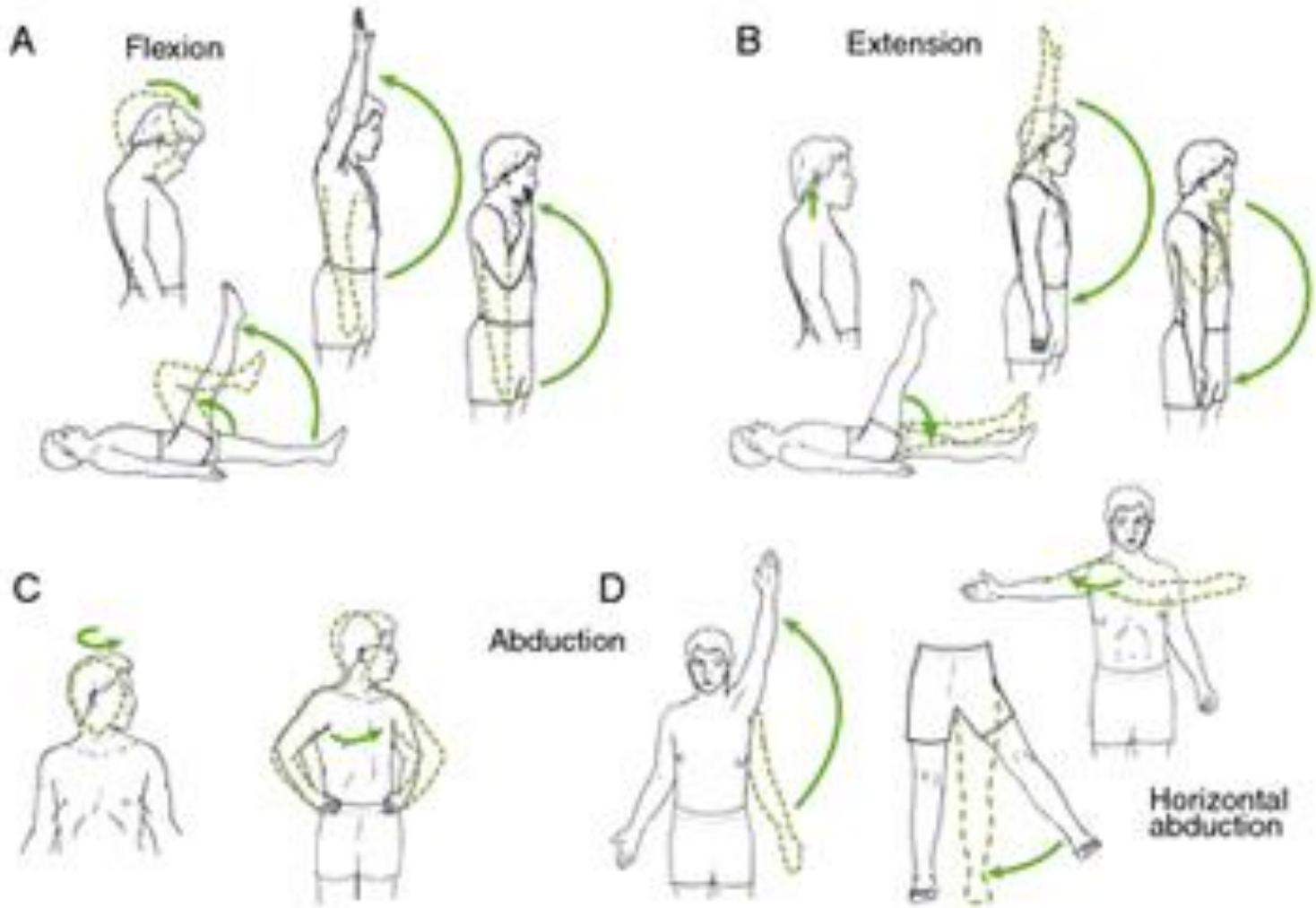
Optimizing Abilities and Capacities: Range of Motion, Strength, and Endurance

- Three capacities necessary for performing physical activity are range of motion (ROM),strength, and endurance.
- Occupational therapists help clients improve these basic capacities as a preparatory means for developing higher level skills needed for the performance of everyday activities or occupations.
- The principles are applied to the remediation of impairments from acute injuries; the prevention of illnesses and conditions caused by repetitive motion, cumulative trauma, or poor biomechanics; and as compensation for or adaptation to chronic disability.

MUSCULOSKELETAL SYSTEM
Maintaining or Preventing Limitation in Range of Motion

- ROM is the maximal distance that bones move about a connecting joint. It involves the length and excursion of muscles as well as the extensibility of connective tissues that cross the joint.
- The actual ROM at any joint is directly affected by the structures surrounding the segments that are moving. Occupational therapists are concerned with the total range allowed by these structures, but more importantly, they are concerned with functional ROM, which is the range necessary to perform daily activities. To this end, it is the therapist's responsibility to provide treatment that helps clients maintain functional motion or to help patients gain motion when there are limitations that interfere with occupation.

RANGE OF MOTION



Factors That Limit Range of Motion

- There are numerous reasons for limited ROM such as:
  - Systemic, neurological, or muscular diseases that impair muscle performance.
  - Joint diseases such as arthritis that create pain and inflammation decrease motion, and surgical or traumatic insults that produce edema and scarring may also limit motion.
  - Finally, simple inactivity or immobilization affects ROM.
- Forces that act across a joint during motion determine the quantity, alignment, length, and structural organization of the collagen fibres that make up the majority of connective tissue around a joint.
- When a joint is not put through its full ROM because of either internal factors such as pain and inflammation or external factors such as casting, splinting, or bed rest, physiological changes in the connective tissues occur.

- For muscle, this includes changes in the length and numbers of sarcomeres, thickening of the tissue, a loss of fibres, and potential atrophy, resulting in a muscle's inability to exert force on the bony lever.
- For ligaments, joint capsules, and tendons, a lack of motion results in a decrease in collagen fibres, which results in weakness, and when new collagen is formed, it is done in a shortened, disorganized fashion that results in stiffness.
- In the joints themselves, a loss of motion results in the breakdown of articular cartilage because synovial fluid is no longer moving to carry the necessary nutrients to the joint surfaces. This in turn creates further loss of motion because of pain, inflammation, and edema.

- Edema, defined as the accumulation of excessive fluid in intercellular spaces, is a natural result of trauma or injury.
- The fluid (made up mostly of water and dissolved electrolytes) usually dissipates as the healing process progresses. However, if the edema persists over time, the content of the fluid changes to a highly viscous, protein-laden material, which if not managed can increase circumference of a joint, cause fibrosis and thickening of tissues, and result in adhesions and contractures that restrict motion and limit a person's ability to engage in purposeful activity.

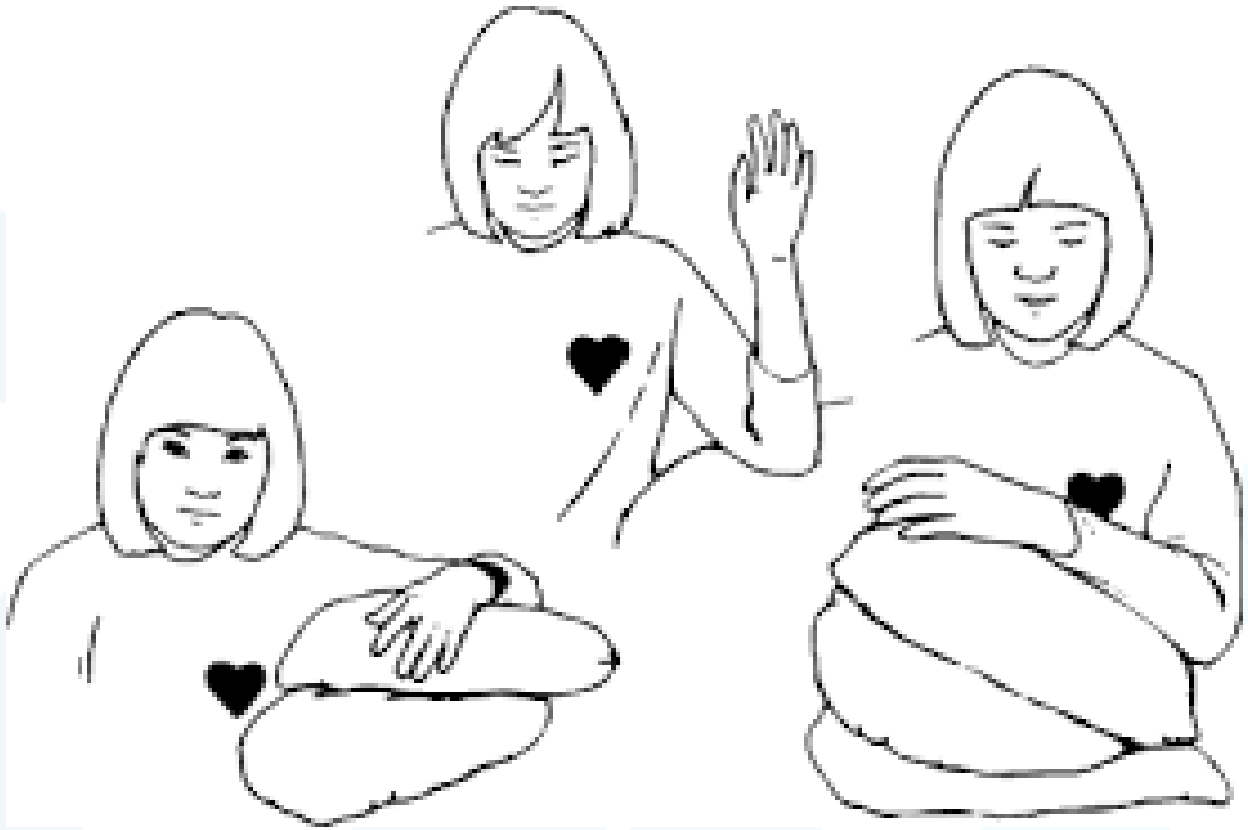
Intervention Methods

- Many ROM limitations can and should be prevented. Limited motion creates a pathological cycle where the loss of motion results in pain, edema, and shortened structures that result in further loss of motion. It is important for occupational therapists to help patients break the cycle in order to remain as functional as possible.
- This is done by providing therapy that is aimed at decreasing edema, helping patients prevent contractures through proper positioning and/or splinting, and facilitating joint movement through as much range as possible if motion is not contraindicated.

Decreasing Edema.

- In order to prevent ROM limitations secondary to edema, occupational therapists commonly use techniques of elevation, cryotherapy, compression, massage, and at times electrical current.
- During acute injuries or right after surgery, patients who do not have any arterial compromise are instructed to slightly elevate injured extremities above the heart in order to use gravity to improve venous and lymphatic flow and decrease swelling.


wikiHow



- Cryotherapy or the use of cold application is helpful in managing edema by producing vasoconstriction, which reduces blood flow, slows down metabolic activity, and decreases the inflammatory response that causes edema.
- Compression limits edema by restricting the accumulation of subcutaneous fluid in tissues through external pressure. The pressure is provided by form fitting compressive garments like gloves or hosiery, tubular sleeves, or elastic wraps.

- There are various techniques of massage to reduce edema, including retrograde massage, which involves a constant stroking massage from the distal portion of the extremity back proximally toward the heart, and a newer technique called manual edema mobilization.
- Finally, although the effectiveness of high-voltage pulsed current at reducing edema has not been established, some therapists use this technique in the belief that it helps decrease edema that may be limiting ROM.
- Note that use of many of these intervention techniques require specialized training and/or licensure.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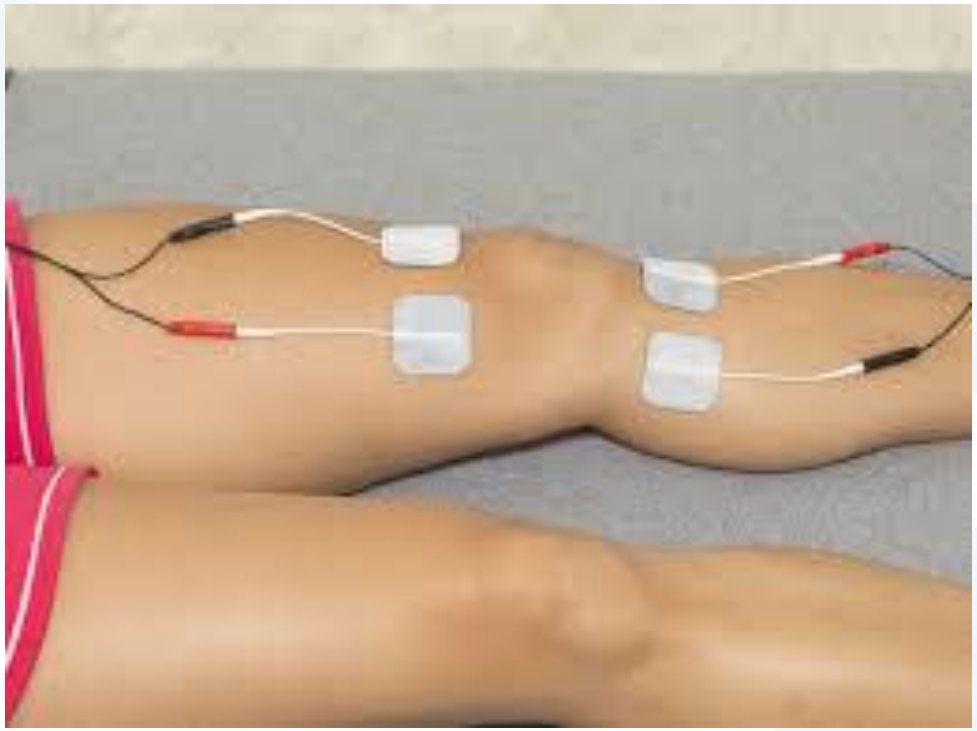
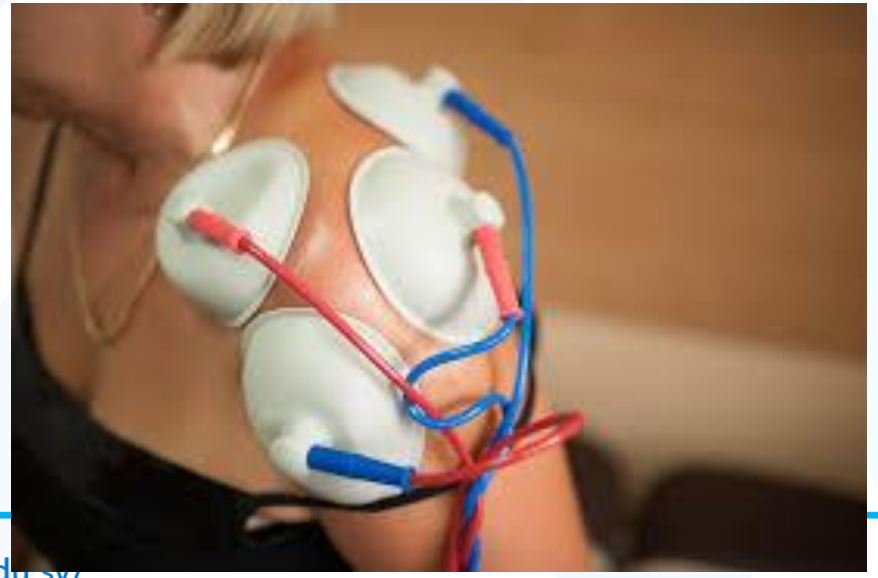




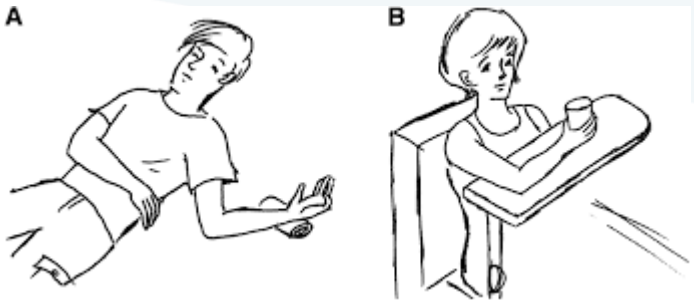
Applying Self-Adhesive Elastic Bandages for Compression

- Choose the appropriate width of bandage, understanding that the narrower the bandage, the greater the pressure.
- Start at the distal end of the limb or digit and wrap proximally, keeping the tension constant at about 50% of the stretch of the material.
- Wrap in a spiral motion overlapping 50% so that the fluid can flow evenly back toward the body and not be trapped in pockets of unwrapped tissue.
- If wrapping a digit, leave the tip open to observe skin color and preservation of circulation.
- Instruct patient on amount of wear (nighttime, hourly, or multiple hours).
- Instruct patient to remove bandage periodically to inspect skin for color and maceration.

Minimizing Contractures

- Contractures are defined as static shortening of muscle and connective tissue that result in reduced joint mobility and an increase in resistance to passive joint movement.
- People suffering from hypertonicity caused by a stroke or traumatic brain injury may develop contractures in the upper extremity when elbow or wrist flexors continually fire, resulting in a shortening of the flexors and lengthening of the extensors.
- Even without hypertonicity, patients with paralysis often rest with their affected arm in the lap, which predisposes the shoulder muscles and tissues to shorten. Patients with burns or deep wounds as a result of trauma may develop contractures when normal skin is replaced by scar tissue.

- Therapeutic positioning is designed to help with edema resolution when limbs are elevated, to help preserve function by holding limbs at a proper muscle length, and to help patients avoid positions that result in tissue shortening or contracture.
- For example, patients often develop tightness in the shoulder extensors, adductors, and internal rotators after stroke. Therefore, positioning the patient with the arm in shoulder flexion, abduction, and external rotation helps prevent that tightness from developing.



Positioning the Right Hemiplegic Arm

Stroke Strategy
Southwestern Ontario

Lying on Hemiplegic Side

- Hemiplegic arm forward at the shoulder; elbow extended and hand supported with the palm up
- Unaffected arm supported forward on the pillow
- Pillow behind back
- Both legs bent at the hips and knees; pillow in between

Lying on Unaffected Side

- Hemiplegic arm supported forward on two pillows
- Pillow behind back
- Both legs bent at the hips and knees, a pillow in between

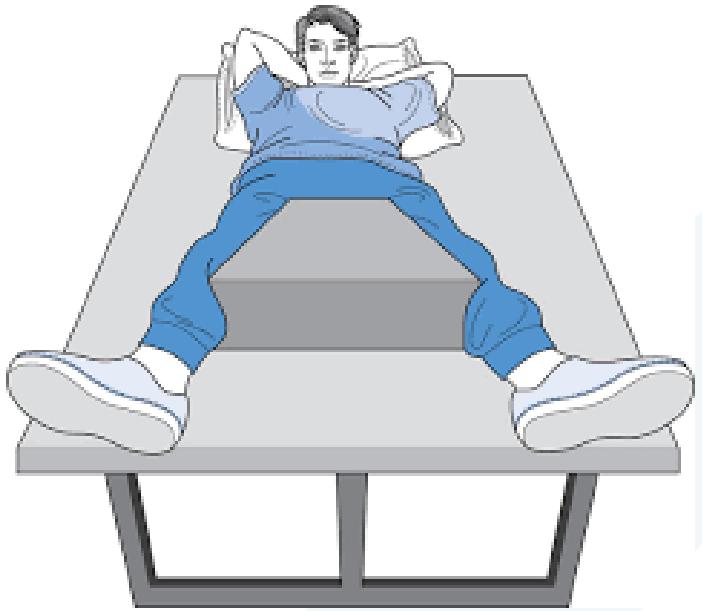
Sitting in Bed

- Hemiplegic arm supported on two pillows
- Trunk in midline
- Pillows under unaffected arm as required

London Health Sciences Centre

Sitting in Wheelchair

- Lap tray on wheelchair
- Pillow under hemiplegic arm with shoulder abducted, forearm pointing forward and hand supported

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- Splinting, which is an extension of positioning, is indicated when there is a need to prevent unwanted motion or when a patient does not have the capability to assume postures and positions that prevent tissue shortening.
- Splints can be used to hold joints in a position with optimum tissue length, and in the case of burns, they are used to prevent or limit scar contracture.

- In spite of prevention, sometimes contractures and consequent ankylosis are unavoidable because of the disease process. In these instances, positioning and splinting patients in a safe, functional position that allow the patient to manage self-care and other functional tasks, is necessary.
- The functional position of the hand and wrist is slight (20°–30°) extension of the wrist, opposition and abduction of the thumb, metacarpal-phalangeal joints in 40°–60° of flexion and semiflexion of the finger joints.

- Then, if a patient's hand contracts in that position, the person can still hold objects. If, however, the hand or digits were to contract in a fully flexed or fully extended posture, function is lost. When positioning and splinting a patient, the occupational therapist must be vigilant in anticipating eventual outcomes of prolonged immobilization that may compromise occupational performance.

Movement through Full Range of Motion

- Immobilization is often necessary to protect structures such as bone and skin while they heal, but prolonged immobilization can lead to decreased strength, shortened tissues, contractures, and loss of motion.
- Controlled motion applied early in the rehabilitation process helps minimize the negative effects of immobilization.
- The method used for movement through full ROM, referred to as ranging, involves teaching the patient to move the joints that are injured, immobilized, or edematous or passively moving the joints if the patient is unable to actively move the joint themselves.

- In active range of motion (AROM), the patient actively moves the joint through full range with their own muscle power, and in passive range of motion (PROM), the patient's limb is moved through the desired motion by an external source.
- If a patient has some strength but is unable to fully move a joint through its desired ROM because of weakness, a therapist may use active-assistive ROM (AAROM) to provide just enough assistance to help the patient achieve the desired motion.

- AROM or AAROM is preferred to PROM because the contraction of the muscles helps pump the fluid out of the extremity helping with edema and stiffness. However, if AROM is not possible, PROM and in particular the use of a continuous passive motion (CPM) machine, which electronically moves a joint through a set ROM, also reduce stiffness and edema.

- Whatever kind of motion is being applied, therapists must pay attention to the plane of motion a joint is moving through, the structures involved with the movement of the joint, and joint biomechanics.
- For example, the therapist pays special attention to the scapulohumeral rhythm when ranging the shoulder girdle. By moving the scapula with one hand and the humerus with the other, the therapist ensures that they are moving in synchrony.
- Attention to this alignment during movement of the scapula and humerus eliminates injury to the glenohumeral joint, bursae, capsule, and ligaments.

- To maintain ROM, joints must periodically be moved through their available ranges. As for the frequency of AROM or PROM when trying to maintain motion, there is no set protocol.
- Therapists constantly monitor a patient's response to any intervention and adjust treatment accordingly. The amount of motion is dependent on the patient's status (inpatient versus outpatient), time constraints during treatment, and the patient's own abilities, both physical and cognitive.

- If a patient has the physical and cognitive abilities, occupational therapists use activity to promote the AROM and PROM needed to prevent loss of motion. For example, using a Wii™ golf or tennis program during therapy encourages a patient who has either of those interests to move at the shoulder, elbow, and wrist.
- Another example is having a patient use his or her hemiplegic upper extremity in weight-bearing activities for balance and postural stability while passively stretching the wrist and fingers in extension.

Increasing Range of Motion

- Whereas some significant limitations of ROM can be improved or corrected through the use of occupation and exercise, others cannot.
- Occupational therapists may treat ROM limitations using several time-tested interventions such as moist heat, PROM with prolonged passive stretch at the patient's end range, CPM, and various splinting techniques.
- However, therapists universally recognize the importance of stretch in helping patients develop the capabilities needed to perform occupations. Some problems cannot be changed through these means including ankylosis or arthrodesis, long-standing contractures in which there are extensive fibrotic changes in soft tissue and severe joint destruction.
- If ROM limitations cannot be overcome, occupational therapy facilitates functional mobility by providing compensatory techniques through the use of equipment to enable participation in life occupations.

Stretching

- Stretch is a process by which the target tissue is lengthened by an external force, usually through manual therapy or through the use of splinting, casting, or external equipment.
- Stretch produces change in the extensibility of soft tissue that dissipates when the stress is removed, so to make lasting gains, the stretch needs to be repeated or sustained over time.
- Factors that determine the effectiveness of stretching are the duration, the intensity, the speed, and the frequency of the stretch being applied.

- The duration of a stretch refers to the amount of time tissues are held under an external force.
- According to the total end range time principle the longer a joint is held at the end range under adequate tension, the greater the gains will be in ROM.
- However, there are different types of stretching such as ballistic stretching or joint mobilization techniques that incorporate shorter stretches. It is clinically recognized that maintained stretching is more effective; however, gains are also noted using the briefly held stretches.

- Gentle, controlled stretching that achieves small increments of gain over time is thought to be more effective than vigorous stretching aimed at large, rapid gains.
- Residual pain after stretching indicates that the stretch was too forceful and caused tearing of soft tissues or blood vessels.
- The method of moving gently to the point of maximal stretch and holding that position allows connective tissue to gradually adapt to its new elongated state over time.

- In static progressive stretching, shortened tissues are held comfortably in a lengthened position until a degree of relaxation is felt by the patient or the therapist.
- Once this is achieved, the newly lengthened tissues are lengthened again, and over time the accommodated tissues lengthen to a functional position.
- for the velocity of a stretch, it is generally thought that the speed should be slow to allow the tissues to adjust gradually to the forces being applied.
- There are two types of stretching: active and passive. In active stretching, contraction of muscles opposite to the direction of limitation is the source of the force, and in passive stretching, an external force is applied.

- Active Stretching. A n occupational therapist's clinical expertise lies in using occupation as a treatment medium and in this case, as a means for reaching the goal of increasing ROM in a given joint or mobility within a given extremity. The use of occupation for stretching is empirically based on the idea that a person involved in an interesting and purposeful activity will gain greater range because he or she is relaxed, is not anticipating pain, is motivated to complete the task, and therefore is likely to move as the activity demands

- Occupations used as a means to increase ROM must provide a gentle active stretch by use of slow, repetitive isotonic contractions of the muscle opposite the contracture or by use of prolonged passive stretched position of the contracted tissue.
- increasing or decreasing the placement distance from the patient's center of gravity, and increasing the weight of the object being transferred to and from the various levels all address active stretching with ROM.

- Another technique that increases the range of shortened tissue is the proprioceptive neuromuscular facilitation technique called contract relax (CR) and agonist contraction.
- CR involves a maximal isometric contraction of the tight muscle, usually performed at the point of limitation. The muscle is contracted maximally for 3–10 seconds against resistance provided by the therapist and then relaxed. During the relaxation phase, the therapist moves the part in the direction opposite to the contraction and holds it.

- Passive Stretching. Passive stretching is often done by an occupational therapist as a preparatory method for increasing ROM so patients are able to engage in purposeful activity. Techniques for passive stretching may include manual stretch and the use of orthotic devices, such as splints or casts, to provide controlled passive stretching

Manual Stretching Methods

- Provide a relaxing environment for the patient.
- Describe manual stretching, noting that it involves tolerable pain.
- Use motions identical to motions used in ROM evaluation.
- Stabilize the bone proximal and distal to the joint that is to be moved to avoid any compensatory movement.
- Move the bone smoothly, slowly, and gently to the point of maximal stretch (mild discomfort indicated verbally or facially by the patient).
- Make sure the movement is in the line of pull of the muscle.
- Encourage the patient to assist in moving the limb if possible.
- Hold the limb at the point of maximal stretch for 15–60 seconds.
- Relief of discomfort should immediately follow the release of stretch.
- If the patient complains of residual pain, future stretches should be performed more slowly and with less force.

Strengthening

- Strengthening interventions are defined as any intervention that involves an attempt at repetitive, effortful, muscle contraction and may include biofeedback, electrical stimulation, muscle reeducation, and progressive resistance exercise.
- Occupations or functional activity may also be used to increase strength. Therapists find that various occupations provide sufficient opportunities for muscle strengthening and are more effective at maintaining the patient's interest and motivation than exercise alone

- For strength to increase and muscle hypertrophy to occur, there must be a gradual increase of stress placed on the muscles.
- Parameters that may be manipulated to increase stress to muscle include exercise intensity, volume, the amount of rest between exercises, the type and velocity of contraction, and the frequency of exercise.
- The starting point for resistance is based on a therapist's judgment or on the data ascertained through manual muscle testing or testing with standardized equipment. Another method to calculate the appropriate starting load for strength training is to determine a Repetition maximum (RM).

- RM defined as the greatest amount of weight a muscle can move through available ROM just one time.
- Patients at the beginning of training or rehabilitation should use a lower percentage (40%–60% of 1 RM) versus those who have progressed or are well trained, where 80% of 1 RM is recommended.
- Training volume refers to the number of repetitions and sets performed during a training session multiplied by the resistance.

- An occupational therapist alters the training volume by changing the number of repetitions of an activity, changing the number of sets required of that one activity, or changing the number of activities done during a treatment session. The volume of strength training is also linked to the goal for treatment. If the goal is muscle strengthening, then it is recommended that fewer repetitions are done with increased resistance; if the goal is muscle endurance, then more repetitions are required with less resistance

- A rest period between exercises affects the muscle's response to strength training and is related to the intensity and volume of activity.
- The recommendation is that for activities that call for high loads or repetitions or if the patient is very young, elderly, or easily prone to fatigue, the rest period between activity should be 3–4 minutes, and for low intensity or low repetition activity, it should be 1–2 minutes.

- The type and velocity of muscle contraction during a strengthening program is established by the demands of the task and the physical abilities of the patient.
- During dynamic concentric muscle contraction, the velocity of the muscle action can be manipulated to simulate the demands of functional activity that call for fast movement (sports) or slow movement (painting). The velocity of muscle contraction in training should eventually match the velocity of muscle contraction that is required in the patient's occupational routine.

- With dynamic eccentric muscle contraction, it is easier to control a load, meaning that it takes less effort to lower a weight than to lift a weight. This is why, when dealing with a patient who is very weak, it is better to start with active eccentric exercise (i.e., having the patient lower the weakened limb while resisting gravity) rather than lifting the limb.
- Isometric strengthening is used when joint movement is not available or contraindicated, but strengthening is still warranted, such as after repair of soft tissue or to minimize atrophy during immobilization.
- Even though there is no joint movement, an isometric contraction can still produce a forceful contraction.

- For this reason, when the patient has hypertension or cardiovascular problems, isometric contraction should be avoided because contraction of either large or small muscles increases blood pressure and heart rate.
- It is recommended that people who are starting a strengthening program should exercise 2–3 days a week, which can then increase to 3–5 days a week as the strength progresses.

Increasing Endurance

- Muscle endurance refers to the ability of a muscle to maintain performance over a sustained period of time.
- During light resistive activities, motor units within the muscles are recruited and activated asynchronously. This allows for prolonged activity or muscle contraction. With activities that call for maximum muscle contraction, such as lifting heavy loads, more motor units must contract simultaneously without the opportunity to recover, resulting in quicker fatigue.
- Other factors that influence muscle endurance include the predominant type of fiber that is contracting during the activity (type I slow twitch fi bers fatigue slower than type II fast twitch fibers)

Grading Occupations to Increase Endurance.

The key elements of endurance training are low-intensity muscle contractions, a large number of repetitions, and a prolonged time period of training to the point of muscle overload.

The American College of Sports Medicine advocates for light to moderate loads (40%–60% of 1 RM) for high repetitions (>15) using short rest periods (<90 seconds) for endurance training

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Activity-Focused Analysis

Describe the task demands	Objects used	Properties of the utensils, tools, and materials and their locations relative to the person	
	Environmental demands	Characteristics of the environment in which the activity is usually carried out, including possible environmental barriers and enablers	Indoors No obstacles
	Social demands	Nature of and extent to which the activity involves others and/or holds particular meaning associated with social roles	Does /not require participation of others
	Contextual demands	Nature of and extent to which the activity or the way it is carried out holds particular meaning to certain cultures or age groups	Appropriate for individuals who are of work age and any cultural background
	Sequencing and timing	Monological task (requiring a singular sequence in order to be performed correctly) or a multilogical task in which a variety of sequences will work Extent to which the task involves	

	Required actions	Steps that comprise the activity	
	Prerequisite capacities, abilities, skills necessary to successful task performance	Sensorimotor: range of motion, strength, motor control, postural control, endurance, coordination/dexterity	
		Vision-perceptual: visual acuity, visual scanning, visual perception, awareness of extrapersonal space	Visual proficiency with small objects Ability to differentiate color Adequate spatial relations
		Cognitive: attention, memory, executive functioning, problem solving, self- awareness	Ability to sustain attention for 20 minutes Ability to follow directions
		Emotional, relational	Varies based on patient background with activity; can be performed with or without social interaction

	Safety precautions	Nature of safety considerations if performed in a therapy context	Patients who perform the task standing may need supervision related to balance and/or endurance. Patients with limited sensation in digits need to be aware

Prerequisite Biomechanical Capacities, Abilities, Skills Necessary

Motions	ROM (°), Distances	Primary Muscles	Gravity Assists, Resists, No Effect	Minimal Strength Required	Type of Contraction
Shoulder flexion	90–0	Anterior deltoid, coracobrachialis, pectoralis major	Resists	4- to 4	Concentric
Shoulder extension	90–0	Anterior deltoid, coracobrachialis, pectoralis major	Assists	3+to 4–	Eccentric
Cylindrical grasp		Finger flexors, finger extensors, interossei	No effect	4- to 4	Isometric

Type of Exercise	Definition	Muscle Grades	Procedures
Isometric	Exercise in which a weak muscle is isometrically contracted to its maximal force 10 times with rest periods between each contraction	Trace (0) The force of contraction is not sufficient to move the part.	• Provide a stimulating environment. • Explain procedures. • Instruct the patient to contract the weak muscle (“hold”). • External resistance applied by the therapist may help the patient isolate the contraction to the weak muscle or muscle group. • Patient holds contraction at maximum effort as long as possible while breathing normally. • Repeat 10 times with a rest between each contraction. • Increase duration of maximal contraction as patient improves. Safety Message: Maximal isometric contraction is contraindicated for patients with cardiac disease.

Type of Exercise	Definition	Muscle Grades	Procedures
Dynamic assistive (active assistive ROM)	Exercise in which a weak muscle is concentrically or eccentrically contracted through as much ROM as patient can achieve; therapist and/or external device provides assistance to complete motion	Poor minus (2-) Fair minus (3-) The muscle can move only through partial available range in either a gravity eliminated or against-gravity plane.	• Provide a stimulating environment. • Explain procedures. • For a 2- muscle, position limb to move in a gravity-eliminated plane. • For a 3- muscle, position the limb to move against gravity. • Patient moves weak muscle through as much range as possible. • Therapist provides external force to complete motion. • Although this seems similar to PROM, it differs because the • patient actively contracts the weak muscle.

Type of Exercise	Definition	Muscle Grades	Procedures
Dynamic active (active ROM)	Patient contracts muscle to move part through full ROM.	Poor (2) Fair (3) Muscle can move through full available range in either gravity eliminated Or against-gravity plane.	• Provide a stimulating environment. • Explain procedures. • For a 2 muscle, position the limb to move in a gravity eliminated plane. • For a 3 muscle, position the limb to move against gravity. • Patient moves weak muscle through full available ROM. • Patient repeats motion for three sets of 10 repetitions with rest break between sets.

Type of Exercise	Definition	Muscle Grades	Procedures
Dynamic active resistive (active resistive ROM)	Patient contracts muscle to move part through full available ROM against resistance	Poor plus (2+) Fair (3) Fair plus (3+) Good (4) Good plus (4+)	• Provide a stimulating environment. • Explain procedures. • For a 2+ or 3 muscle, position limb to move in a gravity eliminated plane. • For a 3+ or above muscle, position limb to move against gravity. • Therapist determines appropriate amount of resistance depending on the strengthening protocol chosen. If a 1RM has been established, then a percentage of that maximum can be used starting at 40%–60% and progressing to 80% as strength increases. Patient moves weak muscle through full available ROM against resistance. • The patient will do three or four sets of 10 with varying resistance and rest breaks between sets.

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