

MODALITIES IN PHYSICAL THERAPY

An Honors Thesis (HONRS 499)

by

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Purpose of Thesis

This discussion of modalities in physical therapy is limited to hydrotherapy, massage, and various methods of heat. The professional techniques and guidelines for administering each modality are recognized, as well as the standard apparatus, indications, and contraindications for each. In addition, a discussion concerning the underlying physical properties and laws governing each modality is included as an attempt to further understand the basis for their operation and utilization.

MODALITIES IN PHYSICAL THERAPY

Introduction

As part of the curriculum in the exercise science and wellness program, the author undertook a fifteen week internship in which she participated in a physical therapy/work-hardening clinic, cardiac rehabilitation program, and the wellness center located in Ball Memorial Hospital. Although all three sites provided valuable hands-on experience and learning, the author particularly enjoyed the work-hardening clinic (Work Performance Center). Physical therapy has always been of great interest to the author; she anticipates a career in the physical therapy field sometime in the future. Consequently, this paper describes several physical modalities employed by therapists in their practice of physical therapy. In addition, the various modalities were researched extensively by the author who utilized numerous texts and reference manuals pertaining to physical therapy.

Physical therapy is the use of physical modalities, or methods, on the body to bring about relief or a cure. A modality would include any standard method used on the body to relieve pain (ex. ice). Health professionals have long been aware of the great benefits of physical medicine and rehabilitation. However, it was not until recently that the field of physical therapy has skyrocketed. In the past, traditional exercises and basic means of alleviating pain (hot pack, ice) were primarily used for rehabilitation. Today, advancements in technology have upgraded the field

like never before. Sophisticated machines and equipment now perform the exercises the therapist would normally do. Computers display directions for the patient, countdown the time and number of repetitions performed, and offer encouragement. However, not all clinics can afford these new-found luxuries. Many old, seemingly outdated, modalities are still used today. The Work Performance Center contained a combination of both advanced and basic modalities for the patients to use. Often, patients appeared intimidated or frustrated by the complication of using a computer. This paper focuses on more traditional methods of rehabilitation: hydrotherapy, massage, and the use of heat including conductive, radiant, and coversive sources. The reader will find that these traditional methods are both widely used and extremely effective.

Hydrotherapy

Hydrotherapy is rapidly becoming one of the most promising, safest methods of rehabilitation. Water is essential to human beings--they cannot exist without it. In the beginning, water was used solely for the purpose of survival. As humankind developed, so did the uses of water. It was used to generate power, transport goods, and was the basis for the explosion of civilization as we know it today. The role of water in therapy dates back to the ancient Greeks and Romans where the sick were believed to be cured by the cleansing and steaming action of the agent. Ancient religious men also believed that blessed water could "drive out" evil spirits thereby curing the mentally ill. Many methods using

water, some of them bizarre, were practiced on the ill hoping to achieve some relief from their maladie. Water is, by no means, new to the therapeutic field. Christa and Jost Benedum are quoted as saying, "Long have the praises of water been sung. It has cleansed cult and creed, cured psyche and soma" (3,p.1). Water and its modern role in the field of rehabilitation dates back to the 1920's. In 1928, the Hubbard tank was developed and designed specifically for exercise. It was around this time that therapeutic pool exercises really began to develop systematically (3,p.4). There are different types of therapy that can be done with water including hydrotherapy pool rehabilitation, whirlpool baths, contrast baths, and the Hubbard tank. Before these modalities are discussed, it is necessary to explore some of the properties of water that make it an ideal method of therapy for some patients.

Mass, weight, density, buoyancy, hydrostatic pressure, surface tension, refraction, and turbulence are all properties of water that must be considered when designing a treatment program for a patient. A patient's mass and weight will have bearing on their ability to float. Density also relates to an individual's ability to float. Density equals mass divided by volume ($D = \frac{m}{V}$). For therapeutic purposes, this mass to volume ratio is equivalent to one. In order for an individual to float, their ratio of mass to volume must be less than one (3,p.22). This ratio changes with age. For example, an average child has a density of .86, an average adult has a density of .97, and an average elderly person

has a density of .86 (due to an accumulation of adipose tissue) (3,p.25). Therefore, it is easier for a child to float than an adult. Different body parts also have different densities. Arms are less dense than legs causing arms to float and legs to sink when submerged in water.

Buoyancy is another critically important feature of water. Buoyancy is the upward force in water working against the downward force of gravity. Buoyancy is special in that it diminishes the effects of gravity leaving a person in the water feeling "weightless". Buoyancy and gravity also account for the metacentre balance in water. If these two forces are equal, a person remains in a static position. However, an inequality in these two forces results in movement, particularly rotation (3,p.37).

Hydrostatic pressure is the pressure of water at varying depths. This is an important property when dealing with different injuries. Injuries where swelling is present at sub-acute and chronic stage benefit from immersion in deep water where higher pressure exists. This, however, would be contraindicated for swelling in the acute, or beginning, stage. The pressure of the water primarily affects swelling and it is for this reason that the therapist must know the varying pressures at various depths and be able to judge according to their patients particular needs (3,p.178).

Surface tension, refraction, and turbulence are all other properties of water that must be considered. Surface tension is important when the patient is entering the water as well as during the therapy session. The initial resistance

between the water and the patient is the surface tension. The surface tension also affects the patient by providing some resistance at all times during various movements (3,p.43). Refraction is water's ability to project back. In physics, according to Isaac Newton, for every action there is an equal and opposite reaction. Refraction also works something like this. For example, if a beam of sunlight is cast upon the water, the water is able to project that same amount of light back into the atmosphere. If an individual takes their flat hand and slaps it against the surface of the water, the water is able to produce the same amount of force against the hand. This is important to insure that the patient does not enter the water in a painful way. Turbulence is created by movements. The speed and shape of the movements influence the production of turbulence. The greater the speed, the more turbulence that is produced. All movements, no matter how small, will produce turbulence. Turbulence is important because it can be used to assist and resist movement during exercise (3,p.17). The therapist is required to have a complete understanding of all the properties of water before prescribing a treatment program for patients. Once the foundation has been mastered, there are a variety of options to choose from when designing a beneficial, effective hydrotherapy program. Hydrotherapy pool rehabilitation exercises, whirlpool baths, contrast baths, and the Hubbard tank are some of the ways in which water is employed as a modality.

Hydrotherapy- Pool Rehabilitation

Hydrotherapy pool rehabilitation can range from doing general group therapy to specializing in treating specific illnesses. In all situations, however, there are some common benefits, indications, and guidelines. In general, the benefits of hydrotherapy include relaxing of tense muscles, decreased pain, improved circulation, a removal of waste products, and an increased range of motion (3,p.31). Water provides a means for exercising and treating non-weight bearing patients. Because of buoyancy, injuries that would normally require a longer healing period due to inflammation, spasm, or swelling, can be treated earlier due to the "weightless" feeling of water. Patients are able to "bear down" in the water much earlier than they can on land (3,p.178). However, therapists must remain aware that modification of land exercises is required due to the buoyancy of water.

When exercising patients in a pool, the temperature of the water is crucial to determining the success of therapy. Pools that are too hot may cause sleepiness and tiredness in the patient. Elevated pool temperatures have also been shown to result in patients who demonstrate a lack of drive towards therapy (3,p.11). Pools that are too cool may cause tenseness in a patient, shivering, and irritability. Many studies have been conducted to determine the best temperature for maintaining a pool for therapy. In general, a temperature between 89-93°F is best suited to cater to all conditions (3,p.11).

When the therapist is ready to begin a hydrotherapy treatment program for an individual, organization is very important. The program should, as in all exercise programs, involve a warm-up, an exercise bout, and a cool-down. If the program is being developed for an athlete, the therapist should include sport specific exercises (aerobic vs. anaerobic training). General mobilization exercises should be included in all programs for uninjured parts to maintain strength and flexibility (3,p.192). Buoyancy assisted, supported, and resisted exercises are the most common exercises carried out in hydrotherapy (3,p.23). When utilizing buoyancy influenced exercises there are three ways in which the physical therapist can relate to the patient:

1. The therapist acts as a fixation and the patient moves toward, away, or around the physical therapist.
2. The therapist acts as a stabilizing factor and moves with the patient.
3. The patient acts as a fixation and the therapist moves around him/her. (3,p.21).

Many disabilities, illnesses, and injuries can be treated with hydrotherapy. Athletic injuries including stress fractures, strains, sprains, and knee problems respond very well to pool exercises. In athletes or other individuals who must rehabilitate and improve their weight-bearing ability, water can also provide varying degrees of resistance. Depth can increase difficulty. For example, immersion in the pool up to the level of C7 results in 8% weight bearing to the patient. Immersion to the xiphisternum results in

25-35% weight bearing to the patient. Immersion to the anterior superior iliac crest results in 47 to 54% weight bearing to the patient. Therapists can use the special properties of water to implement progressively resistant, exciting programs. Other conditions that can be treated include arthritis, stiff joints, circulatory problems, obesity, diabetes, head injuries, open wounds, burns, ulcers, neck injuries, and injuries of the spine. Hydrotherapy has been used to treat multiple sclerosis (MS). A study conducted by Gehlsen, Grigsby, and Winant of Ball State University in 1983 indicated that an effective aquatic program could, indeed, benefit patients with MS. They found that patients with MS displayed increased muscle strength, work ability, and power output when participating in a regular aquatics program. More importantly, MS patients complained of less fatigue, a problem that significantly affects the majority of these individuals (6,p.653-656).

Hydrotherapy- Hubbard Tank

A second type of hydrotherapy that is widely utilized is the Hubbard tank. This is a large, metal tub used for total body immersion purposes. Common indications for the Hubbard tank include arthritis in the upper and lower limbs, relieving stiffness, conducting exercises for various bone and joint diseases without the effects of gravity, and cleansing open wounds, particularly decubiti (7,p.450). The water temperature for the Hubbard tank should be maintained between 40.6 and 46.1°C. Treatment duration time usually ranges between 20-30 minutes.

Hydrotherapy- Whirlpool Baths

The whirlpool bath is similar to the Hubbard tank in all aspects except it is used for partial body immersions rather than total. Whirlpools use compressed air as an agitator to prevent the backflow of infections. Indications, temperatures, and treatment time are the same as for the Hubbard tank (7,p.450).

Hydrotherapy- Contrast Baths

Contrast baths are simple and can be done in the clinical setting as well as at home. Common indications for the contrast baths include arthritis of the fingers, wrists, feet, and ankles. A contrast bath is started by having the patient place the affected area in hot water (40.6 and 43.3°C) for ten minutes and then transferring it to cold water (15° and 20°C) for one minute. The next cycle consists of the patient immersing in hot water for four minutes and cold water for one minute. The patient would continue this 4:1 cycle until a total treatment time of thirty minutes was achieved. Contrast baths are excellent for relieving stiffness and pain (7,p.451).

Hydrotherapy is a very versatile, effective method for relieving pain and other physical problems. The use of pool exercises is relatively new but greatly on the rise. Whirlpools are quite common and have been used for years. The use of hydrotherapy is safe and can provide a great many benefits to the patients who receive it. More therapists are recognizing the extensive benefits of water in rehabilitation and are therefore prescribing it for more of their patients.

The long known benefits and healing power of water can be summed up with this statement by Shakespeare ... "And grew a seething bath which yet men prove against strange maladies a sovereign cure" (3,p.1).

Massage

Massage is another modality that has been in therapy for years. Massage is the manipulation of soft tissues with the hands to produce a therapeutic effect. The origin of therapeutic massage is considered to be with the Greeks (4,p.3). Modern massage is commonly modeled after the Swedish massage. Per Henrik Ling (1775-1893) developed the massage techniques that we are familiar with today (2,p.3). Massage is considered an art and not an exact science. One can learn the basic techniques of massage yet still add their own special touch. This author had the privilege of observing over thirty hours of therapeutic Swedish massage executed by LuAnn Williams, massage therapist at the Wellness Center. Massage can be used for a multitude of conditions. For these purposes, a concentration of the practice of sports massage will be explored.

There are three main purposes for using massage in athletics. The first purpose is to prepare an athlete for a particular event. Athletes can be instructed in these cases on how to implement self-massage. The advantages of receiving a massage before an event include preparing the body by relaxing the muscles, relieving tightness and tenseness, and increasing circulation and stimulation (2,p.6). Secondly, massage can aid during periods of actual activity. Massage can provide the athlete with a quick "pick-me-up" and a feeling of recuperation (2,p.6). Lastly, massage is used in the recovery from injuries. A study done at the University of Kentucky tested the effects of massage upon performance. Athletes received regular massage in recuperation of injuries and before performance for eight weeks. Athletes were then given a submaximal test on an ergonomic bicycle and were found to have increased their

performance by 29-30%. In instructing athletes on how to administer self-massage, it is important to teach proper techniques and executions (2,p.70).

Administering a massage is not as simple as it appears. Massage takes hours of practice and requires extensive knowledge. A masseur/masseuse must be an individual with strength and tremendous energy due to the exhausting nature of delivering a thorough, intensive massage. As in other forms of therapy, there are a few general practices to consider before giving a massage. The massage therapist should always have clean hands and try to avoid excess moisture accumulation or letting them get too humid. Often, depending on the condition of the skin, it is necessary to use a lubricant or drying agent. Agents that are commonly used include powder, oil, salve, lotion, and even water (2,p.4). Massage should never be painful; movements should always be continuous and rhythmical. The therapist should have knowledge of the energy expenditure required for massage and therefore attempt to eliminate unnecessary wastes of energy (unnecessary conversation, large, awkward movements, or an uncomfortable position for the therapist). Finally, the therapist should allow for plenty of time to execute the massage to make sure it is done correctly. A beneficial, thorough massage can take up to an hour if performed over the entire body.

Technique is essential in massage. There are five basic methods that serve as the foundation for massage: effleurage (stroking), petrissage (kneading), friction (rubbing), tapotement (percussion), and vibration (shaking). Each of these techniques will be discussed.

-Effleurage, or stroking, can affect the body both superficially and deeply. It can work to improve local circulation, provide relaxation, and promote lymph drainage (9,p.120). Stroking increases local venous circulation. However, stroking does not increase overall circulation because the heart itself is not directly stimulated. If the heart were directly stimulated, there would be an increased output which would result in an overall increased

venous return. Because this does not happen, stroking only works to increase local circulation (2,p.14). The execution of effleurage can be done with one or both hands and even the knuckles. It is best to work proximal (near) to distal (far) relative to the area to be treated on the patients body. It is also best to work from the periphery (outside) to the center (9,p.120). The upstroke should be heavy and the downstroke light (2,p.20). The main objective of effleurage is to squeeze the soft tissue to empty lymph vessels and accelerate circulation towards the heart.

-Petrissage, or kneading, is also known as compression, squeezing and skin rolling. It is normally used when large areas of the body are to be massaged. Petrissage can promote relaxation, relieve muscle tightness, and improve local circulation (9,p.120). The execution of petrissage requires both hands- one contracting in upward motion while the other relaxes and moves downward. It is best to move from the periphery (outside) to the center. The therapist attempts to lift the muscle from the bone as much as possible. Often, this is difficult to do as in the case of treating the muscles of the hand and foot (2,p.21). In these cases, the tips of the thumbs are used to execute the kneading and squeezing. Skin rolling requires a somewhat different technique. The muscle is separated from the bone and then rolled between the hands as if rolling dough. For flat, broad muscles such as the muscles of the back, it is necessary to use a two or three finger movement (thumb, index, and middle finger) (2,p.21). The main objective of petrissage is to squeeze, wring, or roll the muscles to be treated in order to stimulate contractions in the individual muscle fibers thereby exercising and strengthening muscles.

-Friction, or rubbing, is a special form of petrissage. Friction dilates blood vessels, reduces pathological products, and reduces adhesions following sprains, strains, muscle pulls, or tendinitis (9,p.120). Friction can also be utilized at injured musculotendinous junctions. The execution of friction is done with one or both hands (2,p.31). The movement

consists of a deep, circular, rolling motion. Friction is done over a small area of a tendon, muscle, or ligament. It is also possible to combine friction with effleurage (9,p.120). The main objective of friction is to reduce pathological products by absorption through dilated blood vessels.

-Tapotement, or percussion, refers to the rapid, alternative, striking movements of the hands. Tapotement is further classified into hacking, clapping (cupping), tapping, slapping, beating, and vibration (shaking). The main objective of all forms of tapotement is to improve blood flow, sensory stimulation, and pulmonary drainage (o,p.120).

-Hacking is the type of tapotement that is most frequently used. The execution takes place from the wrist. The fifth metacarpal on the ulnar side of the hand should be the only one to strike the surface of the body. Hacking is generally administered with both hands. Hacking should only be executed on areas of the body with well developed muscles. Hacking produces a great increase in blood flow in the areas where it is implemented (2,p.27).

-Clapping, or cupping, is executed with the cupped palmar surface of the hands. It requires flexibility of the wrists and fingers. The main purpose of clapping is to produce dilation of the blood vessels in the skin and the subcutaneous tissues (2,p.27).

-Tapping is similar to both hacking and clapping. However, the main difference with tapping is that the tips of the fingers strike the body. Tapping can be done with one or both hands. Tapping is executed from the wrists and shoulders (2,p.23).

-Slapping utilizes flattened hands. The whole palm of the hand should strike the body (2,p.23).

-Beating requires the hands to be in a half-clenched position with the wrists relaxed. When striking the body, only the ulnar side of the hand should come in contact with the area. The therapist should aim to deliver two to six blows per second with each hand. The more the fist is clenched, the deeper the tissues will be affected by each

blow. Beating should be done lightly where the muscle layers are thin and where the bone is near the surface. Beating induces a stimulation of blood, lymph flow, and nerves, and provides for better nourishment of the muscles (2,p.26).

-Vibration, or shaking, is the most difficult and tiring massage technique to apply. In executing vibration, the therapist aims for continuous trembling of the muscles being massaged. Mechanical vibrators can be used to achieve the same result. Vibration increases circulation and stimulates nerves while providing a feeling of relaxation (2,p.30).

One last form of massage that will be briefly discussed is ice massage. Ice massage is classified as a form of cryotherapy, or the application of cold as a therapeutic modality. Ice used for an ice massage is generally in the form of a ball or cube made in a styrofoam cup. The body part being massaged should have towels under it for the absorption of the melted ice. The ice is generally massaged over the body part in a circular motion. The benefits of this type of massage include a decrease in inflammation of the affected area, decrease in edema, a decrease in muscle spasm, and a decrease in swelling.

The effects of massage last from 20-60 minutes (9,p.120). Although the objective of each type has been stated, the general physiological responses to massage have yet to be discussed. Massage primarily benefits the blood and lymph vessels because they are located directly beneath the skin. Massage produces a dilation in the capillaries and arterioles. Massage also may help to increase lymph drainage in the extremities. Massage can also help promote digestion, muscle recuperation, and relaxation (9,p.120). Massage should not be used on individuals with infections as it may increase the spreading of the virus. Massage is also contraindicated for skin inflammation, burns, new growths, clotting disorders, and fractures (2,p.19). Massage in therapy is continuing to grow and diversify. For many people, massage is a special luxury, for others a relief from pain, and yet for others a means for getting well. The mental benefits of massage are as prominent as the physical benefits and should not be

overlooked. Massage is an excellent way to promote health and healing through both body and mind.

Heat

Heat is another physical modality used to treat an array of conditions. Heat therapy involves a multitude of techniques used to transfer heat from one source to another. Heat is transferred from one source to another by one of three processes- conduction, convection, or radiation. In conduction, heat transfer takes place in and through matter by molecular collisions (10,p.12). An example of this is holding one end of a metal bar and the other end rapidly becomes hot. When applying this definition to therapy, conduction would refer to a source of heat in direct contact with the skin where there is a difference in temperature between the source and the skin (11,p.646). Convection is heat that is transferred by movements of mass. An example of this is the fact that hot air expands and is pushed up by cooler air (10,p.12). This definition, for therapeutic purposes, refers to heat that is transferred when a moving liquid or substance contacts the skin (11,p.646). Radiation refers to a transference of heat through a medium. An example of this kind of heating is the Sun heating the Earth through the atmosphere (10,p.12). This definition is the same for therapeutic purposes. Conversion is also another way heat is transferred in therapy. Conversion is the changing of one form of energy into another form. An example of this would be mechanical energy converted into heat. Another example is using electricity to heat the body.

The benefits of heat therapy are, indeed, great. Several of the benefits include increased extensibility of collagen tissues, decreased joint stiffness, pain relief, muscle spasm, and increased blood flow (7,p.417). While all the benefits of heat are equally important, the primary effect of heat on the body is to produce a thermal response. The secondary effect of heat is to increase circulation. Generally, it is recommended that heat be used no sooner than several days post-injury to avoid the risk of increasing edema and hemorrhaging (7,p.433). For each specific heat modality

there are specific contraindications to using it. Generally speaking, for all heat modalities, heat is contraindicated for areas that have been numbed with anesthesia, for obtunded patients, for patients who are not able to perceive pain normally, for tissues with an inadequate vascular supply, and for malignant tumors because of the possibility of growth. Heat should never be applied to the gonads or a developing fetus (7,p.439). Heat is also categorized according to the way it is applied to the body: directly, radiantly, electrically, or through waves. Examples of all these sources of heat will be discussed.

Conductive Sources of Heat

An extremely easy and inexpensive way to apply heat to the body is by having it come in direct contact with the skin. Heat that is transferred in this way is said to be conductive.

The amount of heat (H) which flows through a body by conduction is directly proportional to the time of flow (t) and the area through which it flows (A), the temperature of the gradient (T), and the thermal conductivity (k), and it is inversely proportional to the thickness of the layer (L) across which the temperature gradient is measured.

$$H = KA t \left(\frac{T}{L} \right) \quad (7, p.445)$$

This statement is true for all superficial heat applications. In administering superficial heat treatments, towels are normally used to regulate the intensity of the heat in contact with the skin. According to the above statement, increased towel thickness would reduce heat flow and produce less of a temperature rise.

Hot Water Bottle- Conductive

A simple device that can be used in both the home and the clinical setting is the hot water bottle. Hot water bottles help ease the pain of mild musculoskeletal disorders and improve local circulation (9,p.116). When preparing the bottle, water should be heated to a maximum of 150°F. Water

bottles are sometimes considered an inefficient water source because it does not provide constant heat penetration.

After the water is heated, three to six bath towels are placed between the patient's skin and the bottle. The bath towels are then removed as the bottle cools. The patient should be instructed never to lie on the bottle to avoid the possibility of water leakage that could cause burns. Some patients may be unable to use the water bottle because of the pressure it exerts on the area it is treating (10,p.12). Treatment time normally ranges from twenty to thirty minutes with the highest temperature reached in the skin after approximately eight minutes (7,p.445). Hot water bottles can be very effective if proper safety procedures and caution are used.

Hydrocollator Packs- Conductive

Hydrocollator packs (hot packs) are another source of conductive heating. Hydrocollator packs consist of a silicate gel enclosed in canvas or cotton. The purpose of the gel is to absorb and hold a large amount of water with high heat carrying capacity (7,p.444). The packs usually measure 50 X 50 cm. and are used for small areas such as the lower back or the ankles (9,p.117). Preparation of hot packs is relatively simple. Packs are immersed in water between 160-175°F. Packs are then placed on top of terry cloths or towels to protect the skin. The towels can then be removed as the packs cool. The therapist should carefully monitor the patients skin throughout the treatment to avoid overheating and unnecessary burns (9,p.117). Hot packs are beneficial in reducing spasms and soreness, relieving

abdominal cramps and itching, reducing inflammation, osteoarthritis, rheumatoid arthritis, and prior to exercise as a part of warm up. Packs remain on the patient for twenty to thirty minutes (7,p.444). Hydrocollator packs are used frequently in the clinical setting when superficial, rapid, moist heating is prescribed. Extreme caution should be practiced in patients with cardiovascular disease, peripheral vascular disease, and decreased temperature sensation.

Paraffin Baths- Conductive

Paraffin baths are yet another source of conductive heating. The baths are maintained at a temperature between 51.7 to 54.4°C (126 to 128°F) and have a thermostat or some comparable device for monitoring the temperature (7,p.650). Paraffin baths are a mixture of wax combined with mineral oil, water, and liquid paraffin. It is possible for the patient to enjoy the benefits of paraffin at home. Paraffin is most popular when treating hand or foot problems. Benefits of paraffin include loosening of stiff joints, increasing joint range of motion, and creating a feeling of warmth for the patient (7,p.448). Paraffin is applied for twenty to thirty minutes and can be used as often as needed (9,p.116). There are two methods for applying paraffin- the dip method and the immersion method. the dip method, which is used for mild heating, involves the patient dipping the clean part to be treated into the paraffin and allowing a thin layer to solidify. The patient then continues to dip the affected part eight to twelve consecutive times until a thick glove is formed. The patient should always dip with their hand in the same position to avoid the cracking of paraffin and the possibility of burning. After the glove is formed, it is covered with a plastic bag and a terry cloth mitt then wrapped in several layers of towels. When the treatment is

complete, the patient should carefully insert a finger underneath the glove and gently peel off the paraffin. Stretching after the use of paraffin greatly enhances its benefits. The immersion method is used for more vigorous heating. The affected part is dipped until a glove is formed and then submerged in the paraffin for twenty minutes. This provides for constant heating surrounding the affected part. Paraffin should never be used to treat open wounds or burns (9,p.112). Direct contact heating methods are used widely in physical therapy. Cost, simplicity, and quick results all contribute to its success. If used properly these methods can provide satisfactory relief to patients suffering from a multitude of conditions.

Radiant Sources of Heat

Radiant heating is another acceptable way to treat the body. Radiant heat is a form of convective heating. Infrared, visible, and ultraviolet rays are all examples of radiant energy (10,p.12). Radiant heat is dry and non-contact, usually transmitted in the form of a lamp. Heat radiation has clinical uses that make it somewhat advantageous over conductive sources. First of all, its depth of penetration is much greater than with conductive sources. Secondly, by being non-contact, patients are relieved of the pressure that can exist when using conductive sources. Finally, it is much easier to observe the body part throughout the treatment and avoid painful burns (10,p.32). Although there are

many ways in which radiant heat can be applied, two of the most common methods include heat lamps and quartz infrared lamps.

Heat Lamps- Radiant

Heat lamps are made of tungsten filaments enclosed in a glass bulb which are then centered in a concave reflector. Heat lamps vary in power from 150 to 1500 watts. The smaller powered heat lamps treat small body parts while the higher powered lamps treat larger body parts (10,p.12).

Quartz Infrared Lamp- Radiant

Another form of radiant heat is the quartz infrared lamp. This consists of a tungsten filament sealed in a glass filled quartz tube or bulb. The filaments are capable of heating up or cooling down in less than a second. Quartz infrared lamps are able to generate 50 to 1500 watts of power depending on their size (10,p.25).

Technique is crucial when applying radiant heat. First, the patient should be in a comfortable, relaxed position. Second, the therapist should maintain proper distancing between the lamp and the patient. The heat should never be uncomfortable or overbearing. Treatment time, on the average, lasts from 20-30 minutes. Protective eyewear should always be worn. It is best to treat the naked skin but, in cases of extreme heat sensitivity, a sheet can be used to shield the skin (10,p.34). Physiological effects of radiant therapy include stimulation and increased circulation (local), stimulation of the nerve endings of

the skin, marked hyperemia, tissue relaxation, and pain relief. Indications for radiant heat include subacute and chronic inflammatory conditions, contusions, muscle strains and sprains, dislocations, fractures, arthritis, and infections of the skin (10,p.30). Precaution should be taken to avoid edema, blistering, and burning. As with all types of heat, supervision is the key to receiving the best results possible. Stretching before and after utilizing radiant heat may further add to its benefits. Special instructions should be given to patients who wish to use this modality at home.

Conversive Sources of Heat- Short-Wave Diathermy

Heat can also be transferred conversively by changing one form of energy into another. Short wave diathermy is a means of heating the body by converting electricity (high frequency currents) into heat. Although short wave diathermy is categorized as electrotherapy due to its use of electricity, its primary effect on the body is heat and will therefore be classified as heat for purposes of this paper. Short wave diathermy heats the body to a much greater extent than both conductive and radiant sources. Before the procedures of this modality can be discussed, it is essential to understand the general properties and behaviors of electricity.

Matter is anything that takes up space and has weight. All matter is composed of varying elements which are made of atoms. An atom is the smallest part of an element that can exist. Atoms are composed of particles called protons,

electrons, and neutrons. These determine the atoms electrical charge- positive, negative, or neutral. If the number of protons exceeds the number of electrons, the atom has a positive charge. If electrons exceed protons, a negative charge results. Finally, if protons equal electrons, the atom is said to be neutral. A charged atom is called an ion and is the basis for understanding electricity. The fundamental law of static electricity was stated by Coulomb in 1780. This statement described the behaviors of charged atoms when in the vicinity of other charged atoms. According to Coulomb, like charges will repel and opposite charges will attract (10,p.76).

In order for these charged atoms to produce electricity, there must be some form of medium to assist in the procedure. A conductor is a substance that leads off an electric charge quickly- it conducts electricity. Metals, acids, bases, and salts are all good examples of conductors. Non-conductors, or insulators, do the exact opposite of conductors. Glass, rubber, oils, and paraffin are all classified as insulators (11,p.6). Therefore, a current of electricity is produced when a stream of loose electrons passes along a conductor (10,p.70). In applying this definition to physical therapy, a current of electricity can be maintained by providing a source of electricity (generator) and a complete circuit for the energy to pass through.

The apparatus for transmitting short wave diathermy has three basic components:

- a) power supply

b) oscillating current

c) patient circuit (11,p.14).

Patients then receive the heat through plates, electrodes, or coils that are connected to conducting cables joined with the machine. The conducting cable is simply the heavy, insulated cable containing the conducting wires (10,p.115). Spaced metal electrodes (condensor pads) consist of metal enveloped in rubber, plastic, glass. These are usually applied to the skin with a medium such as terrycloth, felt, or towel. It is important when utilizing electrodes to space adequately and properly in between them. Overloading the treated area can be extremely dangerous. Spaced plates are made of a metal disc enclosed in a hard, circular, rubber treatment drum. The drum is attached to the machine by an adjustable arm (10,p.116). Coils consist of a single electrode joined to a heavily insulated wire. Coils should be applied with a medium and can be used to wrap circular loops around the body (10,p.116). To produce a therapeutic effect in the tissues, short wave diathermy machines must produce a power output greater than 40 watts.

All electrical currents in the body cause a rise in temperature due to the conversion of electricity into heat. All electrical currents also obey Joule's Laws. These laws state:

1. The heat produced is directly proportional to the square of the current strength.
2. The heat produced by the same current in different conductors is directly proportional to the resistance of each conductor.

3. The resulting quantity of heat is in direct proportion to the duration of the passage of the current. (10,p.79)

Body tissues all possess varying resistance and electrical conductivity. Tissues that contain the most water also contain the most ions, therefore making them the best conductors. Conductivity is approximately equivalent to the tissues content of water: muscle is the best conductor at 72 to 75%, the brain conducts approximately 68% of the current, fat conducts 14 to 15%, nerves, skin and bones conduct 5 to 16% with bone being the absolute poorest conductor of electricity (10,p.122). Skin provides the body with its chief resistance to current and is considered a terrific insulator.

The technique of applying short wave diathermy requires much skill and knowledge. The patient should lie on a wooden treatment table (9,p.119). The therapist should then apply the heat through a medium onto the unclothed skin. It is impossible for the therapist to know the amount of energy that is passing through the patient. It is often beneficial to discuss the four grades of heat sensation with the patient and explain which sensation is trying to be achieved with the therapy. The four grades of heat sensation that have been established are: 1) threshold value (glowlike sensation) .2) a distinct feeling of agreeable warmth 3) intensive heat and 4) unbearable heat (10,p.221). It is generally recommended that for mild dosage the threshold value should be strived for and for more vigorous treatments and chronic injuries the intensive

value should be attained. The patient should be able to perceive pain normally as it is the best indicator of treatment effectiveness. Treatment should immediately cease upon any complaints of discomfort. Constant supervision by the therapist is required at all times unless the patient is able to shut off the current at any time (10,p.231). Treatment time ranges from 20-30 minutes depending on the body part. The skin should not be broken, metallic objects should be removed as well as clothing. Patients should always cool down after their treatment before leaving.

The effects of short wave diathermy include dilation of the blood vessels, increase in local blood flow and circulation of the area to be treated, rise in blood temperature, increase in pulse rate, increase in respiration, and an increase in metabolism. Short wave diathermy also produces a marked sedative effect on the sensory and motor nerves (10,p.217). Short wave diathermy is indicated to decrease swelling, relieve pain and spasm, for congestive conditions, and chronic infections (11,p.106). It is also used to treat traumatic and inflammatory conditions of bursae, bones, and joints after the acute stage, arthritis, stiffness, rheumatic diseases, reduce edema, and treat chronic inflammatory pelvic diseases (7,p.474). Shortwave diathermy is contraindicated for patients with a cardiac pacemaker, a pregnant woman or to the epiphyseal growth areas in children (9,p.119). It is also contraindicated for those patients with a tendency to hemorrhage, malignant tumors, large varicose veins, or metal implants. Shortwave diathermy is always contraindicated when a simpler method of superficial heat could achieve the same consequences (10,p.220). There are some precautions to using electricity to produce heat. Electric shock and electric burn are two major dangers the patient faces when being treated with electricity. Electric shock results from a sudden, powerful surge of electricity. For example, if the patient touches the grounded object in an electric

circuit. Electric burn occurs when there is an excessive current overloading a part of the body. Electric burn can result in erythema and blistering (10,p.120).

Conversive Heat- Ultrasound

Ultrasound should always be administered with special precaution as it is able to produce deep burns rapidly (9,p.18). Ultrasound does not heat the skin or subcutaneous layer which serves as the patients primary warning signal against burns. According to Arden, Jones, and Herrick, a study they conducted showed that ultrasound was not a good modality for heating either the subcutaneous fat or muscle, however, the researchers also found that ultrasound did produce a heat rise in bone because bone cannot transmit ultrasound, instead, it absorbs it (10,p.419). Another study done by Carstensen et al. showed that ultrasound absorption occurred primarily in the tissue proteins (4,p.288). As is evident, ultrasound produces deep heating and should be used with extreme caution.

Ultrasound is the process of transmitting inaudible sound waves through a medium to heat the body. Ultrasound is applied to the body through a sound head. The most common method of transmitting ultrasound from the sound head to the skin and other tissues is by using a coupling medium such as mineral oil, Soni-gel, Aqua-sonic, or Medco (7,p.544). The coupling medium is primarily used to help maintain adequate maximum transmission into the tissues. There should be absolutely no air gaps between the skin and the sound head because air reflects 100% of acoustic waves

(5,p.14). The coupling medium also serves as a lubricant to make application smoother. Underwater coupling is suggested for treating bony prominences such as the knuckles and for treating sensitive patients. The body part should be completely submerged when applying ultrasound in this manner and the sound head should remain near the surface of the skin without actually touching it (7,p.544). When applying ultrasound to the dry skin without a medium, stroking is used. Circular or longitudinal strokes are used for maximum results. The pressure should remain firm but not overbearing throughout the treatment. Effects of ultrasound usually begin after three to six treatments with the average treatment time lasting five to ten minutes (10,p.240). The applicator should be completely cooled between each patient by dipping it in the tap water. There are three situations for which ultrasound use is indicated:

- a) Where effectiveness superior to other modalities has been proven
Ex. arthritis, joint disease, rheumatic diseases
- b) Indications where ultrasound is of suggested value
Ex. rheumatoid arthritis, chronic skin ulcerations
- c) Indications where ultrasound has been purely used on an empirical basis
Ex. treating pain after a sprain, epicondylitis (7,p.549-558).

Ultrasound is also used for bursitis or tendinitis of the shoulder, bursitis of the hip region, cervical strain, low back strain, and loosening scar tissue (10,p.244). Ultrasound is contraindicated for use around the eye and on pregnant women. It is also recommended to avoid use on the spinal

cord, brain, ear, heart, and reproductive organs due to the risk of injuring neurons (7,p.561). Ultrasound should never be used on acute infections or malignant lesions. One condition that ultrasound can be used on where diathermy could not was in the case of metallic implants. Many studies have been done to prove the safety in treating this condition. One study, conducted by Lehmann et al., tested surgical metallic implants in pigs. Pigs were then treated with ultrasound at temperatures in the human therapeutic range and were shown to have no untoward effects. Pigs were also implanted bilaterally and treated with ultrasound on one side. Autopsies after the pigs deaths revealed no signs of damage or nonthermal effects to the side that had been treated with ultrasound (8,p.486). Ultrasound, when used properly, can provide patients with enormous relief from a multitude of conditions. More research is being done on ultrasound to learn more about its purpose and role in therapy.

Summary and Conclusion

In conclusion, there are many other modalities in use in physical therapy today. Of all the modalities mentioned, it was found that heat is the most widely used and most effective in the clinic. Heat alone, though, is not always the best solution. The benefits of heat are greatly enhanced when combined with exercise, stretching, and range of motion activities. The physical therapists' and the patients' attitudes toward rehabilitation also play a major role in determining the outcome. An encouraging, patient, empathetic personality is one that results in success. The

therapist should also attempt to be creative in designing the rehabilitation program to eliminate boredom and frustration for the patient. Hydrotherapy, massage, heat, and electrical stimulation are all acceptable, effective methods for treating a variety of conditions. Depending on the status and nature of the injury, one or all may be utilized in a combination that is suitable for the patient. However, a modality that works for one patient may not necessarily be effective for another. The indications and contraindications discussed for each modality are just a few of the established do's and don'ts in the field. The therapist should feel free to experiment among the various modalities unless the patient's condition absolutely contraindicates the modality. The size and financial status of the clinic is also a contributing factor to what modalities are available. All of the above modalities should only be administered by a trained, licensed therapist. Hydrotherapy requires an extensive knowledge of proper technique and experience in using water to a person's advantage. Conductive sources of heating including the hydrocollator packs, paraffin, and hot water bottles require little supervision to administer but proper application and use are essential. Short wave diathermy and ultrasound require a working knowledge of electricity and how it affects the body as well as technique and application. All of these modalities, no matter how primitive they may seem, have the potential to cause additional harm to the patient. If used properly and under the supervision of a therapist, all of these modalities can be effective and beneficial. Today,

physical therapy has grown to be a tremendous field in medicine. More and more research is being conducted to prove the modalities that exist and to create new ones. Physical therapists undergo extensive training to prepare for their careers. Technology has made it possible to develop therapeutic aids that were never thought possible before. Physical therapy is, indeed, one of hottest careers in medicine today.

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