016) compared the effects of McKenzie extension exercises program (EEP) versus Mulligan Sustained Natural Apophyseal Glides (SNAGs) for chronic mechanical LBP (CMLBP). The inclusion criteria were patients of both gender and age range of 30 to 70 years with minimum 4 weeks history of CMLBP. A total of 37 patients were screened out as per inclusion criteria and randomly placed into 2 groups: (i) 20 patients in group A were treated with Mulligan SNAGs, and (ii) 17 patients in group B with McKenzie EEP for 4 weeks at 2 session per week and single session per day; VAS, Oswestry Disability Scale (ODI) and lumber ROM were used as an assessment tools and were measured at baseline and at the completion 4 weeks intervention. The data was analyzed with SPSS to draw the statistical and clinical significance of both interventions. At the completion of 4 weeks intervention the pre- and post- statistical analysis revealed that clinically the McKenzie EEP improved pain (mean 9.12 to 1.46) and disability (73.82 to 6.24) slightly more than Mulligan SNAGs (pain: from 8.85 to 2.55, disability 73.75 to 7.05), while the Mulligan SNAGs improved lumbar ROM more effectively than McKenzie EEP in all directions including flexion, extension, side bending and rotation. Statistically there was no significant difference between the effects of 2 interventions in managing pain and disability, and improving Lumber ROM. The authors concluded that the McKenzie EEP is clinically slightly more effective in the management of pain and disability as compared with Mulligan SNAGs, while Mulligan SNAGs are more effective in the improvement of lumbar ROM as compared with Mechanize EEP in the management of CMLBP. Moreover, these researchers stated that their recommendations are to conduct further studies with large sample size and long duration of intervention for the investigation of long-term effects of both interventions in chronic mechanical and other types of LBP.

Furthermore, an UpToDate review on “Physical therapy and other rehabilitation issues in the palliative care setting” (Montagnini and Javier, 2017) does not mention McKenzie exercises/physical therapy.

Manual Physical Therapy for Hip Pain

In a retrospective, chart-review study, Galleher and colleagues (2017) evaluated the benefit of adding manual therapy (MT) to PT care in pediatric patients with anterior hip pain; assessed the relative risk of adverse reactions when MT was used; and reported the types of MT used. This study included patients who were treated in a hospital-based sports medicine clinic. The charts of 201 patients (mean age of 14.23 ± 2.15 years) met the inclusion criteria and were reviewed. Patients were grouped into those who received MT during their episode of care, and those who did not. Pain efficiency (change in pain/number of visits), number and type of adverse reactions, as well as frequency and type of manual therapy interventions used, were the main health outcomes. The mean pain efficiency was significantly less if MT was carried out (MT = 0.60 [95 % CI: 0.47 to 0.72], no MT = 0.80 [95 % CI: 0.71 to 0.90] p = 0.01). There was no significant difference between groups in risk of adverse reactions (MT = 5, no MT = 5). The number of visits was significantly different between groups (MT = 9.43 ± 3.9 sessions, and no MT = 7.6 ± 5.2 sessions). The authors concluded that MT did not increase the risk of an adverse reaction in pediatric patients with anterior hip pain. However, while it appeared to be a safe intervention, it did not improve pain efficiency or patient adherence. They stated that future research should be performed to evaluate the effectiveness of MT, when performed by skilled therapists, in pediatric patients with hip pain in a controlled manner. Level of Evidence = IIIb.

Physical Therapy for Femoro-Acetabular Impingement Syndrome

Mansell and associates (2018) noted that arthroscopic hip surgery has risen 18-fold in the past decade; however, there is a dearth of clinical trials comparing surgery with non-operative management. In a RCT, these researchers determined the comparative effectiveness of surgery and physical therapy for femoro-acetabular impingement (FAI) syndrome. Patients were recruited from a large military hospital after referral to the orthopedic surgery clinic and were eligible for surgery. Of

104 eligible patients, 80 elected to participate, and the majority were active-duty service members (91.3 %). No patients withdrew because of adverse events (AEs). These investigators randomly selected patients to undergo either arthroscopic hip surgery (surgery group) or PT (rehabilitation group). Patients in the PT group began a 12-session supervised clinic program within 3 weeks, and patients in the surgery group were scheduled for the next available surgery at a mean of 4 months after enrollment. Patient-reported outcomes of pain, disability, and perception of improvement over a 2-year period were collected. The primary outcome was the Hip Outcome Score (HOS; range of 0 to 100 [lower scores indicating greater disability]; 2 subscales: activities of daily living and sport). Secondary measures included the International Hip Outcome Tool (iHOT-33), Global Rating of Change (GRC), and return to work at 2 years. The primary analysis was on patients within their original randomization group. Statistically significant improvements were seen in both groups on the HOS and iHOT-33, but the mean difference was not significant between the groups at 2 years (HOS activities of daily living, 3.8 [95 % CI: -6.0 to 13.6]; HOS sport, 1.8 [95 % CI: -11.2 to 14.7]; iHOT-33, 6.3 [95 % CI: -6.1 to 18.7]). The median GRC across all patients was that they "felt about the same" (GRC = 0). Two patients assigned to the surgery group did not undergo surgery, and 28 patients in the PT group ended up undergoing surgery. A sensitivity analysis of "actual surgery" to "no surgery" did not change the outcome; 20 (33.3 %) patients who underwent surgery and 4 (33.3 %) who did not undergo surgery were medically separated from military service at 2 years. The authors concluded that there was no significant difference between the groups at 2 years. Most patients perceived little to no change in status at 2 years, and 1/3 of military patients were not medically fit for duty at 2 years. Drawbacks of this study included a single hospital, a single surgeon, and a high rate of cross-over. Level of Evidence = I.

Physical Therapy for Lumbar Spinal Stenosis

Minetama and co-workers (2018) stated that the efficacy of PT for patients with lumbar spinal stenosis (LSS) has been reported only for the short-term, and few reports have compared outcomes of surgical treatment with non-surgical treatment after PT. These researchers evaluated 2-year outcomes of LSS patients treated with surgery or under follow-up observation after PT for 6 weeks. Patients presenting with

neurogenic claudication, radiologically-confirmed central LSS affecting both legs and refractory symptoms to pharmacotherapy of more than 3 months were enrolled. Patients were treated with MT, stretching and strengthening exercises, and body weight-supported treadmill walking once-weekly for 6 weeks. Clinical outcomes were measured using the Zurich Claudication Questionnaire (ZCQ), VAS of LBP, leg pain, and numbness, the Japanese Orthopedic Association Back Pain Evaluation Questionnaire and the SF-36. Two years after PT, patients were classified into the observation group (Group I) or the surgery group (Group II), whose patients failed to respond to PT and wanted to undergo surgery. A total of 38 patients were enrolled; 28 had complete data at 2 years: 21 and 7 in Groups I and II, respectively. Group II had a higher body mass index (BMI) than Group I. There were no significant differences in clinical outcomes at baseline. Six weeks after PT, Group I had significantly better outcomes for symptom severity and physical function on the ZCQ subscales, physical functioning and bodily pain on the SF-36 subscales. These outcomes in Group I were maintained or improved and did not differ significantly between groups at 2-years. However, the physical function on the ZCQ subscales was improved in Group II more than those in Group I (MD of -0.6; 95 % CI: -1.2 to -0.03, $p < 0.05$) at 2 years. The authors concluded that at 2 years, the outcomes except for the change in physical function score in the ZCQ subscale did not differ significantly between patients who had undergone surgery and those who avoided surgery.

Early Surgery versus Physical Therapy on Knee Function Among Patients With Non-Obstructive Meniscal Tears

van de Graaf and colleagues (2018) stated that despite recent studies suggesting arthroscopic partial meniscectomy (APM) is not more effective than PT, the procedure is still frequently performed in patients with meniscal tears. In a multi-center, randomized clinical trial, these investigators examined if PT is non-inferior to APM for improving patient-reported knee function in patients with meniscal tears. This study was conducted in 9 hospitals in the Netherlands. Participants were aged 45 to 70 years with non-obstructive meniscal tears (i.e., no locking of the knee joint). Patients with knee instability, severe OA, and BMI greater than 35 were excluded. Recruitment took place between July 17, 2013, and November 4, 2015. Participants were followed-up for 24 months (final

participant follow-up was October 11, 2017). A total of 321 subjects were randomly assigned to APM (n = 159) or a pre-defined PT protocol (n = 162). The PT protocol consisted of 16 sessions of exercise therapy over 8 weeks focused on coordination and closed kinetic chain strength exercises. The primary outcome was change in patient-reported knee function on the International Knee Documentation Committee Subjective Knee Form (range of 0 to 100; from worse to best) from baseline over a 24-month follow-up period. The non-inferiority margin was defined as a difference between treatment groups of 8 points and was assessed with a 1-sided α of 0.025. The primary analysis followed the intention-to-treat (ITT) principle. Among 321 patients who were randomized (mean [SD] age of 58 [6.6] years; 161 women [50 %]), 289 (90 %) completed the trial (161 women and 158 men). In the PT group, 47 participants (29 %) had APM during the 24-month follow-up period, and 8 participants randomized to APM (5 %) did not have APM. Over a 24-month follow-up period, knee function improved in the APM group by 26.2 points (from 44.8 to 71.5) and in the PT group by 20.4 points (from 46.5 to 67.7). The overall between-group difference was 3.6 points (97.5 % CI: -∞ to 6.5; p value for non-inferiority = 0.001); AEs occurred in 18 participants in the APM group and 12 in the PT group. Repeat surgery (3 in the APM group and 1 in the PT group); and additional out-patient visits for knee pain (6 in the APM group and 2 in the PT group) were the most frequent AEs. The authors concluded that among patients with non-obstructive meniscal tears, PT was non-inferior to APM for improving patient-reported knee function over a 24-month follow-up period. These investigators stated that based on these results, PT may be considered an alternative to surgery for patients with non-obstructive meniscal tears.

Hip-Targeted Physical Therapy on Low Back Pain

In a systematic review and meta-analysis, Bernet and colleagues (2019) examined the effects of PT interventions of the hip on outcomes of pain and disability in patients with LBP. PubMed, CINAHL, Scopus, Web of Science, and SPORTDiscus were searched from inception to April 18, 2018. The following inclusion criteria were required to be met: RCTs; populations with diagnosed LBP; and interventions that target the hip joint; 2 researchers independently screened titles, abstracts, and full texts for inclusion. Data were extracted for information related to patient demographics, specific interventions, and outcomes assessed. When

studies demonstrated homogeneity on outcome measures, the MDs or SMDs with 95 % CI were calculated and pooled in a meta-analysis. A total of 6 articles with a total of 387 participants were included in the review and meta-analysis. Specific intervention categories that were found in the search included: hydrotherapy (n = 1); exercise therapy (n = 4); and manual therapy (n = 2). Trivial effect size was found for the pain outcomes and small effect size was found for disability. All of these studies were found to have high risk of bias according the Cochrane Risk of Bias tool. The authors concluded that the findings of this meta-analyses from the pooled studies did not result in statistically significant reductions in either pain or disability with the addition of hip-targeted PT interventions to patients with LBP.

Home-Based Physical Therapy for Rehabilitation of the Elderly After Hip Fracture

Magaziner and colleagues (2019) noted that disability persists after hip fracture in older persons. Current rehabilitation may be insufficient to restore ability to walk in the community. In a parallel, 2-group, randomized clinical trial conducted at 3 U.S. clinical centers, these investigators compared a multi-component home-based PT intervention (training) with an active control on ability to walk in the community. Randomization began on September 16, 2013, and ended on June 20, 2017; follow-up ended on October 17, 2017. Patients aged 60 years and older were enrolled after non-pathologic, minimal trauma hip fracture, if they were living in the community and walking without human assistance before the fracture, were assessed within 26 weeks of hospitalization, and were not able to walk during daily activities at the time of enrollment. A total of 210 subjects were randomized and re-assessed 16 and 40 weeks later. The training intervention (active treatment) (n = 105) included aerobic, strength, balance, and functional training. The active control group (n = 105) received transcutaneous electrical nerve stimulation (TENS) and AROM exercises. Both groups received 2 to 3 home visits from a physical therapist weekly for 16 weeks; nutritional counseling; and daily vitamin D (2,000 IU), calcium (600 mg), and multi-vitamins. The primary outcome (community ambulation) was defined as walking 300 m or more in 6 mins at 16 weeks after randomization . The study was designed to test a 1-sided hypothesis of superiority of training compared with active control. Among 210 randomized participants (mean

age of 80.8 years; 161 women [76.7 %]), 197 (93.8 %) completed the trial (187 [89.0 %] by completing the 6-min walk test (6MWT) at 16 weeks and 10 [4.8 %] by adjudication of the primary outcome). Among these, 22 of 96 training participants (22.9 %) and 18 of 101 active control participants (17.8 %) (difference, 5.1% [1-sided 97.5 % CI: -∞ to 16.3 %]; 1-sided p = 0.19) became community ambulators; 17 training participants (16.2 %) and 15 control participants (14.3 %) had 1 or more reportable AEs during the intervention period. The most common reportable AEs were falls (training: 6 [5.7 %], control: 4 [3.8 %]), femur/hip fracture (2 in each group), pneumonia (training: 2, control: 0), urinary tract infection (training: 2, control: 0), dehydration (training: 0, control: 2), and dyspnea (training: 0, control: 2). The authors concluded that among older adults with a hip fracture, a multi-component home-based PT intervention compared with an active control that TENS and AROM exercises did not result in a statistically significant improvement in the ability to walk 300 m or more in 6 mins after 16 weeks.

Postural Restoration Form of Physical Therapy

Postural restoration is a posture-based approach to physical therapy, which claims that it improves postural adaptations, the function of the respiratory system and asymmetrical patterns. Postural restoration supposedly re-position the musculo-skeletal system, correct movement imbalance, restore normal tonicity to muscles and strengthen efficient, balanced, functional activity. Physical therapists who administer postural restoration would initiate a process of rehabilitation that begins with re-positioning; and re-positioning therapeutic activities are carefully constructed exercises to restore neutral alignment to the musculo-skeletal system. Once neutral alignment is attained, it must be maintained and integrated into the movement patterns individuals use in daily activities. A personalized exercise program is designed to improve strengthening from lying to sitting to standing and finally back into up-right movement in a more balanced way. In summary, postural restoration physical therapy create a more balanced / less stressed physical foundation for life activities, sports activities and for rehabilitation following trauma or surgery.

However, there is no published data on the clinical value of postural restoration form of physical therapy.

Muscle Activation Techniques (MAT)

Muscle Activation Techniques (MAT) is a technique that aids activate muscles into full contraction. It does this by intentionally loading a muscle unit thereby sending a signal to the brain to contract that muscle unit. Muscle Activation Techniques thrive by evaluating, testing and treating dysfunctional muscles. It aids muscles return to a state of efficient contractility. It has been shown that jump-starting weak muscles through specialized techniques provides the muscle with an opportunity to function with maximum efficiency. This is also the case of the MAT for the management of muscle weakness conditions. There is a lack of evidence on the effectiveness of Muscle Activation Techniques.

Myofascial Physical Therapy for the Treatment of Chronic Pelvic Pain Syndrome

In a randomized, multi-center feasibility study, Fitzgerald and associates (2013) compared 2 methods of manual therapy (myofascial physical therapy and global therapeutic massage) in patients with urological chronic pelvic pain syndromes (CPPS). These investigators recruited 48 subjects with chronic prostatitis/CPPS or interstitial cystitis/painful bladder syndrome at 6 clinical centers. Eligible patients were randomized to myofascial physical therapy or global therapeutic massage and were scheduled to receive up to 10 weekly treatments of 1 hour each. Criteria to examine feasibility included adherence of therapists to prescribed therapeutic protocol as determined by records of treatment, AEs during study treatment and rate of response to therapy as evaluated by the patient global response assessment. Primary outcome analysis compared response rates between treatment arms using Mantel-Haenszel methods. There were 23 (49 %) men and 24 (51 %) women randomized during a 6-month period. Of the patients 24 (51 %) were randomized to global therapeutic massage, 23 (49 %) to myofascial physical therapy and 44 (94 %) completed the study. Therapist adherence to the treatment protocols was excellent. The global response assessment response rate of 57 % in the myofascial physical therapy group was significantly higher than the rate of 21 % in the global therapeutic massage treatment group ($p = 0.03$). The authors judged the

feasibility of conducting a full-scale trial of physical therapy methods and the preliminary findings of a beneficial effect of myofascial physical therapy warrants further study.

Grinberg and colleagues (2019) stated CPPS is a multi-factorial disorder comprising structural and functional muscular abnormalities, a dysfunctional pain system, and psychological distress. Myofascial physical Therapy (MPT) that is targeted at improving pelvic muscle functioning is considered a 1st line non-pharmacological treatment for CPPS, although the precise mechanisms that lead to symptoms alleviation have not yet been elucidated. In a longitudinal study, these researchers examined the local and systemic effects of MPT intervention, including biopsychophysiological processes, among CPPS patients (n = 50 CPPS women). Morphologic assessment of the levator ani and quantitative sensory testing (QST) of the pain system were applied alongside with evaluation of pain-related psychological factors using designated questionnaires. All measures were examined both before and after MPT in 39 patients. The long-term effects of MPT were examined by clinical pain reports obtained at 3 and 9 months following MPT that were compared with a non-treated group of 11 untreated CPPS women. Along with an improvement in the clinical pain intensity ($p = 0.001$) and sensitivity to experimental pain tests ($p = 0.001$) following MPT, the results also indicated that MPT has anatomical, psychological, and social therapeutic effects ($p = 0.04$; $p = 0.001$; $p = 0.01$, respectively). Furthermore, clinical pain evaluation at 3 and 9 months after MPT revealed a significant improvement in women who received treatment ($p = 0.001$). The authors concluded that the findings of this pilot study suggested multi-systemic (direct and indirect anatomical, neurophysiological, and psychological) effects of MPT on the multi-factorial pain disorder of CPPS; thus, placing MPT as a mechanism-based intervention. Moreover, these researchers stated that future RCTs carried out on larger cohorts of patients may allow the reliability of these findings to be validated.

The authors stated that this pilot study had several drawbacks. First, the relatively small sample size (50 CPPS women) limited the generalization of these findings given the variability in psychophysical and pain-related personality measures. The small sample size was due to the restrictive inclusion criteria that reduced the number of CPPS patients that could be

enrolled. Second, due to the fact that the 11 women who did not undergo MPT were not randomly selected and that their assignment to this group was based solely on their reports of clinical CPPS symptoms, this non-treated group was not a “true” control group. In order to present an understanding of the mechanistic processes, a real randomized control group should be obtained and tested with both psychophysical and psychological measures; thus, the significance of the findings should be carefully interpreted relating to this pilot study. It could not be ignored that the ability to make decisive conclusions from the findings of this pilot study was limited.

Furthermore, an UpToDate review on “Chronic pelvic pain in adult females: Treatment” (Tu and As-Sanie, 2021) states that “Despite its widespread utilization as a primary mode of therapy for CPP, formal studies that evaluate the efficacy of PT for the treatment of CPP remain limited and are difficult to compare due to significant heterogeneity in therapy techniques and study design. Much of the presumed positive effect of PT is extrapolated from studies on other types of pelvic pain. In an observational cohort study of 374 men and women with myofascial pelvic pain syndrome (MPPS), 22 % fewer patients reported using any pain medication at 6 months following treatment after learning to perform internal myofascial trigger point release using a therapy wand. In a trial of 81 patients with painful bladder syndrome comparing pelvic floor PT with global therapeutic massage, patients receiving pelvic floor PT demonstrated a greater reduction in pain, urinary urgency, and frequency. In a retrospective chart review of 124 patients with coccydynia, treatment with PT was associated with decreased mean average pain ratings (from 5.08 to 1.91) and mean highest pain ratings (from 8.81 to 4.75) on a 10-point visual analog scale”.

Physical Therapy on Brain-Derived Neurotrophic Factor Levels in Patients Chronic Musculoskeletal Pain

Di-Bonaventura et al (2023) stated that based on the theory that neurotrophic factors such as brain-derived neurotrophic factor (BDNF) play a fundamental role in the initiation and/or maintenance of hyper-excitability of central neurons in pain, it was hypothesized that the levels of BDNF may be modified by the use of therapeutic interventions, favoring a reduction in pain intensity. In a systematic review, these

investigators examined the effect of different physiotherapy interventions on BDNF levels. They also analyzed the influence of physiotherapy on pain levels to subsequently draw conclusions regarding its possible relationship with BDNF. These researchers carried out a literature search of multiple electronic databases (PubMed, PsycINFO, Medline (Ebsco), Scopus, WOS, Embase) to identify RCTs published without language restrictions up to and including March 2022. The search strategy was based on the combination of medical terms (MeSH) and keywords relating to the following concepts: "pain", "chronic pain", "brain derived neurotrophic factor", "BDNF", "physiotherapy", and "physical therapy". A total of 7 studies were included. There were 2 studies that showed statistically significant differences in pain intensity reduction and an increase in the BDNF levels that used therapies such as repetitive transcranial magnetic stimulation (rTMS) and intra-muscular electrical stimulation (IM-ES), in patients with chronic myofascial pain. However, the same conclusions could not be drawn for the other physical therapies applied. The authors concluded that rTMS and IM-ES interventions achieved greater short-term reductions in pain intensity and increased BDNF over other types of interventions in chronic myofascial pain patients, as indexed by a moderate amount of evidence. In contrast, other types of PT interventions did not appear to be more effective in decreasing pain intensity and increasing BDNF levels than placebo PT or minimal intervention, as a low amount of evidence was found. These researchers noted that they could not extract firm conclusions according to the results of this review. They stated that new studies are needed to examine the types, intensities, and duration of PT interventions that would be most appropriate to increase the peripheral levels of BDNF in individuals in pain.

Low-Dye Strapping for the Treatment of Stress Fracture of the Ankle

UpToDate reviews on “Overview of stress fractures” (deWeber, 2023), “Stress fractures of the tibia and fibula” (Fields, 2023), “Ankle fractures in adults” (Koehler, 2023), and “Ankle pain in the active child or skeletally immature adolescent: Overview of causes” (Chorley and Ernest, 2023) do not mention strapping as a management / therapeutic option.

Strapping for the Treatment of Hip Pain

UpToDate reviews on “Approach to the adult with unspecified hip pain” (Paoloni, 2023), “Approach to hip and groin pain in the athlete and active adult” (Johnson, 2023) and “Management of hip osteoarthritis” (Deveza and Eyles, 2023) do not mention strapping as a management / therapeutic option.

Virtual Reality Facilitated Gait Training

Dos Santos et al (2016) stated that virtual reality (VR)-based applications play an increasing role in motor rehabilitation. They provide an interactive and individualized environment in addition to increased motivation during motor tasks as well as facilitating motor learning via multi-modal sensory information. Several previous studies have reported positive effect of VR-based treatments for lower extremity motor rehabilitation in neurological conditions; however, the characteristics of these VR applications have not been systematically examined. The visual information on the user's movement in the virtual environment, also called movement visualization (MV), is a key element of VR-based rehabilitation interventions. In a systematic review, these researchers proposed categorization of movement visualizations of VR-based rehabilitation therapy for neurological conditions; and also summarized current research in lower limb application. These investigators carried out a systematic search of literature on VR-based intervention for gait and balance rehabilitation in neurological conditions in the databases; namely, Medline (Ovid), AMED, Embase, CINAHL, and PsycInfo. Studies using non-virtual environments or applications to improve cognitive function, ADL, or psychotherapy were excluded. The VR interventions of the included studies were analyzed on their MV. A total 43 studies were selected based on the inclusion criteria; 7 distinct MV groups could be differentiated: indirect MV (n = 13), abstract MV (n = 11), augmented reality MV (n = 9), avatar MV (n = 5), tracking MV (n = 4), combined MV (n = 1), and no MV (n = 2). In 2 included studies the visualization conditions included different MV groups within the same study. Furthermore, differences in motor performance could not be analyzed because of the differences in the study design; 3 studies examined different visualizations within the same MV group and hence limited information could be extracted from 1 study. The authors concluded that

this review showed that individuals' movements during VR-based motor training could be displayed in different ways. Moreover, these researchers stated that further investigations are needed to examine the nature of this VR information and its effect on motor outcome.

Porras et al (2018) noted that VR has emerged as a therapeutic tool facilitating motor learning for balance and gait rehabilitation. The evidence, however, has not yet resulted in standardized guidelines. In a systematic review, these investigators examined the application of VR-based rehabilitation of balance and gait in 6 neurologic cohorts, describing methodologic quality, intervention programs, and reported effectiveness. This study follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. VR-based treatments of Parkinson disease (PD), multiple sclerosis (MS), acute and chronic post-stroke, traumatic brain injury (TBI), and cerebral palsy (CP) were researched in PubMed and Scopus, including earliest available records. Therapeutic validity (CONTENT scale) and risk of bias in RCT (Cochrane Collaboration tool) and non-RCT (Newcastle-Ottawa scale) were assessed. A total of 97 studies were included, 68 published in 2013 or later. VR improved balance and gait in all cohorts, especially when combined with conventional rehabilitation. Most studies presented poor methodologic quality, lacked a clear rationale for intervention programs, and did not utilize motor learning principles meticulously. RCTs with more robust methodologic designs were widely recommended. The authors concluded that these findings suggested that VR-based rehabilitation is developing rapidly, has the potential to improve balance and gait in neurologic patients, and brings additional benefits when combined with conventional rehabilitation. This systematic review provided detailed information for developing theory-driven protocols that may aid in overcoming the observed lack of argued choices for intervention programs and motor learning implementation and serves as a reference for the design and planning of personalized VR-based treatments.

Lei et al (2019) stated that in recent years, VR has been tested as a therapeutic tool in neurorehabilitation research; however, the impact of VR technology on PD patients still remained controversial. In order to provide a more scientific basis for rehabilitative modalities in patients with PD, these researchers carried out a systematic review of VR rehabilitation for PD patients and focused on the improvement of gait and

balance. They carried out a comprehensive search using the following databases: PubMed, Web of Science, Cochrane Library, CINHAL, Embase and CNKI (China National Knowledge Infrastructure). Studies published before December 30, 2018 and of a RCT design to study the effects of VR for patients with PD were included. Data were pooled and a meta-analysis was conducted. This systematic review was performed in accordance with the PRISMA guidelines. A total of 16 studies involving 555 participants with PD were included in this analysis. VR rehabilitation performed better than conventional or traditional rehabilitation in 3 aspects: step and stride length (SMD = 0.72, 95 % CI: 0.40 to 1.04, Z = 4.38, p < 0.01), balance function (SMD = 0.22, 95 % CI: 0.01 to 0.42, Z = 2.09, p = 0.037), and mobility (MD = -1.95, 95 % CI: -2.81 to -1.08, Z = 4.41, p < 0.01). There was no effect on the dynamic gait index (SMD = -0.15, 95 % CI: -0.50 to 0.19, Z = 0.86, p = 0.387), and gait speed (SMD = 0.19, 95 % CI: -0.03 to 0.40, Z = 1.71, p = 0.088). As for the secondary outcomes, compared with the control group, VR rehabilitation demonstrated more significant effects on the improvement of QOL (SMD = -0.47, 95 % CI: -0.73 to -0.22, Z = 3.64, p < 0.01), level of confidence (SMD = -0.73, 95 % CI: -1.43 to -0.03, Z = 2.05, p = 0.040), and neuropsychiatric symptoms (SMD = -0.96, 95 % CI: -1.27 to -0.65, Z = 6.07, p < 0.01), while it may have similar effects on global motor function (SMD = -0.50, 95 % CI: -1.48 to 0.48, Z = 0.99, p = 0.32), ADL (SMD = 0.25, 95 % CI: -0.14 to 0.64, Z = 1.24, p = 0.216), and cognitive function (SMD = 0.21, 95 % CI: -0.28 to 0.69, Z = 0.84, p = 0.399). During the included interventions, 4 patients developed mild dizziness and 1 patient developed severe dizziness and vomiting. The authors concluded that according to the findings of this study, they found that VR rehabilitation training could not only achieve the same effect as conventional rehabilitation training, it exhibited better performance on gait and balance in patients with PD. Taken together, when the effect of traditional rehabilitation training on gait and balance of PD patients was not good enough, these investigators believed that VR rehabilitation training could at least be used as an alternative therapy. These researchers stated that more rigorous design of large-sample, multi-center RCTs are needed to provide a stronger evidence-based basis for verifying the potential advantages of VR rehabilitation training.

Weber et al (2020) stated that VR technologies are increasingly used in physical rehabilitation; however, it is unclear how VR interventions are being delivered, and, in particular, the role of the therapist remains unknown. In a systematic review, these investigators examined how commercially available VR technologies are being implemented in gait, posture, and balance rehabilitation, including justification, content, procedures, and dosage of the intervention and details of the therapist role. A total of 5 databases were searched between 2008 and 2018. Supervised interventional trials with more than 10 adult participants using commercially available VR technologies to address mobility limitations were independently selected by 2 authors. One author extracted reported intervention characteristics into a pre-designed table and assessed methodological quality, which was independently verified by a 2nd author. A total of 29 studies were included. In general, minimal clinical reasoning was provided to justify technology or activity selection, with recreational systems and games used most commonly (n = 25). All but 1 study used a single interventional technology. When explicitly described, the intervention was delivered by a physical therapist (n = 14), a therapist assistant (n = 2), both (n = 1), or an occupational therapist (n = 1). Most studies reported supervision (n = 12) and safeguarding (n = 8) as key therapist roles, with detail of therapist feedback less frequently reported (n = 4). Therapist involvement in program selection, tailoring, and progression was poorly described. The authors concluded that intervention protocols of VR rehabilitation studies were incompletely described and generally lacked detail on clinical rationale for technology and activity selection and on the therapist role in intervention design and delivery, hindering replication and translation of research into clinical practice. These researchers stated that future studies employing commercially available VR technologies should report all aspects of intervention design and delivery and consider protocols that allow therapists to exercise clinical autonomy in intervention delivery.

Gulcan et al (2023) noted that augmented reality (AR) and VR facilitate motor learning by enabling the practice of task-specific activities in a rich environment; thus, AR and VR gait training may improve balance and gait in patients with PD. These researchers examined the effects of AR- and VR-based gait training on balance and gait in patients with PD. A total of 30 subjects were randomly divided into study (n = 15) and control (n = 15) groups. The study group was given AR and VR gait training combined

with conventional training. The control group was given conventional training only. The training was applied to both groups 3 days per week for 6 weeks. Motor symptoms with the Unified Parkinson Disease Rating Scale-Motor Examination (UPDRS-III), balance with posturography and Berg Balance Scale (BBS), perceived balance confidence with Activity-Specific Balance Confidence Scale (ABC), gait with spatio-temporal gait analysis, and functional mobility with Timed Up and Go Test (TUG) were assessed. At the end of the trial, UPDRS-III, posturography measurements, BBS, ABC, spatio-temporal gait parameters, and TUG improved in the study group ($p < 0.05$), while BBS, ABC, and only spatial gait parameters (except for step width) improved in the control group ($p < 0.05$). There was no change in posturography measurement, temporal gait parameters, and TUG in control group ($p > 0.05$). When the developed parameters in both groups were compared, the amount of improvement in BBS and ABC was found similar ($p > 0.05$), while the improvement in the other parameters was found higher in the study group ($p < 0.05$). The authors concluded that AR and VR gait training provided the opportunity to practice walking with different tasks in increasingly difficult environments; thus, improving balance and walking by facilitating motor learning.

The authors stated that the main drawback of this trial was that although they provided dual-task walking training, they did not examine the improvement in dual-task performance. These researchers stated that other drawbacks included that they did not examine the long-term effects of the training due to the COVID-19 pandemic, and the low number of cases in this study. These investigators recommended that future studies be carried out by including more cases.

Cortes-Perez et al (2023) carried out a meta-analysis to examine the effect of VR-based therapy (VRBT) on balance dimensions and fear of falling in patients with MS (PwMS); and to determine the most recommendable dose of VRBT to improve balance. PubMed Medline, Web of Science, Scopus, CINAHL and PEDro were screened, without publication date restrictions, until September 30, 2021; RCTs comparing the effectiveness of VRBT against other interventions in PwMS were included. Functional and dynamic balance, confidence of balance, postural control in posturography, fear of falling and gait speed were the variables assessed. A meta-analysis was performed by pooling the

Cohen's standardized mean difference (SMD) with 95 % CI using Comprehensive Meta-Analysis 3.0. A total of 19 RCTs, reporting 858 PwMS, were included. These findings reported that VRBT was effective in improving functional balance (SMD = 0.8; 95 % CI: 0.47 to 1.14; $p < 0.001$); dynamic balance (SMD = - 0.3; 95 % CI: - 0.48 to - 0.11; $p = 0.002$); postural control with posturography (SMD = - 0.54; 95 % CI: - 0.99 to - 0.1; $p = 0.017$); confidence of balance (SMD = 0.43; 95 % CI: 0.15 to 0.71; $p = 0.003$); and in reducing fear of falling (SMD = - 1.04; 95 % CI: - 2 to - 0.07; $p = 0.035$); but not on gait speed (SMD = - 0.11; 95 % CI: - 0.35 to 0.14; $p = 0.4$). In addition, the most adequate dose of VRBT to achieve the greatest improvement in functional balance was at least 40 sessions, 5 sessions/week and 40 to 45 mins/sessions; and for dynamic balance, it would be between 8 and 19 weeks, twice-weekly and 20 to 30 mins/session. The authors concluded that VRBT may have a short-term beneficial role in improving balance and reducing fear of falling in PwMS. Moreover, these researchers stated that further RCTs using a larger sample size and a control of risk of bias are needed to increase the generalizability of the present findings.

The authors stated that this meta-analysis had several drawbacks. First, the low number of participants per meta-analysis may reduce the accuracy of these findings, although studies involving neurological patients usually have small sample sizes. Second, the small number of studies that examined some outcomes, such as balance confidence, fear of falling or postural control may also reduce the generalization of the findings. Third, the medium risk of bias in the included studies, resulting from the impossibility of blinding participants and therapists, and assessors in sometimes, increased the selection risk, performance and detection biases. Fourth, the risk of publication bias observed in some meta-analysis, and the impossibility of assessing this variable in some studies, which also reduced the generalization of the findings. Fifth, sensitivity analysis surpassed 20 %, which reduced the precision of these findings. Sixth, the low-quality evidence found in some meta-analysis. Seventh, all the included studies conducted the assessment in the short-time; thus, it has not been possible to examine the effect of VRBT in the medium- and long-term.

Darekar (2023) stated that VR affords clinicians the ability to deliver safe, controlled, task-specific customized interventions that are motivating and engaging. Elements of training in VR comply with principles of learning implicated in new skill acquisition and re-learning skills post-neurological disorders. However, heterogeneity in the description of VR systems and the description and control of “active” ingredients of interventions (like dosage, type of feedback, task specificity, etc.) have resulted in inconsistency in the synthesis and interpretation of evidence related to the effectiveness of VR-based interventions, especially in post-stroke and PD rehabilitation. The author described VR interventions with respect to their compliance with principles of neurorehabilitation, with the objective of optimizing interventions for effective training and facilitation of maximum functional recovery. Darekar also advocated using a uniform framework to describe VR systems to promote homogeneity in literature to aid in the synthesizing evidence. An overview of the evidence revealed that VR systems are effective in mediating deficits in upper extremity, posture and gait function observed in post-stroke and PD patients. In general, interventions were more effective when they were delivered as an adjunct to conventional therapy and were customized for rehabilitation purposes, in addition to complying with principles of learning and neurorehabilitation. The author concluded that although recent studies implied that their VR intervention was compliant with principles of learning, only a few explicitly described how these principles were incorporated as “active ingredients” of the intervention. The author stated that VR interventions targeting community ambulation and cognitive rehabilitation are yet limited and therefore warrant attention.

Muldowney Method of Physical Therapy

According to the Muldowney Physical Therapy website, this is a family-owned outpatient clinic; the staff members are trained with advanced manual techniques. They are devoted to helping patients with Ehlers-Danlos syndrome (EDS) live a better life through manual therapy, PT education, and exercise. The owner of Muldowney Physical Therapy, Kevin Muldowney, PT, has been treating patients with EDS for many years. Over the years, he has observed many similarities among patients with EDS when it comes to exercises. Based on his years of treating this population, Kevin has figured out what PT techniques help these patients

best, as well as what techniques can hurt these patients. Kevin has developed a PT protocol for the EDS population unlike any other protocol in existence today.

However, there is a lack of evidence that the Muldowney method, or protocol, is superior to standard PT methods. However, there is some evidence on the effectiveness of PT for patients with EDS.

Simmonds et al (2019) carried out a cross-sectional questionnaire survey to examine exercise beliefs and behaviors of individuals with joint hypermobility syndrome/Ehlers-Danlos syndrome -- hypermobility type (hEDS) and examined patient experiences of physiotherapy. A total of 946 questionnaires were returned and analyzed. Participants who received exercise advice from a physiotherapist were 1.75 more likely to report high volumes of weekly exercise (odds ratio [OR] = 1.75, 95 % CI: 1.30 to 2.36, $p < 0.001$) than those with no advice. Participants who believed that exercise was important for long-term management were 2.76 times more likely to report a high volume of weekly exercise compared to the participants who did not hold this belief (OR = 2.76, 95 % CI: 1.38 to 5.50, $p = 0.004$). Three themes emerged regarding experience of physiotherapy; physiotherapist as a partner, communication - knowledge, experience, and safety. The authors concluded that pain, fatigue, and fear are common barriers to exercise. Advice from a physiotherapist and beliefs regarding the benefits of exercise influenced the reported exercise behaviors of individuals with hEDS in this survey.

Reychler et al (2021) noted that that physiotherapy techniques are often prescribed in the management of hEDS. In a systematic review, these investigators examined the effect of the different physiotherapy techniques related to the children and adult patients with hEDS. PubMed, SPORTDiscus, Cochrane Library, PEDro, Scopus, and Embase databases were analyzed from inception to April 2020. Characteristics of the studies (authors), patients (sample size, sex, age, Beighton score), and non-pharmacological treatment (length of the program, number of session, duration of the session, and type of intervention), and the results with the drop-out rate were extracted. From a total of 1,045 retrieved references, 6 RCTs with a sample size ranging from 20 to 57 patients were included in the systematic review. There was a huge heterogeneity in the interventions. The durations of the program were from 4 to 8

weeks. Pain or proprioception showed significant improvements in the intervention group regardless of the type of intervention. A benefit of the inspiratory muscle training was observed on functional exercise capacity; QOL was systematically improved. The authors concluded that physiotherapy resulted in benefits on proprioception and pain in patients with hEDS even if robust RCTs were missing.

Yew et al (2021) stated that hEDS and hypermobility spectrum disorders are the most common symptomatic joint hypermobility conditions observed in clinical practice. The 2017 International Classification of the Ehlers-Danlos syndromes replaced previous terms for symptomatic joint hypermobility with hypermobile EDS and introduced the term hypermobility spectrum disorders for patients not meeting diagnostic criteria for hypermobile EDS. Both are diagnosed by applying the 2017 diagnostic criteria, which also excludes other less common conditions presenting with joint hypermobility such as other forms of EDS and heritable connective tissue disorders. Hypermobile EDS is inherited in an autosomal dominant pattern; however, it does not have a known genetic mutation to help with diagnosis. Clinical features of hEDS include joint hypermobility, skin findings, and joint pains or recurrent dislocations. Hypermobile EDS and, less commonly, hypermobility spectrum disorders may also be associated with several extra-articular symptoms, including anxiety disorders, chronic pain, fatigue, orthostatic intolerance, functional gastro-intestinal (GI) disorders, and pelvic and bladder dysfunction. The main objectives of therapy are managing symptoms, preventing joint injury, and educating patients regarding their condition. Based on limited evidence, patients with hEDS/hypermobility spectrum disorders may benefit from PT and occupational therapy, psychological support, and self-management. Primary care physicians play a key role not only in initial recognition, diagnosis, and patient education, but by virtue of their ongoing relationship, they can also help oversee and coordinate the multi-disciplinary team many of these patients require.

Blood Flow Restriction Therapy

Baker et al (2020) stated that blood flow restriction (BFR) is a process that uses inflatable cuffs to create vascular occlusion within a limb during exercise. The technique is said to stimulate muscle hypertrophy and improve physical function; however, the studies have mainly included

healthy, young males with a focus on athletic performance. In addition, much of the information came from studies with small samples sizes, limited follow-up time, and varied research designs resulting in greater design, selection, and sampling bias. Despite these drawbacks, BFR's popularity is increasing as a clinical rehabilitation tool for aging patients. Therefore, these investigators carried out a systematic review to examine if BFR therapy could induce skeletal muscle hypertrophy in adults older than 50 years of age, and whether BFR would improve muscle strength and/or physical function in that population. They found that BFR, in combination with a variety of exercises, was found to result in muscle hypertrophy as measured by muscle cross-sectional area (CSA), thickness, volume, mass, or circumference. Effect sizes for BFR's ability to induce muscle hypertrophy were calculated for 16 of the 30 studiers and averaged 0.75. BFR was also shown to improve muscle strength and functional performance. Effect sizes were calculated for 21 of the 30 studies averaging 1.15. The authors concluded that available evidence suggested BFR can induce muscle hypertrophy; thereby, increasing muscle strength and improving physical function in older adults; however, these findings must be considered carefully, as most studies were at moderate or high-risk for bias and featured only small sample sizes. These researchers stated that future studies needed to determine appropriate indications for prescription in older orthopedic patients by extending the follow-up periods, enrolling larger and more diverse sample sizes, and using randomization techniques. Level of Evidence = II.

The authors noted that 2 important limitations of this body of evidence that clinicians and practitioners need to carefully consider are the heterogeneity of BFR protocols as well as the disparate participant ages and health conditions among the included studies. One example of BFR protocol heterogeneity was occlusion pressure, which could vary widely between days, exercise conditions, and participants. Some studies employed a patient-dependent pressure ramp protocol while others relied on fixed pressure throughout the intervention, and these varying occlusion pressures made direct comparisons between study results difficult. Much research on the ideal BFR methodology and application has already been published in young adults; however, currently no consensus exists for adults older than 50 years of age, which is a necessary next step to ensure practical and safe implementation in the clinical setting. Another important limitation to consider was the variability

in participant age and health status. Despite the positive effects of BFR reported in most of the studies included in this review, the average age of participants was 64 years. The extent to which adults older than 80 years may respond to BFR is still unknown, which is of concern as this age group comprises a large proportion of orthopedic patients. In addition, particular medical conditions may be more influential than others on BFR's effects. For example, in patients with OA and those who were completely immobilized, the percent change and effect sizes ranged from 3.3 % to 42.0 % and 0.45 to 1.9, respectively. In patients with sporadic inclusion body myositis and osteoporosis, the percent change and effect sizes ranged from 9 % to 24.25 % and 0 to 0.68, respectively. These researchers stated that future studies are needed to specifically target adults older than 80 years who are healthy and battling a variety of diseases to better understand the potential utility of BFR as a clinical rehabilitation tool.

Saraf et al (2022) conducted a narrative review to discuss the implication of BFR training (BFRT) in physical therapy. These investigators stated that BFRT is a novel strengthening technique that works on the principle of peripheral vascular occlusion created with the help of pneumatic compression that can be induced by TheraBand, blood pressure cuffs or tourniquet to help conditions such as muscle weakness. These researchers reviewed the literature regarding the topic. They found that BFRT is a novel strength training program that has not been explored in India but is a very effective, less expensive, and innovative way of rehabilitation. The utility of BFRT is evident in post-operative disuse atrophy in the initial days of bed-rest. The evidence depict that BFRT is a very effective training modality that can efficiently improve the muscle function, strength, and mass. The authors concluded that that their review shed light on the emerging "importance" of BFRT that has not been explored much, and may play a significant role to reach up to the level of prosthesis for better QOL. These researchers stated that under proper assessment and guidance, BFRT may prove to be game-changer in clinical settings. It may be used under phases in the intensive care unit (ICU) settings. They noted that BFRT has various implications and is a novel strength training protocol creating windows for a new generation of physical therapy.

Zhang et al (2022) noted that the combination of low-load (LL) training with BFR has recently been shown to trigger a series of hemodynamic responses and promote vascular function in various populations; however, available evidence is sparse as to how this training regimen would influence hemodynamic response and vascular function in the elderly. In a meta-analysis, these investigators examined the effects of LL-BFR training on hemodynamic response and vascular function in older adults. They carried out a PRISMA-compliant systematic review and meta-analysis. The systematic literature research was conducted in the following electronic databases from their inception to February 28, 2022: PubMed, Web of Science, Scopus, EBSCO host, the Cochrane Library and CNKI. Subsequently, a meta-analysis with inverse variance weighting was conducted. A total of 1,437 articles were screened, and 12 RCTs with a total 378 subjects were included in the meta-analysis. The meta-analysis results showed that LL-BFR training caused a significant acute increase in heart rate (WMD: 4.02, 95 % CI: 0.93 to 7.10, $p < 0.05$), systolic blood pressure (SBP) (WMD: 5.05, 95 % CI: 0.63 to 9.48, $p < 0.05$) and diastolic blood pressure (DBP) (WMD: 4.87, 95 % CI: 1.37 to 8.37, $p < 0.01$). The acute hemodynamic response induced by LL-BFR training was similar to that elicited by high-load (HL) training. Training volume, cuff pressure and width were identified as significant moderators in the subgroup and meta-regression analyses. After 30 mins of training, resting SBP significantly decreased (WMD: −6.595, 95 % CI: −8.88 to −3.31, $p < 0.01$) in the LL-BFR training group; however, resting hemodynamic indexes exhibited no significant differences compared with common LL and HL training; long-term LL-BFR training resulted in significant improvements in flow-mediated vasodilation (FMD) (WMD: 1.30, 95 % CI: 0.50 to 2.10, $p < 0.01$), cardio ankle vascular index (CAVI) (WMD: 0.55, 95 % CI: 0.11 to 0.99, $p < 0.05$) and ankle brachial index (ABI) (WMD: 0.03, 95 % CI: 0.00 to 0.06, $p < 0.05$) in older adults. The authors concluded that this systematic review and meta-analysis showed that LL-BFR training will result in an acute hemodynamic response in older adults, which can return to normal levels 30 mins after training, and SBP significantly decreased. In addition, the beneficial effect of LL-BFR training on vascular function was to improve FMD, CAVI and ABI of older adults. Moreover, these researchers stated that due to the influence of the quality of the included studies and the sample size, more high-quality studies are needed to confirm such issues as BFR pressure and training risk.

The authors stated that this study had several drawbacks. First, some outcome categories or subgroups included data from a small number of trials, rendering resultant effect sizes potentially uncertain. Second, since few studies on vascular function indexes were included, no subgroup analysis was performed on these; thus, the role of regulatory variables could not be defined. Third, this study did not consider the potential influence of BMI and other personal health factors on the results. The transient rise and instability of arterial BP caused by sympathetic hyperactivity are risk factors for the occurrence of vascular diseases in the elderly. In order to avoid the possible risk of blind LL-BFR training, a large sample size is still needed to verify the regulatory effect of more variables and the appropriate BFR training approach for older adults. Fourth, at present, the mechanism of BP changes in older adults after LL-BFR training remains to be explored, and could be considered further from the perspective of autonomic nerve regulation.

Kong et al (2022) noted that age-related sarcopenia places a tremendous burden on healthcare providers and patients' families; BFRT may be a promising treatment to bring sarcopenia down, and it offers numerous advantages over traditional resistance training. In a systematic review and meta-analysis, these investigators compared the effects of BFRT and conventional resistance training on clinically delayed sarcopenia in the elderly. Databases such as PubMed, Web of Science, Embase, and Science Direct were searched to identify eligible studies; blinded data extraction was carried out to evaluate study quality, and conflicts were submitted to 3rd parties. A total of 14 studies fulfilled the inclusion criteria for this review. The funnel plots of the studies did not show any substantial publication bias. Low-load BFR (LL-BFR) had no significant effect on muscle mass compared with high-load resistance training (HL-RT) ($p = 0.74$, SMD = 0.07, 95 % CI: 0.33 to 0. 46) and LL-BFR had a significant effect on muscle strength compared with HL-RT ($p = 0.03$, $Z = 2.16$, SMD = -0.34, 95 % CI: 0.65 to -0.03). LL-BFR showed a slight effect on mass compared to LL-RT ($p = 0.26$, SMD = 0.25, 95 % CI: 0.19 to 0.69). Sensitivity analysis produced a non-significant change, suggesting that the results of this study were reasonable. The authors concluded that the findings of this review/meta-analysis suggested the possibility that BFRT could improve age-related sarcopenia.

The authors stated that this analysis had several drawbacks. First, few studies (n = 14) were retrieved for inclusion in this review, making it susceptible to publication bias, which was detrimental to the obtained results, it was also on this basis that funnel plots were abandoned to be drawn to test for publication bias between studies. Second, the review was unable to perform subgroup analyses to determine the effects of LL-BFR versus LL-RT with different training durations and frequencies on muscle mass and muscle strength due to the limited number of included studies. Third, the results of LL-BFR versus LL-RT for muscle mass were not obtained by this review analysis based on the obtained studies and data, which casted doubt on the veracity of the LL-BFR advantage. fourth, variability in the timing of training interventions included in the study may result in bias.

Okoroha et al (2023) stated that quadriceps muscle atrophy remains a limiting factor in returning to activity following anterior cruciate ligament reconstruction (ACLR); BFRT may accelerate quadriceps strengthening in the peri-operative period. In a randomized controlled trial, these investigators examined post-operative isometric quadriceps strength in patients who underwent ACLR with a peri-operative BFR program. Patients indicated for ACLR were randomized into 2 groups, BFR and control, at their initial clinic visit. All patients underwent 2 weeks of pre-habilitation pre-operatively, with the BFR group performing exercises with a pneumatic cuff set to 80 % limb occlusion pressure placed over the proximal thigh. All patients also underwent a standardized post-operative 12-week PT protocol, with the BFR group using pneumatic cuffs during exercise. Quadriceps strength was measured as peak and mean torque during seated leg extension and presented as quadriceps index (percentage versus healthy limb). Patient-reported outcomes (PROs), knee ROM, and quadriceps circumference were also gathered at 6 weeks, 3 months, and 6 months post-operatively, and adverse effects were recorded. This trial included 46 patients, 22 in the BFR group (mean age of 25.4 ± 10.6 years) and 24 in the control group (mean age of 27.5 ± 12.0 years). At 6 weeks post-operatively, the BFR group showed significantly greater strength compared with the controls (quadriceps index: 57 % ± 24 % versus 40 % ± 18 %; p = 0.029), and the BFR group had significantly better PROM Information System-Physical Function (42.69 ± 5.64 versus 39.20 ± 5.51; p = 0.001) and International Knee Documentation Committee (IKDC; 58.22 ± 7.64 versus 47.05 ± 13.50; p =

0.011) scores. At 6 weeks post-operatively, controls showed a significant drop in the peak torque generation of the operative versus non-operative leg. There were no significant differences in strength or PROs at 3 or 6 months post-operatively; 3 patients elected to drop out of the BFR group secondary to cuff intolerance during exercise; otherwise, no other severe AEs were reported. The authors concluded that integrating BFR into peri-operative PT protocols resulted in improved strength and increased PROs at 6 weeks after ACLR; however, no differences in strength or PROs were found at 3 and 6 months between the 2 groups.

The authors stated that this study had several drawbacks. First, One is that multiple patients were lost to follow-up, as well as a large number of excluded patients. Each patient was called once per week for 3 weeks surrounding their proposed appointment time, and despite this, there was still difficulty in obtaining follow-up measurements, which may have also been influenced by the ongoing COVID-19 pandemic throughout the study period. While prior investigations have validated the use of handheld dynamometers in measuring isometric knee extension torque, the utility of these measurements as a surrogate for overall quadriceps function likely does not fully represent the patients' complete quadriceps function.16,24 We also recruited all patients evaluated at our clinics with an ACL tear with plans to undergo reconstruction; thus, there was a variability in the age, sex, preoperative activity level, and athletic ability of our patient population, which may have also contributed to the rather large variation in measured strength via the dynamometer. While there was no statistically significant difference, there was also variability in meniscal work as well as graft choice, which may have contributed to the difference between groups. This is important to note as hamstring and quadriceps tendon autografts have been associated with less of a negative impact on quadriceps strength postoperatively. Additionally, while we disseminated our physical therapy protocol to each physical therapist, there could be variability in therapy based on provider and location. While the 6-month follow-up represents a relatively short follow-up period, BFR was only used for the first 3 months, and longer-term studies will be useful to determine if there are lasting effects of BFR training. While there were some statistically significant differences between groups, these may not translate to clinically significant differences. Patients and providers were also not blinded to their treatment group, which has the potential to introduce bias.

Wedig et al (2023) noted that accumulating evidence indicates that some COVID-19 survivors display reduced muscle mass, muscle strength, as well as aerobic capacity, which contribute to impairments in physical function that can persist for months after the acute phase of illness. Accordingly, strategies to restore muscle mass, muscle strength, and aerobic capacity following infection are critical to mitigate the long-term consequences of COVID-19. Blood flow restriction, which entails the use of mechanical compression to the limbs, presents a promising therapy that could be employed throughout different phases of COVID-19 illness. These researchers hypothesized that use of passive BFR modalities can mitigate losses of muscle mass and muscle strength that occur during acute infection; and exercise with BFR can serve as an effective alternative to high-intensity exercise without BFR for regaining muscle mass, muscle strength, and aerobic capacity during convalescence. The various applications of BFR may also serve as a targeted therapy to address the underlying pathophysiology of COVID-19 and provide benefits to the musculoskeletal system as well as other organ systems affected by the disease. As a consequent, these investigators presented a theoretical frame-work with which BFR could be implemented throughout the progression from acute illness to outpatient rehabilitation with the objective of improving short- and long-term outcomes in COVID-19 survivors. They envision that this paper will encourage discussion and consideration among researchers and clinicians of the potential therapeutic benefits of BFR to treat not only COVID-1, but similar pathologies and cases of acute critical illness.

Yuan et al (2023) stated that as an emerging training method, BFRT has been shown to promote the growth of muscle mass and strength. In recent years, it has been gradually applied in different populations; however, there are few studies on how BFRT would affect muscle mass and strength in the elderly. The relevant literature was compiled and summarized in this study. Through the comparison of BFRT with traditional training methods and its application in the elderly, it showed that BFRT could increase muscle mass and strength, prevent muscle atrophy, improve cardiopulmonary function, facilitate injury and post-operative rehabilitation, and intervene in related degenerative diseases as a training method suitable for the elderly,. The main mechanism of BFRT's promotion of muscle mass and strength growth is metabolic stress response, including muscle fiber recruitment, protein synthesis

signal pathway activation, hormone secretion, etc., and is also related to cell swelling caused by pressure. The authors concluded that although the use of BFRT in the elderly population is increasing, there is a lack of personalized programs. These investigators stated that further investigations on the dose effect and safety of BFRT are needed to develop more accurate personalized training programs.

RomTech PortableConnect

The RomTech PortableConnect is a medical device that delivers clinician-controlled PT sessions to patients in their homes. There is a lack of reliable evidence to support the use of RomTech PortableConnect.

Summers et al (2022) evaluated the PortableConnect -- a novel, home-based, clinician-controlled, multi-modal evaluation and therapy device with telerehabilitation functionality for total knee arthroplasty (TKA). A total of 135 consecutive TKA patients receiving standard therapy protocol (STP) were compared to 135 consecutive patients receiving a home-based clinician-controlled therapy system (HCTS). Outcomes were assessed at 2, 6, and 12 weeks, including visual analog scale (VAS) for pain, knee injury and osteoarthritis outcome score JR (KOOS JR), and knee range of motion (ROM) measured by the same certified physical therapists. Postoperative knee ROM was greater in the HCTS group at all time points throughout the study period ($P < .001$ at 2, 6, and 12 weeks). VAS and the KOOS JR functional scores were statistically better ($P < .001$) in the HCTS group at all time points and exceeded the threshold for minimal clinically important difference (MCID) for both VAS and KOOS JR. There were significantly fewer cases of arthrofibrosis requiring manipulation under anesthesia (MUA) in the HCTS group (1.48 versus 4.44%). The investigators concluded that, following TKA, this novel, home-based, clinician-controlled, multi-modal therapy device was superior to standard PT during the first 12 weeks postoperatively for ROM, KOOS JR, and VAS (with all scores exceeding the MCID) and had substantially fewer manipulations for arthrofibrosis.

The drawbacks of this study include its non-randomized, consecutive cohort design, which introduces potential for selection bias and confounding, as patients were not randomly assigned to the home-based, remote-clinician-controlled therapy system (HCTS) or standard physical

therapy (SPT) groups. This design limits the ability to attribute observed differences solely to the intervention, as unmeasured variables may have influenced outcomes. Additionally, the study was conducted at a single institution, which may limit the generalizability of the findings to other settings or patient populations. The follow-up period was limited to 12 weeks, so long-term outcomes, durability of benefits, and late complications were not assessed. There is also a lack of detailed reporting on adverse events beyond manipulation under anesthesia.

Summers et al (2024) noted that the costs and benefits of different rehabilitation protocols following TKA are unclear. The emergence of tele-rehabilitation has introduced the potential for enhanced patient convenience and cost reduction. In a retrospective, single-surgeon study, these investigators examined the cost difference between standard PT (SPT) and a tele-rehabilitation home-based clinician-controlled therapy system (HCTS). This trial included 109 Medicare patients who received SPT; they were compared to 101 Medicare patients who were treated with a HCTS. The analysis focused on total rehabilitation costs and the assessment of outcome measures: knee ROM, VAS pain levels, and Knee Injury and Osteoarthritis Outcome Score for Joint Replacement scores. The HCTS group showed not only statistically significantly lower average costs but also faster and sustained knee ROM improvements. In addition, in comparison to SPT, the HCTS group exhibited superior VAS pain scores and Knee Injury and Osteoarthritis Outcome Score for Joint Replacement functional scores at all assessment points post-operatively, which were statistically significant (all $p < 0.001$) and surpassed the minimal clinically important difference (MCID) thresholds. The authors concluded that the HCTS used in this study exhibited a remarkable cost-saving advantage of $2,460 per patient compared to standard therapy. As approximately 500,000 primary TKAs in the U.S. are covered by Medicare annually, a switch to HCTS could yield total cost savings of more than $1.23 billion per year. Additionally, the HCTS cohort showed superior functional outcomes and improved pain scores across all assessment time-points, exceeding the MCID. Moreover, these researchers stated that further studies are needed to validate these findings and determine their relevance across diverse patient populations and healthcare settings.

The authors noted that one potential drawback of this trial was that only traditional Medicare patients were included in the cost analysis. While this was intentional since it was easier to calculate costs when comparing Medicare patients accurately, the substantial cost savings found in this study were likely to be more variable when looking at patients who had a TKA with commercial insurance plans. In addition, this was a retrospective study, which inherently could introduce possible biases. These researchers attempted to minimize sampling bias in this trial by including a consecutive series of patients by a single surgeon who did not have any other procedural differences between the treatment groups. Additionally, the study was conducted at a single institution, which may limit the generalizability of the findings to other settings or patient populations. The sample size was modest, and the follow-up period focused on early clinical outcomes rather than long-term functional status or complications.

Appendix

Physical therapy should be provided in accordance with an ongoing, written plan of care. The purpose of the written plan of care is to assist in determining medical necessity and should include the following:

The written plan of care should be sufficient to determine the medical necessity of treatment, including:

I. The diagnosis along with the date of onset or exacerbation of the disorder/diagnosis

A. A reasonable estimate of when the goals will be reached;
B. Long-term and short-term goals that are specific, quantitative and objective;
C. Physical therapy evaluation;
D. The frequency and duration of treatment; and
E. The specific treatment techniques and/or exercises to be used in treatment.

II. Signature of the patient's physical therapist

The plan of care should be ongoing, (i.e., updated as the patient's condition changes), and treatment should demonstrate reasonable expectation of improvement (as defined below):

A. Physical therapy services are considered medically necessary only if there is a reasonable expectation that physical therapy will achieve measurable improvement in the patient's condition in a reasonable and predictable period of time.
B. The patient should be reevaluated regularly (at least monthly), and there should be documentation of progress made toward the goals of physical therapy.

The treatment goals and subsequent documentation of treatment results should specifically demonstrate that physical therapy services are contributing to such improvement.

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