Mandatory Reading & Important forms for clinical documentation
Hand Therapy Checklist

- Hot & Cold Therapy
- Electrotherapy
- Ultrasound
- Fluidotherapy
- Iontophoresis

Chattanooga carries a comprehensive line of hand therapy products that include Vectra® Genisys laser, Intelect® ultrasound and electrotherapy, Fluidotherapy®, Iomed® iontophoresis and heat and cold therapy.

For the modalities you use, choose the brand you trust.

chattanooga™

chattgroup.com
800.592.7329
Paul Bonzani is a graduate of the Occupational Therapy program at New York University. After 10 years in general rehabilitation practice, Paul specialized in hand and upper extremity orthopedics in 1988. He has been the clinical director of three major university programs and has been performing continuing education seminars in the areas of upper extremity orthopedics, peripheral nerve rehabilitation, physical agent modalities and repetitive stress injuries since 1994. He is the author of multiple book chapters and journal articles ranging from repetitive stress injuries to reconstructive microsurgical rehabilitation. After 27 years of clinical practice, Paul has completed his MHS from the University of Florida in 2007. Paul is now in practice with Blue Ridge Bone and Joint in Asheville, North Carolina where he resides with his family.
Physical Agent Modalities for the Occupational Therapist

Course Description

This instructional course is designed to assist occupational therapists in integrating physical agent modalities into practice. The ability of these interventions to improve human occupational performance will be elucidated. Theoretical concepts of each physical agent modality are presented in addition to biological principles underlining the application of the agent. Evidence identifying effectiveness of each modality intervention is presented as well as the step by step practical application of each device. The format includes lecture, demonstration and practicum, case study presentation with emphasis on treatment planning and assessing effectiveness. A pre and post test format is employed to demonstrate mastery of the material presented.

Course Objectives:

Upon completion of this seminar, the participant will:

1) Differentiate physical impairments from deficits in occupational performance.
2) Delineate the biological, psychosocial, and contextual issues resulting in impairment of occupation engagement.
3) Identify the biological, psychosocial and contextual problems that could be enhanced through the use of physical agent modalities.
4) Determine the appropriate intervention following careful assessment of the underlying biological, psychosocial and contextual pathology.
5) Distinguish which underlying biological process is enhanced through the use of an appropriate physical agent modality.
6) Recognize effective responses from ineffective ones and adjust interventions accordingly.
Physical Agent Modalities for the Occupational Therapist
Integration into Occupation Based Practice

**Introduction:** The relevance of physical agent modality intervention to occupational therapy practice.

Chapter Overview

This chapter will review current Occupational Therapy terminology and philosophy to establish the theoretical basis for the use of physical agent modalities into Occupational Therapy practice. Recent models of practice will be presented to ensure the OT practitioner integrates these intervention in a manner consistent with the profession’s ethical standards.

Objectives:

1) Establish the basis for the use of physical agent modalities in Occupational Therapy Practice
2) Validate the link between engagement in occupation and the promotion of health.
3) Determine how the use of physical agents is consistent with the MOHO and Occupational Adaption model of practice.

**THERMAL:** The case for physical agent modality use within the framework of Occupational Therapy: A review of the AOTA domain and framework and the AOTA ethics standard.

**THERMAL:** Wilcox and the occupational brain: The anthropological basis for the use of physical agent modalities.

**THERMAL:** Performance models in Occupational Therapy and the use of physical agent modalities.

**THERMAL AGENTS:** The biological and physical principles underlying the use of thermodynamic physical agent modalities.

Chapter Overview

In this chapter, the underlying biological and physical processes that are affected by physical agent modalities are presented. Wounding and the natural repair process are presented. The potential of thermodynamic physical agents to positively and negatively influence this process is explored. The relationship between improved wound healing and decreased pain and improved performance of occupation is investigated.
Objectives:

1) The participant will identify the stages of wound healing and be able to delineate the cellular events unique to each phase.
2) The participant will distinguish the physical principles of thermodynamics and their influence on the wound healing process.
3) The participant will identify the principles of sound propagation and determine the potential use to positively influence the wounding and repair process.
4) The participant will recognize all precautions and contraindications to ensure the safe use of these interventions.

THERMAL: Principles of wounding and wound healing: modification through the use of physical agents.

THERMAL: Thermodynamics: application to biological tissue.

THERMAL: The physical principles of sound and its application to biological tissue.

THERMAL: Application of thermodynamic modalities: Superficial Heating Agents

   - Moist Heat, Paraffin and Fluidotherapy:
   - Theory of treatment/biological responses
   - Indications/Contraindications
   - Clinical decision making and practicum

THERMAL: Application of Thermodynamic modalities: Cryotherapy

   - Ice Application
   - Theory of treatment/biological responses
   - Indications/Contraindications
   - Clinical decision making and practicum

THERMAL: Therapeutic Ultrasound

   Continuous Ultrasound Application
   - Theory of treatment/biological responses
   - Indications/Contraindications
   - Clinical decision making and practicum

   Pulsed Wave Ultrasound Application
   - Theory of treatment/biological responses
   - Indications/Contraindications
   - Clinical decision making and practicum
Talking Points:
A chapter by chapter review of salient points for effective application of thermal modalities in occupational therapy practice

Chapter 1: The integration of Occupation and Physical Agent Modalities

Occupational Therapy has defined itself as a profession that “supports health and participation in life through engagement in occupation” (American Occupational Therapy Association, 2008). Before we can address the question of the role of physical agents in Occupational Therapy practice, it is helpful to consider how we as a profession define occupation. This is central to who we are as a profession. The definition of occupation has evolved over many years and we have now come to understand that for something to be an occupation, it must have meaning and value to the client. The term “purposeful activity” has been used to define occupation; however activities can have purpose without meaning. For example, I must take out the trash on Tuesday night. When I do the steps necessary to take out the trash I am performing an activity with a purpose, I would not call this an occupation however, as this activity is meaningless to me. Someone else may be fulfilled by the completion of this activity; I however, would gladly pay never to have to do this again in my life!

There have been many proposed definitions of occupation. One definition that has been presented is as follows: “Activities of everyday life, named, organized and given value and meaning by individuals and a culture. Occupation is everything people do to occupy themselves enjoying life and contributing to the social and economic fabric of their communities.” (Law, Polatajko, Baptiste & Townsend, 1997) This definition resonates because it includes the intersection of the person and the culture/context that that person lives in. Therefore, Occupational Therapy is not a profession that is defined by a set of technical skills. It can be thought of as a profession that allows encourages practitioners to develop the necessary skills to intervene on a client’s behalf to support that client’s engagement in occupation. It is in this light, that the role of physical agents in Occupational Therapy is presented.

There are a number of questions that the Occupational Therapy practitioner must ask before we can use physical agent modalities in practice. The first is: “What does the integration of physical agents as interventions in occupational therapy do to allow the client to engage in occupation”.

By addressing physical performance issues our clients can return to their desired occupation. Engagement in their desired occupation allows the individual to return to a state of health and well being. They may never physically return to their pre-injury or disease state but they that should not be confused with a return to well being. Restoring the normal physical function is not the prerequisite for
occupational performance. The alleviation of pain or of physical performance issues will allow the client to gain the psychosocial benefits of returning to occupational performance. These benefits further enhance the client’s health and well-being. So for the occupational therapist, the use of a PAM intervention must be done with the overarching goal of improved occupational performance.

**Physical Agents and the Occupational Therapy process**

**Evaluative Considerations:** The purpose here is not to recount the Occupational Therapy evaluation process. The point is to consider where PAM interventions belong in that process. One component of the occupational profile that is relevant is to consider what occupations and activities are causing problems for the client. Once the therapist understands the issues with occupational performance from the profile this information can be synthesized and combined with observations of the client’s performance and the effectiveness of performance skills. Impairments and barriers to performance can then be identified. After collaboration with the client interventions should be selected that will address the performance barriers. It is then important to delineate an intervention approach that is grounded in best practice and available evidence. A classic example is the impact of pain on performance at work. Pain is eventually isolated as a major performance barrier for the client in their attempt to return to work. A review of what interventions may be most successful in allowing the client to control pain at work and what is the evidence to support that intervention. An activity analysis of the job components would also be employed permitting the use of a modality in the most efficient manner for that client.

**Treatment Considerations:** Once the evaluation is completed, the treatment process begins and is marked by three components; the plan, the implementation and a review of effectiveness.

The plan should include a measurable goal that demonstrates a reduction of the client’s pain during the performance of a particular skill component of an activity. An example would be “reduce palm down lifting pain from 5/10 to 3/10 with a 5 lb weight to enable the client to place her dishes in a cabinet at shoulder height. Additionally, a reasonable time frame to accomplish the goal would be included.

The implementation would include multiple components of treatment including exercise and activity modification. A PAM (say ultrasound or iontophoresis) could also be incorporated at this stage to add a restorative component of tissue healing or pain control. The PAM is actually a preparatory method that should be combined with purposeful activities or occupation based interventions. This is an important consideration. At no time should the PAM be the sole focus of occupational therapy intervention. The PAM is an intervention that enhances the client’s ability to perform activity or occupational performance.

Review would be ongoing to judge the effectiveness of the intervention and modification as needed. Say Cryotherapy was used initially, if this proved ineffective for pain control in a reasonable time period, a more aggressive intervention may be selected perhaps iontophoresis. This of course would continue to be monitored for effectiveness and discontinued when no longer indicated or proven to be ineffective in accomplishing the stated goal (pain control).
Requirements for the use of physical agent modalities by Occupational Therapists

The first consideration is the practice act that governs the practice of Occupational Therapy for each state. It is the obligation of individual therapist to know that laws governing practice and to abide by those laws. Once that has been considered, it is reasonable to consider the guidance of AOTA in determining the integration of PAM’s into Occupational Therapy practice. The AOTA position paper on modality practice includes the following requirements: Integration of PAMs in occupational therapy practice must include foundational education and training in biological and physical sciences. Modality-specific education consists of biophysiological, neurophysiological, and electrophysiological changes that occur as a result of the application of the selected modality. Education in the application of PAMs also must include indications, contraindications, and precautions; safe and efficacious administration of the modalities; and patient preparation including the process and outcomes of treatment (i.e., risks and benefits). Education should include essential elements related to documentation, including parameters of intervention, subjective and objective criteria, efficacy, and the relationship between the physical agent and occupational performance (Physical Agent Modalities: A Position Paper, 2008)
The Integration of Occupation and Physical Agent Modalities.
Advancing Human Occupation.

Why Should PAMs be a part of Occupational Therapy practice?
Where should we seek this answer?

Domain of Occupational Therapy

“Supporting health and participation in life through engagement in occupation”.

Occupation:
More than just activity!

“Activities of everyday life, named, organized and given value and meaning by individuals and a culture. Occupation is everything people do to occupy themselves enjoying life and contributing to the social and economic fabric of their communities.”

Law, Polatajko, Baptiste & Townsend, 1997
Occupation: Key to the development of a well lived life!

- Engagement in occupation structures everyday life.
- Occupations are central to the client’s identity.
- Occupations have particular meaning and value to the client.

Occupation & PAM’s Perfect Together!

- Pain control.
- Ease of movement.
- Improved strength.
- Increased physical endurance.

Occupation & PAM’s

- Self esteem and confidence.
- Socialization.
- Mood.
- Fulfillment.

Occupational Therapists & PAM’s

“Occupational therapists are responsible for all aspects of occupational therapy service delivery and are accountable for the safety and effectiveness of that service delivery process”
Domain Factors & PAM’s

- Areas of Occupation.
- Client factors.
- Performance skills.
- Performance patterns.
- Context/Environment.
- Activity demands.

Areas of Occupation Impacted by PAM’s

- ADL/IADL.
- Rest/Sleep.
- Work/Play.
- Social participation

Client Factors that can impact the ability to use PAM’s

- Values/Beliefs.
- Body functions.
- Body Structures.

Performance Skills Necessary for the Proper Application of PAM’s

- Sensory/Perceptual skills.
- Motor/Praxis skills.
- Cognitive skills.
- Communication skills.
Performance Patterns that can Affect the Client’s Compliance.

- Routines.
- Roles.
- Habits.

Contextual & Environmental Factors that can impact the use of PAM’s

- Culture.
- Physical.
- Social Acceptance factors.
- Temporal factors.

Activity Demands that Impact the use of PAM’s

- Demands from the intervention.
- Sequencing and timing.
- Required actions from the client to use the PAM effectively.

The Occupational Therapy Process & PAM’s

**Evaluation**

- Occupational Profile.
- Analysis of Occupational Performance
The Occupational Therapy Process & PAM’s

**Intervention**
- Intervention plan.
- Intervention implementation.
- Intervention review.

**Outcomes**
- Occupational performance.
- Health & wellness.
- Participation.
- Quality of life.

AOTA Position on PAMs Education
- The biological, neurophysiological and electrophysiological events with application.
- Indications, contraindications and precautions.
- Safe and efficacious administration.
- Patient preparation.
- Documentation.
- Relationship between the PAM and occupational performance.

Harmonious Existence!
Evidence Based:
The Biological Basis of
tendonitis/tendonopathy

Paul J. Bonzani MHS OTR/L, CHT

Tendon Anatomy/Structure

• Tendons are primarily constructed of Collagen and Proteoglycans.
• Collagen is primarily Type 1 with dense fibril formation. Primary role is to provide tensile strength.
• Proteoglycans contribute to the ground substance and are responsible for the viscoelastic properties of tendon.
Extracellular Matrix

Illustration depicting extracellular matrix in relation to epithelium, endothelium and connective tissue

- epithelial cell
- basement membrane
- endothelial lining the capillary
- connective tissue with interstitial matrix
- muscle cell
- basement membrane
Tendon Tenoblasts/Tenocytes

Chondrocytes

Vascularity

- Blood supply can vary with exercise levels.
- Blood flow to the peritendinous tissue can increase with exercise.
- Synovial tendons receive their blood supply via the mesotenon.
- Avascular regions are common sites of tendonopathy.
Oxygen Consumption

- Oxygen consumption of tendons is 7.5 times less than skeletal muscle.
- Tendons have a well-developed anaerobic energy generation capacity.
- This results in a slower rate of healing after injury and may explain why even vascularized tendon requires prolonged healing intervals.

Nerve Innervation

- At the myotendinous junction:
  - Nerve fibers cross and enter the endotenon septa.
  - Plexus formation occurs in the paratenon.
  - Nerve endings terminate on the surface of the tendon body.
  - Mechanoreceptors (Golgi tendon organs) are a spray of nerve fibers between the collagen bundles.
  - Nociceptors (Unmyelinated nerve endings) are present on tendon surface.
Free Nerve Endings


Golgi tendon organ

Nerve Innervation

- Nerves associated with blood vessels also grow into damaged or ruptured tendons. (neurovascular invasion)
- The nerve ingrowth appears to correlate to the region of tendon pain.
- Eccentric exercise seems to reduce or reverse neurovascular invasion.

Tendon biomechanics
Non linear elasticity

Tendon biomechanics
Viscoelasticity
Tendon biomechanics
Viscoelasticity

Tendon Biomechanics
Hysteresis

Tendons and Aging
Immobilization vs. Exercise

• Immobilization leads to a decrease in load to failure strength.

• Exercise reverses this effect.

• Exercised tendons increase their mechanical properties but do this slowly.
Tendon injuries

1. Musculotendinous junction.
   - Myotendinitis with possible calcification.

2. Paratendinitis.
   - Sheath.

3. Tendinitis.
   - Tendon proper.

4. Enthesitis. (insertional tendinopathy)
   - Insertion.

Tendinitis/Tendinopathy

Tendinitis
- Inflammatory in nature.
- Occurs primarily in synovial tendons and in the mid-substance of the tendon.
- Responds to NASIDS and Corticosteroid steroid injection

Tendinopathy
- Degenerative in nature.
- Occurs primarily at the enthesis but can be in the mid-substance.
- Unresponsive to NASIDS and Corticosteroid injection.

Dequervain's
The Inflammatory Process

Acute inflammation
Inflammation

- Cardinal Signs:
  - Rubor: Redness
  - Calor: Increased temperature
  - Dolor: Pain
  - Tumor: Swelling

Margination/Emigration

- Margination: Cells move from the central axis column to the walls of the blood vessels.
- Changes in the charge of the cell membrane causes the leukocytes to adhere to the cell wall.
- Diapedesis: The cells squeeze through the endothelial junctions and enter the extravascular space.
Chemical Mediators of Inflammation

- Histamine.
- Prostaglandin.
- Cytokines

Histamine reaction

Histamine

- Released following Mast cell degranulation.
- Released immediately after injury.
- Increases vascular permeability and attracts leukocytes to the area.
Prostaglandin

- Released by the cell membrane in response to injury.
- Increases vascular permeability by influencing the endothelial cell junctions to open.
- Attracts leukocytes to the area.
- Enhances the effects of other inflammatory mediators.

Inflammatory Cells

- Polymorphonucleocytes
The Neutrophil

- Has the highest concentration in plasma.
- First responders, most active in the first 24 hours.
- When they begin to breakdown, they release lysome which initiates the debridement process.
- Release chemotactic agents.

Monocytes

- Enter wound after the first 24 hours evolve into macrophages.
- Crucial to normal wound healing.
- Secrete chemotactic factors that cause fibroblast replication and blood vessel growth.
Macrophages

- Release collagenase: assists with necrotic tissue removal.
- Releases fibronectin: chemotactic for fibroblasts.
- Enhance collagen deposition by assisting fibroblastic adherence to the fibrin lattice.
- Signals the body of damage to an area causing more macrophages to be recruited.
Chronic Inflammation

• Reaction to persistent stimuli.
• Can last for months or years.
• Primary cells are the lymphocyte and the monocyte.

Wound Healing Phases

Lymphocytes enter the wound in small numbers.

Generally more important in chronic inflammatory states.
Transition to Phase 2
Proliferative Phase

Phase 2: Proliferative Phase

**Synthesis and Assembly of CT components**

- **Collagen Synthesis**
- **Elastin Synthesis**
- **Procollagen**
- **Tropocollagen**
- **Proteoglycan synthesis**

- **Fibrocyte transform into fibroblasts.**
- **Fibroblasts migrate along the fibrin network.**
- **Synthesize Procollagen.**

*Images of diagrams related to synthesis and assembly of CT components.*
Phase 3: Remodeling

- Collagen synthesis peaks.
- Collagen lysis begins.
- Scar responds to tension.
- Never regains pre-injury arrangement.

Scar within 3 to 4 weeks post op

Scar 6 months
Tendinopathy

What is it?
- Tendon degeneration.
  - Cause: Proposed to be micro traumatic tears that overload the healing response.
  - Therefore to this point the postulation has been a repetitive overloading hypothesis.

Tendinopathy: What do we know?

Degenerative cascade:
- Increased expression of matrix metalloproteinase.
- Decreased collagen density.
- Irregular orientation of collagen.
- Changes in collagen fiber diameters.
- Increased uptake of type III collagen.
- Induction of apoptosis.

Overloading Hypothesis

- Intrinsic predisposition increases loading concentrations. I.e. Foot hyper pronation and Achilles tendon injuries.
- Non uniform stress and frictional forces between collagen fibrils result in micro trauma.
- Maximum tendon loading with ischemia and reperfusion.
- Hypoxia development.
Muscle tightness/weakness

Repetitive Strain Injury Cycle

Tissue Degeneration

Tension/Compression

Decreased Circulation (Hypoxia)

Repetitive Mechanical Loading of a Tendon

Cellular/Matrix Response

Adequate Adeptation

Transient weakness in tendon

Continued loading exceeding healing capacity

OVERUSE INJURY

Arnoldy, 2007
### Response to Loading: Mediator Production

**Mediators**
- Upregulation of inflammatory cytokine production.
- Expression of Cox-2, PGE2 (prostaglandin) and MMP-1 (matrix metalloproteinase-1)

**Strain**
- High levels of repetitive strain increase mediator production. *(in Vitro)*
- Low levels of repetitive stress reduce mediator production.

### Response to Loading: Cellular Response

- Different stress patterns provoke different cellular reactions:
  - Cell proliferation is increased with brief periods of repetitive tension.
  - Long periods of repetitive tension is inhibitory to cellular responses.
  - Modulation of Extracellular Matrix synthesis.

### Response to Loading:

- Loading initially causes an increase in the size and amount of collagen fibrils.
- Persistent loading causes a subsequent decrease in fibril size. *(due to an increase in collagen turnover)*
- As loading progresses, there is a net increase in collagen synthesis.
The Under Stimulation Theory

- Most common tendonopathies occur at the enthesis.
- Tensile loads occur unevenly in this region.
- The area toward the bone is stress-shielded resulting in under stimulation of the tendon.
- Under stimulation of tendon cells results in degenerative enzyme expression.
- Non-uniform stress results from damaged fibrils and produces abnormal loading concentrations.
Supraspinatus muscle
Chapter 2 Wound Healing

Wound healing is a dynamic, multisystem process that can be divided into three distinct phases. Each phase prepares the way for the next phase with the final result a healed wound. Although each phase has a prescribed time interval, there is often overlap of the phases. Further, the there are instances when the normal time intervals do not occur in the predictable fashion and the process can become delayed or remain in a given phase. For this discussion, there are 3 distinct phases: Inflammatory, fibroplasia, and collagen remodeling. The purpose of this chapter is to review the events of each phase and then discuss the implication to physical agent modality practice.

The Inflammatory Phase (0-5 days)

Inflammation is a normal and necessary part of human healing. Without the events that occur during inflammation wounds cannot progress to a healed state. Of course inflammation becomes a problem if it is prolonged or occurs as the result of an auto immune disease. It is important for the clinician who intervenes in patient care during this process to have an understanding of the vascular, chemical and cellular events that mediate inflammation. It is important to remember that these events are tightly integrated and there is considerable overlap and facilitation of further events as the process proceeds.

Vascular Issues:

Clot formation is vital to control the outflow of fluid. This is a hemostatic response that occurs to control bleeding. Platelets within the plasma will bind with exposed collage to release fibrin. Platelet derived growth factor is released. This creates a chemotatic factor to fibroblasts and fibrin/fibronectin. These cross link to type 1 collagen to form the fibrin lattice. This is the structure that the fibroblasts will eventually migrate across.

However while this is occurring, factors are working to open the endothelia cell junctions permitting the outflow of fluid. If the fluid has a low cellular and protein content, it is called a Transudate. When the fluid has high protein content and contains leucocytes it is called an exudate. The movement of cells from the intravascular to the extravascular space happened first through margination and then through emigration. This process is facilitated by chemical attraction of the cell to the extravascular space by chemotatic factors that are released by the cell membrane.

Chemical Factors:

The initial consideration is Hageman factor. This is an important clotting chemical that is released immediately to facilitate clotting. It assists in the initial creation of the fibrin plug. Further, it facilitates the release of killikrein which in turn begins kinin production and most importantly bradykinin. This is a vital chemical mediator of inflammation. Histamine is another early mediator. The most evident clinical finding of histamine release is early edema formation. Prostaglandin is synthesized following the release of arachadonic acid by the cell membrane. It enlarges the opening of the endothelia cell junctions to permit a further outflow of fluid. It is an important chemotatic factor for the attraction of leucocytes to the injured area.

Cellular Activity:

There are two types of cells involved in the inflammatory response; the polymorphonucleocytes and the mononuclear cells. The polymorphonucleocytes consist of the neutrophil, basophil and eosinophil. The
most important of these is the neutrophil. This cell can be considered a “first responder” to the initial injury. These cells have 2 main functions; initiate phagocytosis and the release of chemotactic agents that will attract other leucocytes to the area.

The mononuclear cell that follows the neutrophil is the monocyte. Through an enzymatic reaction, this cell converts to the macrophage. The macrophage has multiple functions to facilitate the inflammatory progression. The macrophage is critical to wound healing due to the chemical cascade that is released by these cells. There is a strong assist by the macrophage to fibroblastic activity. It then follows that if there is a condition to limit the presence of macrophages in an area, there will also be an absence of fibroblasts with resultant delays in wound healing. However, the converse is also true: the macrophage signals the body of damage to an area through the production of ascorbic acid and lactic acid as a byproduct of microorganism digestion. As the level of these chemicals rises, the body is signaled that there is tissue damage and the response is to send more macrophages to the area. However, if more macrophages come, the level of byproduct increases and the inflammatory response can become more intense and prolonged. The macrophage is most efficient when there is adequate oxygen tension in the tissues. This is dependent of the oxygen content of the blood circulating to the area. Therefore, patients with compromised vascular systems can present with delayed wound healing. The macrophage also assists with phagocytosis, matrix synthesis and angiogenesis through the release of growth factors.

The lymphocyte is another mononuclear cell that contributes to the inflammatory process. This cell is contributed by the immune system and is more prevalent in chronic inflammatory states. However, in acute inflammation, this cell will stimulate the complement system to form the membrane attack complex. This complex attacks cell membranes creating pores in the plasma membranes. These pores improve the efficacy of fluid and ion transport through the membrane.

The Fibroblastic Phase (5-28 days)

During the fibroblastic phase, the main activity switches to developing wound tensile strength. This is primarily due to the actions of the fibroblast. Fibroblasts are attracted to the injury site through chemotaxis. Once at the site the fibroblast will migrate along the fibrin network depositing collagen. Initially, this is type 3 collagen which has poor tensile strength. The initial collagen is called procollagen. The aminoterminal and carboxyterminal of the procollagen will cleave and create the type 1 collagen that is made up of the triple helix tropocollagen molecule. Deposition of this collagen increases the wound tensile strength.

Epithelization will also occur during this time in wounds that have a skin defect. This process is controlled by the principles of contact guidance and contact inhibition. The epithelial cells migrate from the wound edges to the center of the wound. This is contact guidance. Once the cells from one side of the wound contact cells from the other side of the wound, the process is supposed to cease. This is contact inhibition. The cell that assists with this wound contraction process is the myofibroblast. If this process fails to cease, the scar may develop into a hypertrophic scar or a keloid scar. The hypertrophic scar stays within the original wound margins. The keloid scar will overflow the original wound bed.
**Remodeling Phase (21 days- 2 years)**

The final phase of the wound healing process is the remodeling phase. During this phase the collagen deposition activity is joined by the process of collagen lysis or removing deposited collagen. This process reshapes the scar by replacing the type 3 with type 1 collagen which increases the tensile breaking strength. At maturation the wound is well healed but tensile strength is only 80% of the previous breaking strength for normal tissue.

**Factors Affecting Wound Healing**

**Aging:** Results in a decreased rate of progression in all three phases of repair. The vascular walls thin significantly during aging which affect the vascular phase of the inflammation phase. The epidermis becomes thinner with degeneration of the alignment of the epithelia cells on the basement membrane. This makes epithelization difficult for larger wounds.

**Diabetes Mellitus:** There are many processes in the diabetic that affect the repair process. Glycosalination of the collagen and keratin increases tissue rigidity. The basement membrane of the cells thickens with decreased local blood flow. Glycosated proteins change cell function and lead to free radical production and decreased perfusion and oxygenation of tissues. Therefore the diabetic must be carefully assessed for healing issues in all wounding situations.

**Thermal agent effects:**

**Inflammatory Phase:**
Cold is an effective mediator to reduce the production of inflammatory mediators that are released by the cell membrane. Cold has been shown to be effective in the prevention of swelling through this mechanism. Cold has not been shown to reduce edema one it has been established in the tissue.

Heat is contraindicated during this phase. Heat has been shown to increase fluid and blood flow to the area due to vasodilatation of the vessels. It therefore can increase bleeding and edema.

Ultrasound can be used but for the non-thermal effects of acoustic and membrane streaming. Thermal ultrasound will have the same effect as the superficial heating agents and should generally be avoided in these circumstances.

**Fibroblastic Phase:**

The preference during this phase reverses. Cold will limit the introduction of new cells into the area through the vasoconstriction associated with it. Heat, by facilitating vasodilatation can increase the fibroblastic cell volume resulting in increased collagen deposition.

**The Remodeling Phase**

Heat energy is well absorbed by collagen. The clinical issue during this phase is to increase extensibility of the scar. Heat will facilitate plastic deformation causing lengthening of the scar. The heat energy is applied either through a superficial or deep agent depending on the target tissue depth.
THERMAL FAQ:

Chapter 2: Biological Principals of Wound Healing

1. Q: You mention the cellular activity in wounding. Does this correlate to the effectiveness of PAMS? If yes how?

   A: It is difficult to prove that any physical agent actually influences cellular activity in humans. In vitro and animal studies have demonstrated that mast cells and fibroblasts are influenced by the application of pulsed wave ultrasound as is cell membrane permeability with increased intracellular calcium and macrophage activity. A study has demonstrated increased wound tensile strength in surgical wounds in pigs. So while there is a lack of randomized controlled clinical trials demonstrated clear effectiveness of ultrasound applications, there is evidence that the cellular activity associated with the wound repair process can be influenced by ultrasound. Cryotherapy has also been shown to be effective in the reduction of chemotatic factors produced by cell membranes during the early phases of the inflammatory process.

2. Q: Would you use any modality in the early stages of wounding when the neutrophils are active? And why?

   A: Theoretically, cryotherapeutic agents would be reasonably effective in the early phases of wounding but not for its effect on neutrophil activity. Cryotherapy reduces production of chemotatic factors and reduces blood flow to the area due to induced vasoconstriction. This would reduce the presence of neutrophils in the interstitium and decrease the inflammatory cascade.

3. A: If you have someone that has a depressed immune system (heart or liver transplants and are on anti-rejection drugs) or HIV/AIDS would you use u/s, electrical modalities or any? Why?

   A: There are no listed FDA warnings, contraindications or precautions for this population. The FDA website can be accessed readily to stay current on all promulgated government safety rules.
Chapter 3 Principles of Hydrotherapy

Water is used as a therapeutic agent in two ways: immersion of the body part or non-immersion techniques. In this seminar we discuss the use of immersion techniques for wound management. When a body is immersed in water, there are four forces that are imparted to the body part. These are: buoyancy, pressure, viscosity and thermal conductivity.

Buoyancy is an upward force that is equal to the amount of water displaced. This is stated as Archimedes’ principle: when a body is immersed in a fluid, it experiences an upward thrust force that is equal to the weight of the fluid that has been displaced by the body.

Whether the body floats or sinks depends on the relative density of the body to the fluid. If the density of the body is less than the fluid it displaces a smaller volume of fluid and the body will float, if the body is denser than the fluid it will displace a larger amount of fluid and will sink. The human body clearly floats as it is less dense than water.

Pressure refers to hydrostatic pressure and it is the pressure exerted by a fluid on a body immersed in the fluid. Pascal’s law governs pressure in liquids. It states: a fluid exerts equal pressure on all surfaces of a body at rest at a given depth and this pressure increases in proportion to the depth of the fluid. For wound applications, the superficial nature of immersion reduces any pressure concerns.

Viscosity provides the resistance to motion of a body in water. This feature of water makes it suitable for use in aquatic rehabilitation. The resistance occurs opposite to the motion of the body and it increases as the speed of motion increases and resistance drops to nothing when the motion stops.

Thermal conductivity refers to the ability of water to transfer thermal energy. Water can transfer energy by conduction or by convection. These methods are discussed later in the sections on superficial heating mechanisms. Water can be used for heating or cooling and is much more efficient than air due to the higher specific heat of water. The specific heat of water is 4 times greater than air. The specific heat of water is 1 calorie/gram °C = 4.186 joule/gram °C which is higher than any other common substance.

The use of hydrotherapy for cleansing is a well established intervention. Water will hydrate and soften tissue and result in easing necrotic tissue and wound debris for removal. Further, the water can be treated with antimicrobial agents to add a disinfecting effect. Additives will be discussed later. There are other effects of water such as using buoyancy to unload musculoskeletal tissues, cardiovascular effects that occur when a large amount of tissue is immersed in hot water. This effect is seen when people are using a spa and there is a subsequent increase in heart rate. So it is
necessary to state that temperature and pressure from immersion create systemic effects. For upper extremity wound management purposes, these effects are minimal.

The turbine is the mechanical device that introduces air in to the water at defined rates. The greater the amount of air introduce, the greater the turbulence created in the water. The use of the turbine makes wound selection critically important. High agitation whirlpool should be avoided with fresh soft tissue reconstructions. Actually many soft tissue reconstructions should not use the turbine but may use wet dressing changes as a technique. This is called wet to dry dressings and they are effective for debridement of dried exudates. This is an example of non-immersion hydrotherapy.

**Safety Issues**

The most important safety issue is the prevention of cross contaminated of patients due to poor infection control practices. Whirlpool tanks provide an excellent environment for bacteria to colonize. The simplest way to address the issue is to use an antimicrobial additive to the water during treatment. The most commonly used additive is chloramine-T and this is readily available from rehabilitation equipment providers. Household bleach can also be used effectively however; this substance releases fumes that can be noxious to patients. Povidone Iodine (betadine) has also been used as an additive for the treatment of open wounds. However, this has never been FDA approved for this purpose. Additives, while effective for infection control carry a downside. These chemicals have been shown to be cytotoxic to fibroblasts, neutrophils and other cells involved in the wound repair process. Therefore, it is reasonable to defer using additives in open, granulating wounds. Table 1 lists common additives and dosage information.

<table>
<thead>
<tr>
<th>Agent</th>
<th>Indication</th>
<th>Dilution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloramine-T</td>
<td>Infected, odorous with exudates and or necrotic tissue</td>
<td>Tanks up to 50 gallons 20 grams (pre-mixed)</td>
</tr>
<tr>
<td>Household Bleach</td>
<td>As above</td>
<td>1:240 dilutions. 7 oz in a 30 gallon hand tank</td>
</tr>
</tbody>
</table>

Table 1

Care must be taken to clean and disinfect the tank following use. The steps of drain, rinse, scrub, rinse, disinfect and rinse should always be followed. During the disinfectant stage, the disinfectant must be in place for 10 minutes. This can be done through soaking and running the turbine. The turbine should be cleaned separately. Cultures of water samples should be taken at regular intervals to ensure no colonization of bacteria. Your individual state and facility will have culture frequency and technique. One area for culturing that should always be considered is the underside of the turbine downspout and the drain.

The second safety component is electrical grounding. The safest outlet to use is a ground fault outlet. This is standard in hospitals and is necessary to interrupt the flow of electricity in case of leakage current to the metal casing of the turbine. This will cease the flow of current and prevent electrocution.
Typically safety inspection of the wiring is done yearly, however, in the interim; all machines should be checked for intact wiring. Other safety measures include assessment of the attachment of the turbine motor to the tank and ensuring proper ventilation to prevent transmission of possible air-born infective agents.

**Temperature**

The safest temperature to use for wound management is the neutral temperature. At this temperature the wound is not subject to vascular or hemostatic changes from the increase in temperature. Further in wounds that are unstable with a vasospasm component this reduces the risks of reflexive vasoconstriction. This is very important in the management of flap reconstructions through immersion treatment. Table 2 lists common temperatures and their applications.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Temperature</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Whirlpool</td>
<td>79 F</td>
<td>Acute injury/inflammation</td>
</tr>
<tr>
<td>Neutral Whirlpool</td>
<td>92-96 F</td>
<td>Open Wounds</td>
</tr>
<tr>
<td>Warm Whirlpool</td>
<td>96-98 F</td>
<td>Burns with epithelialization</td>
</tr>
</tbody>
</table>

Table 2

**Precautions and Contraindications**

The following precautions and contraindications have been listed for the use of this physical agent: insensate tissue, cognitive deficits, infection, soft tissue integrity, maceration of intact surrounding tissue, active bleeding and vascular insufficiency.

Considerations for application include: padding the edge of the tank to avoid pressure on the limb, rinsing the limb upon removal from the tank to complete the bactericidal effect and determining the length of time needed for the intervention. As always in wound management the principles of universal precautions should be applied including hand washing by the clinician, use of gloves, gowns, and masks as indicated.

**Documentation Considerations**

Wound assessment including the classification of the wound, exudate characteristics, size, shape and depth of the wound, and the condition of the surrounding tissue.

The temperature of the water and the use or non-use of additives. If used, the type of additive and the purpose of the additive. Time of immersion should also be recorded.

The changes in the wound characteristics demonstrating improvement and or need for continued intervention.
Principles of Hydrotherapy

Wound Assessment and management.

Hydrotherapy Effects

- Thermodynamic effects: No different than any other superficial agent.
- Cleansing effects:
  - Pressure. Occurs through movement and immersion.
  - Softens tissue.
  - Debrides wound debris.

Forces in Water

- Buoyancy.
- Pressure.
- Viscosity.
- Thermal conductivity.

Whirlpool

Turbine Function

- Mixes water and air to control turbulence.

- Aeration

- Turbulence
### Whirlpool Safety
- Electrical safety-grounded plugs.
- Secured motor.
- Wiring integrity.
- Turbine: never run without water.
- Adequate ventilation of treatment area.

### Temperature & Recommended Applications
- Cold: 32/79F
- Neutral 92/96F
- Mild warmth 96/98
- Acute injury/inflammation.
- Open wounds.
- Burn patients with epithelialization.

### Infection: Management/Containment
- Antimicrobial solutions.
- Drain/rinse.
- Scrub with detergent.
- Rinse.
- Disinfect

### Indications for Whirlpool in Wound Care.
- Removal of necrotic tissue.
- Cleansing
  - With or without antimicrobial agents.
- Soften tissues.
- Increase local circulation.
### Wound Evaluation
- Careful Medical Review.
- Location and condition of the surrounding tissue.
- Wound bed and margins.
- Document: Size, shape depth of the wound.
- Exudate characteristics.
- Wound classification.

### Exudate Characteristics
- Serous.
- Sanguineous.
- Fibrous.
- Purulent.
- Yellow. Thin viscosity.
- Yellow/red, red. Thin viscosity.
- Green. Odorous with viscous consistency.

### Wound Classifications
- Red.
- Yellow.
- Black

### Flaps/Grafts
- Direct agitation away from the reconstruction
- Increase aeration to reduce agitation.
- Grafts: 10 days with “take”.
- Flaps:
  - Can be early on if there is flap necrosis.
  - Neutral to mildly warm pool.
### Precautions & Contraindications

- Insensate tissue.
- Cognitive deficits.
- Infection
- Soft tissue integrity.

- Maceration of intact surrounding tissue.
- Active bleeding.
- Vascular insufficiency.

### Application

![Application Image]

### Post Whirlpool Appearance

![Post Whirlpool Appearance Images]
Chapter 3: Principles of Hydrotherapy

1. Q: Would you recommend portable plastic w/p units? Why?

   A: This is certainly in the realm of opinion as there is little evidence to no evidence demonstrating effectiveness of these units. I have found them convenient however; the agitation is inadequate for loosening exudates and necrotic tissue.

2. Q: What about the hand in dependent position we hear so much about?

   A: This is certainly a consideration with the edematous hand. I would not recommend W/P for patients who have a significant problem with edema.

3. Q: What is the typical duration in terms of days/weeks you treat anyone person in the w/p?

   A: There is no hard rule or recommendation as to the number of treatments necessary. However, it is important to remember that once a bed of granulating tissue has been established, W/P should be discontinued.

4. Q: Many clinics and almost all wound centers do not use w/p because they say they are antiquated. How would you justify using a w/p with the opposition.

   A: I don’t feel justification is the proper term. Certainly the indications for W/P have changed and are significantly limited in current practice. As was stated in the presentation, W/P has an indication for the softening of hard eschar and of dried exudates. In my view, it works best for extremity wounds and the treating therapist must be mindful when considering the use of additives during epithelialization. Non-immersion methods of hydrotherapy particularly pulsatile irrigation and wound vacuuming for debridement have replaced W/P as the treatment of choice with open wounds as it is effective with little risk of cross contamination.

5. Q: You advocate w/p with wounds under certain circumstances. Why not use moist wound products?

   A: I would in many instances. I feel that the wet to dry dressing is an effective way of performing a controlled, gentle debridement of extremity wounds and this would probably be my treatment of choice. When the area to be treated is large and patient compliance is an issue, W/P can make sense as an option.

6. Q: Would you use w/p for a stiff hand with no wounds?

   A: No.
Chapter 4 Thermodynamics

Thermodynamics is the physical principles of heat transference juxtaposed with the actions this causes to biological tissues. This can be referred to as the biophysical principles of heat transference. In this section these principles will be explored as the basis for the application of the specific thermal reviewed in chapter 5.

General Consideration When Applying a Superficial Heating Agent

Consider the size of the area and the location of the area to be heated. For instance, consider the differences between heating agents placed on the one of the following locations: foot/hand, spine, cervical. The spinal hot pack patient can develop systemic response through elevation of the core temperatures. The can lead to increase cardiac output. The cervical pack is located near the stellate ganglions of the autonomic nervous system. This can lead to temperature changes in the upper extremity due to stimulation of the heat regulation system of the body, finally the foot, this is least likely to give systemic response but even though the amount of tissue is small, the foot has temperature regulators that could result in a disproportionate response given the area of tissue heated or cooled.

The amount of increase needed is also a consideration. Are you attempting to have a mild increase in temperature or is the goal a vigorous heating. This speaks to the length of time and amount of energy needed in the agent.

The rate of rise is important. The rate of rise will be rapid if the temperature differential is great and it will be slow if the differential is slight. The rapid rise is necessary to overcome the effects of counter-current heat exchange. This is where the blood from the core is cooler than the blood in the heat area. Heat is then transferred away from the heated area. This will eventually raise core temperature but will also cool the heated area. Of course if the rise in temperature is too rapid, a burn will occur.

Heat Transference Methods

Conduction transference requires direct contact of the agent to the skin. In conduction, the agent has increased energy that is being expressed by heat. The heat is a manifestation of the high frequency vibrations that are occurring among the molecules of an agent. When this is placed in contact to a cooler area, the highly vibrating molecules collide with the molecules of the cooler surface causing them to vibrate at an increased speed. This then causes the contact surface to raise its temperature. This continues until the two surfaces are in equilibrium.

There are four variables to consider ensuring an adequate rate of heat transference. These are: the area of contact, the thermal conductivity of the tissue, temperature differential between the agent and the tissue and the tissue thickness.

Each of these variables is a consideration in the speed of the energy transfer. The area of contact refers to the body part being heated. This was previously discussed. The thermal conductivity refers to the
ease of heat conduction energy as a property of the material. Some materials are insulators such as air which has a low rate of thermal conductivity and is an important variable to control in heat transfer applications. Other materials are good conductors such as water. The temperature differential must be higher than the rate of countercurrent heat exchange and the tissue thickness must be considered in relationship to the target tissue depth.

Convection transference refers to the circulation of fluids. In convection heating the fluid will remain at a constant temperature. In convection heating, the body part is constantly exposed and in contact with the medium. The medium remains at a constant temperature meaning equalization of temperature occurs by raising the tissue temperature only. Therefore, convection methods are more effective in transferring heat energy than conduction heating given the same temperatures for the agents.

**Neurological Regulation**

The temperature regulation system begins with free nerve endings that are scattered throughout the body. These endings act as thermoreceptors which stimulate the sympathetic and parasympathetic nervous systems. The sympathetic system controls skin blood flow and the parasympathetic system controls the sweating response. *This input reaches the hypothalamus for CNS modulation. There is also a spinal cord reflex that occurs through the thermoreceptor synapse in the dorsal root ganglion with spinal interneurons. These spinal interneurons synapse with sympathetic neurons through the lateral horn and through the stellate ganglion chain. This decreases sympathetic activity and there is resultant relaxation of smooth muscle and increased vasodilatation. Finally there is a system for direct local control of temperature information. Thermoreceptors when stimulated may stimulate axons directly to the local cutaneous blood vessels. This causes the release of bradykinin and nitrous oxide and which act as vasoactive mediators that stimulate smooth muscle relaxation facilitating vasodilatation.*

**Metabolic Activity**

Heat increases the rate of chemical reactions in the biological tissue. It also increases the enzymatic activity rate 100% per each ten degree rise in cellular temperature (Van Hoff’s law). This rate continues to increase until a tissue temperature of 113F/45C. At this rate protein begins to denude and the rate will drop to 0 at 50C- tissue destruction begins. The increased cellular activity leads to an increase in oxygen uptake resulting in increased wound healing rates but can also be destructive of cartilage through the increased production of collagenase. Finally, hemoglobin releases more oxygen when heated to 106F (double of what it releases at 97F).
Responses of Biological Tissue to Heating

Connective Tissues

Plastic deformation is the lengthening of soft tissues in response to an applied force. This force must overcome the tendency toward recoverable deformation or creep. This is the transient lengthening of soft tissues. Plastic deformation uses the principle of stress relaxation to attain an increase in length. These principles are illustrated in figures 1 and 2.

![Diagram](image)

**Fig. 1**

*Constant Load*  
*Deformation Load*  
*Creep*  
*Time*

![Diagram](image)

**Fig. 2**

*Constant Load*  
*Deformation Load*  
*Stress Relaxation*  
*Time*

Connective tissue behavior appears to be dependent on the viscoelasticity of the tissue. Heat energy is well absorbed by connective tissue thereby lowering the force needed to attain deformation and ultimately stress relaxation.

Neurological Tissue

Nerve conduction velocity has been demonstrated to increase with heating. There is a suggested ratio that states conduction velocity increase 2 meter/sec for every 1 degree C increase in temperature. This may be the mechanism that contributes to alterations in pain perception. Pain perception is also likely to be altered by the gating mechanism which will be explored in detail when we discuss pain.
propagation. Stimulation of thermoreceptors will synapse into the dorsal horn as previously outlined. Here they will synapse and act as input to influence the gating mechanism.

Elevation of muscle temperature to 108 F has been shown to decrease the firing rate of type II muscle spindle efferents and gamma system efferents. Further the firing rates of GTO’s increase. These events can cause a decrease in the firing rate of the alpha motor neurons with a reduction in muscle spasm. The decrease rate of firing in the gamma system causes a decrease in the stretch response of the muscle and further decreases muscle spindle activity with further relaxation of the muscle.

Muscle Tissue

Heat application has been shown to decrease strength and endurance for 30 minutes following the application. This effect reverses over a 2 hour period. This effect is thought to be related to the changes in muscle spindle firing rates. The clinical concern is performing muscle testing or strengthening activities following heating. For example, attaining a grip strength measurement following a hot pack or fluidotherapy intervention may result in decreased muscle output. Further, task performance and endurance will be reduced following heating therefore; treatment plans must reflect this consideration when they include heating agents.

**Indications/Contraindication of Heating Agents**

Heating agents are indicated for the following clinical conditions: Joint stiffness/contracture, soft tissue tightness, pain control and muscle relaxation/spasm reduction.

Contraindications for application of heating agents include: Insensate tissue, circulatory deficiency, steroid dependency, thrombophlebitis, acute inflammatory conditions and friable skin with little adipose tissue. Precautions must be considered with the following conditions: pregnancy, cardiac insufficiency, edema and open wounds.

**The Biophysical Effects of Cold (Heat Loss)**

Heat transference now works in the opposite direction from heating. Applying a cryotherapeutic agent causes heat to be transferred from the body to an agent or to the environment. When the agent is in direct contact with skin this is conduction cooling. Immersion into a circulating cold water bath is an example of convection cooling. Evaporation however, is unique to heat loss. Evaporation is cooling that occurs at the surface of a liquid. When a liquid evaporates, energy is absorbed and used to turn the substance from a liquid into a gas. This absorption of energy results in cooling of the substance that the energy is drawn from. The biological example of this is sweating. The parasympathetic nervous system will cause sweating whenever the body temperature exceeds 37C. When the sweat evaporates, it draws energy from the body causing a cooling of the skin temperature.

Factors Affecting Heat Loss

The same factors that are important in heat transference to the body are in play with heat transference from the body. However, in cooling there are two additional factors that must be considered. These are
the type of agent used and the length of application. The type of agent is important. Conventional cold packs will extract heat in a similar manner to conduction heating agents. However, direct ice application has a significant advantage. When ice melts it will extract more heat energy from the body resulting in more aggressive cooling, therefore, ice application will require careful monitoring of the length of time it is applied for.

**Neurological Regulation**

The regulation and response to cold inputs is through the system outlined previously. However, the actions of the nervous system are different. The primary response to cold input is vasoconstriction with reduce blood flow to the area. Vasoconstriction is influenced by four events that are produced by cold applications. The local response to cold application is smooth muscle contraction. This is augmented by a reflexive response from the sympathetic nervous system. These responses combine to stimulate a vasoconstriction response. Cold also diminishes the production of chemical inflammatory mediators by the cell membranes. Without these mediators, the vasoconstriction response is enhanced. The final consideration is blood viscosity. Cold will increase the viscosity of the blood resulting in a slower flow through the injured area.

Vasoconstriction results in the following biophysical principle: A cooled area takes longer to return to its previous temperature than a heated area. This is due to diminished countercurrent heat exchange. Countercurrent heat exchange is a mechanism of heat exchange where warm fluids in one system come in contact but do not mix with cooled fluids in another system. Counter current heat exchange is the mechanism by which the body maintains temperature. When warm blood coming from the heart encounters cool blood in the vein returning to the heart, the temperature differentials are evened out over a distance resulting in a constant temperature. Cooled blood is heated and warm blood is cooled. When vasoconstriction causes reduced blood flow to the area there is less blood to heat the area. Therefore the cooled area will take longer to return to a baseline temperature.

A phenomenon that can be observed with cooling is called cold induced vasodilatation. This is when a cold application is applied for a long duration. In response to the impending tissue damage, the temperature regulation system of the body will respond by inducing vasodilatation. If the cold stimulus persists, the area will cycle between vasoconstriction and vasodilatation. This cycling is known as the hunting response.

**Responses of Biological Tissue to Cooling**

**Peripheral Nerve Effects**

Cold applied to peripheral nerve has been shown to reduce the nerve conduction velocity of that nerve. This occurs proportionally to the degree of the temperature change and the amount of time the cold agent is applied. For example, if you cool for five minutes, the conduction velocity will return to normal within 15 minutes. Cooling times of 20 minutes or greater may take over 30 minutes to recover. However, in superficial nerves like the ulna nerve, focal conduction blocks have been reported with neuropraxic and rarely, axontometric lesions occurring.
Neuromuscular Effects

Cold application has been shown to reduce spasticity. This is theorized to occur through direct cooling of muscle, diminished gamma motor neuron activity and decreased muscle spindle and GTO activity. Prolonged cooling ranging from 10-30 minutes has been shown to decrease spasticity, clonus and hyperactive tendon reflexes. These effects have been noted to last for over one hour. Short duration cooling has been shown to facilitate motor output. This is thought to be produced through gamma system stimulation. Short duration cooling of 5 minutes or less has been shown to increase isometric muscle strength although the length of the effect has not been documented. The longer duration cooling has been shown to decrease muscle strength for up to one hour and ten to increase strength to greater than pre treatment levels for up to 3 hours. The mechanisms for this effect are not completely understood. They are thought to be related to the reduced blood flow to the muscle, decreased nerve conduction and increased muscle viscosity.

Metabolic Effects

The effect of cold is to reduce the cellular metabolic rate. The decrease metabolic rate reduces the chemical mediators of inflammation and also fibroblastic activity. While this is helpful in management of acute inflammation, this can have the unintended consequence of prolonging the healing process.

Enzymes such as collagenase, protease and elastase are inhibited when a joint is cooled. This reduces cartilage destruction in the inflammatory diseases and may argue for the use of cold in the management of arthritis. This of course is not the only consideration. Issues such as joint stiffness and Reynaud's disease would argue against the use of cold.

**Indications for Cooling**

Cryotherapy is indication for the following clinical conditions: edema control, reduction of inflammation, pain control, spasticity reduction and facilitation of motor output.

Inflammatory control is related to the hemodynamic events related to vasoconstriction. Reduction of blood flow will reduce bleeding and fluid leakage into the interstitium. Further, the calor and pain of acute inflammation are well controlled with cold. Edema and inflammation control are closely associated and are augmented by elevation and compression. The use of cryotherapy in the 1st 48-72 hours following an injury is a standard approach. Skin temperature can be used as a clinical guide to determine the amount of time that cold should be applied. Cold has also been shown to control delayed onset muscle soreness. This can occur as a result of mild inflammation brought on by exercise. Pain control by cryotherapy has a rapid onset and can be a prolonged effect. The initial pain control is probably through a gating mechanism that is similar to what is seen in heating. The prolonged effect is probably related to the decrease conduction of pain impulses through the a-delta system. The prolonged effect is related to the delay in rewarming that we have previously discussed. This makes cryotherapy excellent for interruption of the pain spasm pain cycle.
**Contraindications to Cooling**

The contraindications of cryotherapy are as follows:

Cryoglobulinemia is characterized by aggregation of serum proteins in the distal parts of the extremities in response to cooling. These proteins form a precipitate or gel that blocks local circulation and creates ischemia. This can result in gangrene development. This is a rare complication but it is noted in association with SLE, RA, or myelomas. It can occur independently of these diseases.

**Cold Hypersensitivity** - There are many forms of cold hypersensitivity, which include:

**Cold hypersensitivity** is a vascular reaction that is seen in response to cold. This is a local response seen only at the site of application. The skin is marked by raised patches that can either be whiter or redder than the surrounding skin. The problem will resolve with rewarming but may be accompanied by significant itching.

**Cold Urticaria** - Also known as hives. This is a release of histamine during re-warming after a period of cooling, causing red, itchy welts on the skin.

**Cold Erythema** - A rash characterized by redness and itching, caused by exposure to cold. It can cause severe pain and muscular spasms.

**Cold Hemoglobinuria** - When red blood cells break down so quickly that some hemoglobin cannot combine with blood proteins.

**Anesthesia** - When there is an area of numbness or altered sensitivity, cold therapy should not be used as pain and the degree of cooling cannot be well regulated by the body.
Thermodynamics: The physics of heat transference

Purpose of Superficial Heating
- Increase temperature of structures with little soft tissue covering.
- Reach deeper tissues through reflexive mechanisms.

Considerations for Heating Responses
- Amount of tissue to be heated.
- Amount of temperature rise needed.
- Rate of temperature rise/temperature differential.
Methods of Heat Transference

- Conduction heating.
- Convection heating.
- Radiation heating.

Conduction Heating

Energy exchange through direct contact.

- **Rate of transfer:**
  - Area of contact.
  - Thermal conductivity.
  - Temperature differential.
  - Tissue thickness.

Rate of transfer is:

\[
\text{Rate of transfer} = \frac{\text{Area of contact} \times \text{thermal conduct.} \times \text{temp difference}}{\text{Tissue Thickness}}
\]

Convection Heating: The movement of fluids.

- Direct contact between a circulating fluid and an object.
- The circulating agent brings energy at a constant rate. Differs from conduction heating.
Biophysical Effects

Circulatory.

- Skin blood flow.
  - Controlled by sympathetic adrenergic nerves.
  - Vasodilatation that occurs through local and reflexive mechanisms.
  - A-V Anastomosis have a critical role in heat regulation.
Biophysical Effects

Causes of skin vasodilatation.

• Axon reflexes.

• Chemical mediators.

• Spinal cord reflexes.
Biophysical Effects

Skeletal muscle blood flow.
• Controlled by metabolic activity.
• Responds to changes in exercise patterns.
• The effects of heat and exercise are cumulative.

Connective Tissue Responses to Heating
• Recoverable deformation. (Creep)
• Plastic elongation.
  ▫ Goal is to attain elongation of soft tissues.
Plastic Elongation

- Temperature required:
  - 104°F - 113°F for 5-10 min.

- 3 methods to attain elongation.
  - Constant loading.
  - Rapid stretch and hold.
  - Low loads over extended time.

Neurological Responses

- Pain reduction.

- Decreased muscle spindle activity.

Muscle Tissue Response

- Reduce strength.

- Reduced endurance.
Metabolic Activity

Van Hof's law

The metabolic rate of the cell will double for each ten degree rise in temperature.

Increase cellular biochemical reactions leads to increased O2 uptake.

Indications for Superficial Heating Agents

- Joint stiffness/contracture.
- Soft tissue tightness.
- Pain control.
- Management of muscle spasm.

Contraindications to Superficial Heating

- Insensate tissue!
- Circulatory deficiency.
- Steroid dependency.
- Neurological conditions.
- Thrombophlebitis/acute inflammation.
- Friable skin with little adipose tissue.
Precautions

• Pregnancy.
• Edema.
• Cardiac insufficiency.
• Open wounds.
• Thermal regulation issues.
• Metal
• Counterirritants to skin.

Harmful Effects

• Burns.
• Fainting.
• Bleeding.

Cryotherapy
The Biophysical Effects of Cold
The Physics of Heat Loss

Two modes of transfer.
• Conduction: transfer of energy by direct surface contact.
• Evaporation: heat loss at the surface of a liquid.

Factors effecting conduction
• Temperature differential.
• Tissue conductivity.
• Length of application.
• Type of agent.

Tissue Response to Cryotherapy

General effects.
• Arteriole vasoconstriction.
• Decreased metabolic rate.
• Decreased inflammation.
• Elevation of the pain threshold.
• Stimulation of the hypothalamus.
Tissue Response to Cryotherapy

Vasoconstriction
- Results from a combination of direct effect and smooth muscle and reflexive activity.
- Reflexive activity occurs through activation of the sympathetic nervous system.

Tissue Response to Cryotherapy

4 factors in reduced blood flow
- Smooth muscle contraction.
- Reflexive vasoconstriction.
- Decreased chemical mediators.
- Increased blood viscosity.

Tissue Response to Cryotherapy

Biophysical principle:
A cooled area takes longer to return to its previous temperature than a heated area.
This is due to diminished countercurrent heat exchange.
Countercurrent Heat Exchange

Tissue Response to Cryotherapy
- Decreased chemical mediators: cold reduces the presence of inflammatory chemicals.
- Increased blood viscosity: results in decreased blood flow.

Tissue Response to Cryotherapy
- Cold induced vasodilatation
  - Occurs when cooling is < 10°C.
  - Follows initial vasoconstriction
  - Occurs at the A-V anastomosis in the skin.
  - Can stimulate the “Hunting Response”.
Tissue Response to Cryotherapy

Peripheral nerve effects

- Decreased synaptic transmission.
- Decreased conduction velocity.

Peripheral Nerve Effects

Afferent fibers
A-delta > a-beta > c-fibers

Efferent fibers
Gamma fibers > alpha fibers

Increased duration >>> decreased conduction
Tissue Response to Cryotherapy

Neuromuscular effects

- Spasticity reduction:
  - Direct cooling of the muscle.
  - Decreased gamma motor activity.
  - Decreased muscle spindle and GTO activity.

Tissue Response to Cryotherapy

Effects on muscle strength

- Short duration (5 minutes or less)
  Facilitates alpha motor neurons.

- Long duration (<30 minutes)
  - Reduced muscle blood flow.
  - Increased muscle viscosity.

Metabolic Effects

- Decreased metabolic reactions.

- Decreased activity of cartilage degrading enzymes.
Indications for Cryotherapy

- Edema Control.
- Inflammation reduction.
- Pain control.
- Reduce spasticity.
- Facilitation of muscle activity

Contraindications to Cryotherapy

- Cold intolerance.
- Raynaud's disease/phenomenon
- Cold hypersensitivity.
- Cryoglobulinemia
- Circulatory deficits/PVD.
Cryotherapy Precautions

- Open Wounds
- Hypertension
- Superficial nerve trunks
- Compromised mentation
Summary Points

- Cellular activity releases chemical mediators that direct the wound healing process.

- Thermal Agents influence the movement of cells through vasodilation and vasoconstriction.

Summary Points

- Thermal agents can decrease/increase the presence of inflammatory chemical mediators.

- Thermal energy is regulated at the local, spinal, and sympathetic ganglion level.
Summary Points

- Thermal agents have neurological and musculoskeletal effects.
- Ultrasound can be used to produce thermal effects at a deeper tissue level.
Chapter 4: Thermodynamics:

1. You mentioned how “we don’t want creep”. I thought in dynamic splinting Brand speaks of achieving plastic deformation via creep and Bounati discusses achieving plastic deformation via stress relaxation. Please explain why we don’t want creep. Creep is the property of tissue with a high collagen content that causes it to lengthen under stress and then return to the original length. Creep does not result in elongation of tissue. The goal of dynamic splinting is to use prolonged stress over time to maximize length. This then achieves plastic elongation which is the goal of interventions designed to correct stiffness.

2. You mentioned true cold hypersensitivity and you showed us the photos in chapter 4. My question is what would a therapist do when we see this has occurred? Immediately remove the cold stimulus. This can be followed with wrapping the area to provide a gentile re-warming through neutral warmth.

3. Do you document that the patient had a adverse reaction and developed hypersensitivity to cold and developed a “cold raised rash”? Any adverse effect from any intervention should be completely documented. This is not limited to modality intervention. In this instance, the type of cryotherapeutic intervention, the insulating material and the length of application should be documented.

4. Would you D/C all cold modalities if your patient had the “cold raised rash” or how would you modify your intervention? I personally would not use other cryotherapeutic intervention if any adverse effect has been documented.

5. I have heard hot packs contribute to legal liability claims because of burns. You also mentioned that too many towels may hinder the physiological goals of heating to therapeutic temperatures. What would you do or suggest a therapist should do when treating an elderly person on:
   a. Blood thinning medication or aspirin therapy
   b. Diabetic
   c. Demented
   d. Or anyone at any age if there is a communication barrier and there is no interpreter.

Let me address each situation individually: Blood thinning and aspirin therapy have the same goals. One should increase observation and monitoring to ensure that no adverse effects develop.

With diabetics, the main concern would be sensory loss from diabetic neuropathy. I would test sensation for hot/cold formally using test tubes and water of different temperatures prior to applying heating agents. If the area presents with normal protective sensation, I would treat it accordingly. If the area to be treated lacked protective sensation, I would consider other interventions or no intervention with a physical agent.

Dementia: The use of any physical agent with cognitively impaired individuals is generally contraindicated. This would also be true of language and communication issues. An important consideration with communication issues is the matter of informed
consent. Any intervention done by a therapist carries with it the need for the patient’s consent. Legally, consent cannot be given if the patient does not understand the intervention. Therefore, I generally do not treat anyone with proper interpreter availability.

6. You mentioned superficial heat alone is not really effective to increase blood flow and therapeutic effects and adding exercise increases the effects. What about using only heat for
   a. OA
   b. Hand Pain
   c. Stiffness
   Would the head just decrease the pain and there is no beneficial increase in blood flow? The point about blood flow was directed to muscle tissue. The effective way to increase muscle tissue temperature is through exercise as muscle reacts to changes in metabolism seen with exercise. The benefits from heat that are seen in the listed conditions are likely to occur through increasing the extensibility of collagen thereby decreasing the stiffness associated with arthritic conditions.

7. You mentioned you like cold modalities to help decrease muscle spasms. What if someone has RSD/CRPS should you try the cold to decrease the muscle spasms that occur often with RSD patients? Why?
   I do not see the rationale for the use of cryotherapy in this clinical instance. In RSD/CRPS Sympathetic type, the primary issue is control and reduction of pain. These patients tend to be reactive to cold input in isolation. While there is no frank contraindication to cryotherapy, a better choice might be contrast baths or perhaps exercises with a TENS intervention in place for pain control. The decision would be influenced by the location of the spasm and by the priority of spasm reduction in the treatment plan.
Chapter 5 Application of Thermal Agents

This chapter augments the video by providing written instructions for applications of thermal agents. This is reference material to be referred to until practice and repetition allows mastery of the technique. Each agent is listed with the appropriate techniques for safe application followed by indications and contraindications for each agent. Prior to selecting any of the following techniques consider these questions:

What is the clinical problem and how does the selected agent address this problem?

Is it the most appropriate agent to meet the clinical need?

Are there any contraindications to prevent the safe use of the selected agent for the patient?

Consider the body part being treated. Select an agent that will contour to the body part and reduce air in the patient–agent interface.

Is the patient able to understand the process and expected outcome? Properly educate the patient prior to application.

Upon completion of the intervention assess the outcome and document the results appropriately.

Superficial Heating Agents: Application Techniques

PARAFFIN:

The use of wax melted with mineral oil in a 6:1 to 7:1 ratio wax to oil. It is best used in the extremities where contours of the extremity make heat application difficult. It is excellent for use in resolving small joint stiffness of the hand. The mineral oil also improves scar suppleness and extensibility.

Indications: Digital stiffness, scar contracture/ hypo mobility

Contraindications: Open wounds.

There are two basic techniques for use in hand rehabilitation. The basic technique is the dip and wrap technique. Prior to paraffin application, the hand must be washed and dried to prevent infection. The hand should be assessed and positioned in flexion for flexion stiffness or extension for extension stiffness.

A) Dip into the wax in the desired position.

B) Allow wax to stop dripping and become slightly opaque.

C) Repeat 6-10 times.

D) Wrap in plastic or wax paper.

E) Wrap in towel, elevate the hand on a wedge and leave in place for 10 minutes until the paraffin is cool.
F) Peel the paraffin off the hand and discard it. (Recommended for clinic application. If the agent is for a single user in home program, the paraffin can be re-used.)

Dip and Stretch Technique

After completing a 5 minute pre-treatment as outlined above, apply a stretch to the stiff digit either with an elastic wrap for flexion deficits or spring splint for extension deficits. Reapply the paraffin in the desired position repeating steps A-F.

**Documentation Sample:**

S: The patient reports inability to open jars due to stiffness of the right hand following Dupytren’s release.

O: Paraffin dip applied for PIP flexion stiffness of the ring finger following Dupytren’s release. 7 dips in a fisted position followed by elevation for 10 minutes. No adverse effects noted following wax removal. Scar mobilization to palmer scar followed by gentle putty exercises using medium soft putty to improved digital flexion strength. The large knob tool (302) used on BTE to simulate jar opening.

A: Patient is able to open a large jar lids however, small lids remain a problem.

P: Continue current treatment approach.

**Hot Packs**

Commercial hot packs are designed to absorb a large quantity of water and deliver heat uniformly. They are stored at 165F in a temperature regulated water cabinet and are available in many shapes and sizes to improve conformity to the different areas of the body. The contour is important to limit the air at the skin interface. Air will prevent even heat transference and all efforts should be made to keep air out. A key consideration with hot packs is the amount of toweling used for insulation. The classic representation of 6-8 layers may not be valid as the new covers may require less insulation. The final consideration is the weight bearing on the pack. This should be avoided if possible. Weight bearing or lying on the pack will squeeze water out of the pack, increasing the temperature and the pressure will decrease the circulation to the area making heat loss difficult. This increases the risks of burns significantly.

Indications: Joint stiffness, Pain Control, Muscle Relaxation.

Contraindications: Insensate tissue.

A) Wrap the pack in the appropriate layers of toweling. 6-8 towel layers is the most recommended number. More or less may be needed. It is recommended that treatment begins with excessive layers to guard against burns.

B) Secure the pack adequately so that there is maximum conformity.
C) Ensure the patient is properly educated to notify personnel if the pack becomes too hot. Provide the means to alert personnel if the patient is not under direct observation.

D) Check the heated area after 5 minutes to ensure no adverse effect from heating.

E) Apply for 20 minutes. Remove the pack and inspect the skin to be sure there was no adverse thermal effect.

**Documentation Sample:**

S: Patient reports inability to reach objects in her dish cabinet following her left radial head fracture.

O: Cervical hot pack applied to anterior elbow for 20 minutes. Elbow positioned in extension with 1 lb cuff weight in place. No adverse skin effects noted upon removal. Treatment with radial head grade 3 a-p oscillations followed by AAROM into extension. Patient then perform Valpar 9 reaching/transfer task to improve forward reaching.

A: Elbow extension increased to -35 from -42. Continued functional reaching impairment noted.

P: Continue treatment plan with goal of -25 elbow extension to permit functional reaching.

**Fluidotherapy**

This agent is a fluidized tank that applies the principles of convection heating without the use of water. Cellulose particles are used as a medium for heat transference. The environment is considered self sterilizing and the technique can be used with open wounds and with orthopedic hardware. This intervention allows for the integration of movement with heating. This modality has been shown to produce mild edema therefore; caution should be used in the presence of edema.

Indications: Joint stiffness, Pain control and scar hypersensitivity.

Contraindications: Edema

A) Pre-heat the medium to the desired temperature. This is typically 102-116 degrees.

B) Select the appropriate portal and insert the extremity. Be sure to fully secure the sleeve to prevent spilling the medium.

C) Select the appropriate agitation speed. Higher speeds can used for more vigorous heating and for a greater desensitization effect. Lower speeds are used for hypersensitive regions.

D) Instruct on movement patterns to be used by the patient while in the tank.

E) Remove extremity from the tank carefully to ensure minimal spillage of the medium.
**Documentation Sample:**

S: Patient reports inability to perform perineal care following toileting due to wrist flexion and supination stiffness.

O: Fluidotherapy at 110 degrees using 50 CPS agitation for 20 minutes combined with wrist flexion/and forearm supination AAROM to address stiffness following a right distal radius fracture with ORIF. Patient performed hammer exercises for supination and these are incorporated into home program.

A: Resolving supination and wrist flexion stiffness. He continues to lack functional motion in these ranges.

P: Continue current treatment approach. Progress to strengthening exercises when permitted by pst-operative protocol (10 weeks post ORIF)

**Cryotherapy Interventions**

*Ice Massage*

This is the use of ice directly over the skin of an inflamed tendon. It is best used with superficial tendons that have little adipose tissue covering the tendon. As the ice is applied, the patient will initially be uncomfortable. This discomfort will last for 3-5 minutes until cold induced anesthesia is attained. The treatment should last for no more than 10 minutes to avoid the risk of thermal injury. Ice cups or popsicles are the standard application methods.

Indications: Local tendon inflammation

Contraindications: open skin lesions, cold intolerance/hypersensitivity issues.

A) Prepare the skin by washing and drying the area. Prepare the area with adequate toweling to absorb water produced by the melting ice.

B) Using moderate to firm pressure, apply the ice with small transverse strokes across the tendon proper or over the enthesis.

C) Continue for 5-10 minutes. The clinician should judge length of time for the application by patient tolerance and by the body part size and contour.

D) Follow with manual techniques or with exercise as indicated.

**Documentation Sample**

S: Patient reports inability to lift and position her child to dress or feed him due to left lateral elbow pain. Pain is rated 5/10 during activity and 0/10 at rest.
O: Dorsal forearm stretching exercises emphasizing wrist flexion and pronation performed. This was followed by isometric strengthening of the wrist extensors with the wrist in neutral for 3 minutes. Ice massage applied to the left lateral epicondyle followed exercise intervention. Education for activity modification to ensure supinated forearm during lifting was completed.

A: Patient demonstrated good comprehension of lifting technique. Pain post treatment is now 3/10 with activity.

P: Continue current plan and goals.

Cold Packs/Ice Bags

The main considerations in selection of a cold pack versus an ice pack are the contours of the surface it is being applied to and the aggressiveness of the cooling needed. Ice packs will always improve contouring of irregular surfaces and provide a more aggressive cooling intervention. If ice packs are used, insulation should be increased to prevent thermal injury. If ice is incorporated into a home exercise program, a slushie with alcohol can be made. The patient can place water and alcohol in a freezer bag at a 4:1 ration of water to alcohol and place this in their home freezer. This recreates the properties of a reusable ice pack in the home.

A) Wrap the commercial cold pack in a moist thin towel. The moisture will improve conductivity. Ice packs can be wrapped in a thin, dry towel to provide a layer of insulation. A pillow case is often used in the clinic setting.

B) Apply to the desired area for 10 minutes. Ensure that the pack is secure and that the patient is comfortable position. Use of cold for relaxation of increased muscle tone requires longer applications; therefore consider insulation needs for this purpose.

C) Ensure the patient is able to notify personnel if the intervention becomes painful. Educate the patient about possible thermal injury.

D) Inspect the skin to ensure no negative effects.

Documentation Sample

S: Patient reports increased left shoulder pain following his home exercise program.

O: Patient completed rotator cuff strengthening with red elastic tube today. Elastic band issued for HEP. Patient education in post exercise ice application completed.

A: Patient remains unable to reach to top shelf in cabinet without pain.

P: Continue per post-op sub acromial decompression protocol.
**Cold Compression Unit**

These units combine compression with cryotherapy to reduce post-operative or post exercise pain and edema. They come with a variety of sleeves for excellent conformity and the therapist must select the appropriate sleeve to ensure maximum effectiveness. These units can be used clinically or as part of a post surgical home program.

A) Select the appropriate sleeve for the part of the extremity that will be treated.

B) Cover the limb in a stockingnet. Ensure that there are no wrinkles in the stockingnet.

C) Wrap the sleeve in place and elevate the extremity.

D) Set the controls for the desire temperature time and compression. Compression settings are in MM of mercury.

E) Remove and inspect to ensure no adverse effects.

**Documentation Sample**

S: My shoulder feels very sore and swollen.

O: Patient is now 7 days post –op SLAP repair of the right shoulder. PROM was performed in all planes except horizontal adduction and internal rotation per protocol. Patient is unable to incorporate the lue into ADL due to post-op restrictions and precautions. Cold compression unit for pain control and edema reduction applied for 15 minutes at 55F @ 40 mm.

A: Functional PROM with good control of pain. Patient is ready to progress to active function next week per protocol.

P: Progression to AROM program next week. Continue cold compression unit following home PROM program.
Clinical Decision-making and Application: Thermal Agents

Clinical Decision-making

- Thermal agents should always augment treatment, not be the sole intervention.
- Evaluation of tissue status is paramount to appropriate selection of physical agents.
- Physical agent application should be documented appropriately.

Clinical Decision-making Heating

Indications
- Decreased collagen extensibility (Stiffness).
- Muscle spasm.
- Pain.
Contraindications to Heating

- **Insensate tissue!**
- **Edema!**
  - Circulatory deficiency/steroid dependency.
  - Areas prone to bleeding.

Paraffin

- Conductive heating.
- Mix with mineral oil 7:1 ratio wax to oil.
- Indications: pain reduction, joint stiffness.
- Specific contraindications: open wounds.

Paraffin

- Glove technique (mild heating)
- Heat and stretch technique
- Dip & re-immers (vigorous heating)
Paraffin

- Heat and stretch technique.
  - Coban flexion wrap.
  - LMB digital extensor splinting.
  - Serial cast application.

Paraffin Application
Glove Technique

Now stop and practice for the paraffin dip and glove technique, flexion wrapping and serial casting over paraffin for extension for 20 minutes. If you do not have the equipment to practice with at this time please review this segment to solidify your understanding of the material presented.
Hot Packs

• Conductive heating.
• 6-8 towel layers.
• Consider pack size and contour. Poor contour introduces air into the intervention.
• Precaution: weight bearing on the pack.

Heat and Stretch Technique
Now stop and practice for the hot pack demonstration for 15 minutes. If you do not have the equipment to practice with at this time please review this segment to solidify your understanding of the material presented.

Fluidotherapy

- Forced convection heating.
- Can vary temperature and particle agitation.
- Permits exercise in combination with heating.

Fluidotherapy

- Precautionary considerations
  - Edema
  - Scar sensitivity
- Advantages
  - Permits active exercise.
  - Provides desensitization.
  - Can be used with open wounds and orthopedic hardware. No cross contamination risk.
Now stop and practice for the Fluidotherapy 20 minutes. If you do not have the equipment to practice with at this time please review this segment to solidify your understanding of the material presented.

Cryotherapy

Indications
- Acute inflammatory states.
- Increased edema.
- Muscle spasm.

Indications
- Diminished mobility.
- Spasticity reduction.
- Myofascial trigger points.
Cryotherapeutic Methods

Ice massage

- Direct skin contact.
- Treatment duration is 5-10 minutes.
- Useful in small localized areas.
- Most appropriate for inflamed, superficial soft tissue structures.

Application Technique

Cold Packs

- Store at -5 C.
- Freeze for 30 prior to application.
- Moist towel interface.
- Consider conformity
Cryotherapy

- Sleeves improve contour.
- Decrease air in interface.
- Ease of use for patient.

Application Technique

Application Technique
Cryotherapeutic Methods

Ice Towels
• Immerse towel and place in freezer.
• Duration limited by tolerance.
• Improves conformity.

Application Technique

Ice Packs/Bags
• More aggressive than cold pack
• Needs increased insulation.
• Can be made at home.
  – 4:1 water to alcohol ration for home packs.
Now stop and practice the ice massage, ice application and cryocompression techniques for 20 minutes. If you do not have the equipment to practice with at this time please review this segment to solidify your understanding of the material presented.
Chapter 5: Clinical Decision making and Application: Thermal Agents:

1. Q: You mentioned careful documentation and I think you mentioned we want to heat under stretch. Since Medicare and other insurances will not reimburse for heat packs can adding a stretching exercise either hands on or with a tool, in your opinion, allow us to charge for the stretching or joint distraction portion?

A: You have asked a question with multiple answers. I would not charge a unit of treatment if the heat and stretch technique is passive with the use of a weight. If an agent is used and a manual technique is applied and or a PROM exercise is applied it is proper to bill for the procedure as long as it is done in context of the 8 minute rule and the rules for units charged within total treatment time. Another consideration is the use of paraffin stretching techniques. In this case, it is acceptable to bill an untimed charge for paraffin.

2. Q: Can you explain/demonstrate various examples of heat under stretch?

A: There are 2 basic techniques: one is to apply the stretch and then heat over the joint while it is under stretch. The second is to heat, apply a stretch with a wrap or a weight and then reapply the heat. See the following examples:

3. Q: What are your thoughts or your opinion in regards to home paraffin units that people purchase at the local merchant?
   a. Safety
   b. Investment/economics
   c. Ease of use

A: With a compliant patient that can follow all safety and treatment recommendations, they are an excellent option for long term problems.

4. Q: Many times therapists will recommend a microwavable heat pack/hot-mitt for home use for either acute problems or chronic like OA or RSD. What is your opinion for using microwavable heat packs and achieving therapeutic heat benefits?

A: My only concern with this method is the potential risk for burns through overheating in an uncontrolled situation. However, these interventions are typically safe and effective for pain and stiffness problems.

5. Q: In relation to the occupational frame model, why would you apply ice?

A: Ice can be used as a pretreatment or post treatment to enhance occupational performance. An example of pretreatment is the use of ice to reduce a muscle spasm allowing freedom of
movement for participation in an activity or ADL. A post treatment example is for pain control following playing tennis or golf.

6. Q: In reference to an ice pack --when the seam on the ice pack breaks and the substance leaks out.
   a. Would you put duck tape on and continue to use? Yes or no, why?

   A: Dispose of the pack. They are not cost prohibitive and it isn’t worth keeping the pack.

7. Q: When you discard/throw away a commercially purchased ice pack, can you throw them away in the garbage can or is there an environmental proper way? Are they environmental hazardous?

   A: The material inside most commercially available cold packs is considered a non-hazardous waste material suitable for solid waste disposal (landfills)
Chapter 6: The Biophysical Principles of Sound

Ultrasound as used in physical medicine refers to the use of high frequency sound waves to positively influence biological tissue. Ultrasound is sound that has a frequency of greater than 20,000 cycles per second. Being a sound wave, ultrasound in biological tissue is governed by basic principles of wave propagation.

Principles of Wave Propagation

Waves have a frequency of occurrence. In ultrasound, this is expressed in Hertz. The most commonly used ultrasound frequencies are 1 and 3.3 megahertz (MHz). The wavelength refers to the time in take to complete one cycle. Wavelength is a measure of the intensity of the individual cycle. See Fig 1.

Another principle of ultrasound wave propagation is that the ultrasound wave is not uniform. The wave has points of condensations and rarefactions. The condensations are areas of high pressure and the rarefactions are areas of low pressure in the wave and together they make up the ultrasound pressure wave. The rapidity of the cycle of condensations and rarefactions is expressed as the frequency. As is seen later, frequency controls the depth of penetration of the beam with lower frequencies penetrating more deeply than higher frequencies.

The ultrasound beam propagates in a linear fashion. As the wave is generated, two waves form: Longitudinal waves and transverse waves. A longitudinal wave is formed parallel to the propagated wave. The transverse wave is perpendicular to the propagated wave. This wave formation is potentially harmful to biological tissue. In soft tissues this wave is quickly dissipated as soft tissues act as a liquid. However, this type of wave is propagated is solids. Bone acts as a solid and this wave formation can be harmful to bone. Moving the ultrasound head will prevent the propagation of the transverse wave in bone. This principle is one of the underlying reasons to move the sound head during application.

Another type of wave to consider is the standing wave. This wave is formed by the imposition of a reflected wave onto a propagated wave creating a standing wave. See Figure 2. This is also avoided by moving the sound head during application.
Ultrasound Terminology

Intensity refers to the power or strength of the ultrasound beam. This is expressed in watts. The size of the transducer head is now considered since this is the size of the area producing the beam. The area of the transducer is expressed in CM2. To express intensity the setting W/cm2 is used.

The ultrasound beam is not a uniform beam. There are areas of high and low concentration. To express this concept the terms spatial peak intensity and spatial average intensity are used. The spatial peak intensity refers to the area of highest concentration of the beam from the transducer. The average intensity refers to the power of the beam averaged over the area of the transducer. The ratio of these two measures of intensity is called the BNR. This stands for the Beam Nonuniformity Ratio. This really is a measure of the transducers ability to create a more uniform beam. The lower this ratio, the more uniform the beam. Most ultrasound units have a BNR of 6:1 or less. The nonuniformity of the beam also must be considered in light of the transducer. The area that the beam is generated from is less than the transducer size. This is the Effective Radiating Area (ERA) of the transducer. This is always smaller than the transducer and is listed in the specifications of the unit.

In clinical settings ultrasound is applied using a continuous beam or the beam is interrupted over a given time period the beam. This refers to the settings for continuous wave or pulsed waves. If the continuous setting is used, the preceding paragraph accurately describes the amount and uniformity of the ultrasound energy applied to the tissue. However, if a pulsed setting is used, the energy applied to the tissue needs to be considered in light of the duty cycle. The duty cycle is the amount of time the beam is on in addition to the amount of time that the beam is off. Consider figure 3. Here the beam is on 20% of the time and off 80% of the time. This is descriptive of what is happening in a 20% pulsed wave setting.
Time now becomes another variable to consider. The expression temporal intensity is used to express the relationship of time to intensity. The spatial average temporal peak intensity (SATP) refers to the intensity during the on time. The spatial average temporal average intensity (SATA) refers to the average intensity of the on time and the off time. In continuous wave settings the peak intensity and the average intensity are the same. In pulsed wave settings the duty cycle is considered and the average intensity is reduced by the percentage of the on time. For figure 3 if a 1.0 W/cm² setting is used with the 20% duty cycle, the SATA is .2 W/cm². All clinical ultrasound machines use the SATP as the measure of intensity and have a separate setting for the duty cycle.

The next consideration is the amount of energy that is lost when an ultrasound beam is applied to biological tissues. There are three considerations: Scattering, Absorption and Attenuation.

Scattering refers to the reflection or the refraction of the beam as it comes in contact with a surface. Reflection is when the beam is redirected away from the contacting surface at an equal and opposite angle to the incident wave. This is seen in figure 4.

There is reflection of the ultrasound beam at tissue interfaces. This reflection is 100% when there is air in the interface between the transducer and the tissue. The coupling medium reduces the reflection to a negligible amount. There is however, significant reflection at the soft tissue/bone interface. The refracted wave occurs when the incident wave continues through the tissue interface at a different angle than the incident angle. This is seen in figure 5.
Absorption is the loss of the ultrasound energy through conversion of the mechanical energy to heat energy. Biological tissue absorbs ultrasound energy differently with the greatest amount of absorption being in the collagen based tissues such as tendon and cartilage.

Scattering and absorption lead to the third consideration which is attenuation. Attenuation is the decrease in ultrasound intensity as the beam travels through tissue. The half depth is the depth of the tissue at which the ultrasound beam has been reduced by 50%. Tissues with a high water and or high protein content have the least effect on attenuation.

Piezoelectricity

This is a property of a substance that causes the substance to change shape in response to an applied electrical current. The generation of ultrasound occurs through this action. In the transducer alternating current from the unit is applied to a piezoelectric crystal in the head of the transducer. The crystal will expand and contract whenever the alternating current reverses polarity. This expansion and contraction creates the condensations and rarefactions that create the ultrasound beam. Older ultrasound machines used single frequency crystals requiring different transducer heads for 1 and 3 MHz ultrasound. Modern ultrasound machines have composite crystals that can produce ultrasound with an acceptable BNR at multiple frequencies eliminating the need for multiple heads. Size of the treatment area and the ERA are the variables to consider when selecting head size.

Effects of Ultrasound

The absorption of ultrasound energy by tissue with a high absorption coefficient leads to the temperature elevation of those tissues. Therefore one of the main effects of ultrasound is to heat tissues at deeper levels than superficial heating agents. This is due to the lower absorption of ultrasound in skin, fat, muscle and blood and the high absorption at tendon, ligament, joint capsule and bone. Ultrasound has been demonstrated to heat tissue at levels of 2-5 cm deep and can be used selectively to heat deeper target tissues. The heating effects of ultrasound are no different than the heating effects from superficial agents. These include: increased collagen extensibility, alteration in blood flow, changes in nerve conduction, increased pain threshold and changes in the contractile activity of skeletal muscle. One consideration that the treating therapist must account for is the increase temperature rise that occurs with higher frequencies of ultrasound. The depth of penetration for 3 MHz ultrasound is considered to be a maximum of 2 cm. This is due to a greater amount of scattering and absorption due to the higher frequency of the beam. That absorption however, increases the tissue temperature more aggressively. Therefore, when treating with the 3 MHz setting, the corresponding intensity should be reduced by a factor of 3. For example, to attain the heating effect of a 2.0 w/cm² setting at 1 MHz using a 3 MHz setting the intensity should be reduced to .5 w/cm². Typically, 3 MHz ultrasound settings use an intensity of .5-.8 w/cm².

There are other effects noted with the application of ultrasound. These are considered non-thermal effects because they are seen in pulsed settings when the heating effect of the beam is negligible. Before reviewing these effects it is important to point out that these effects are also seen in thermal ultrasound applications. The first effect to discuss is cavitation. Cavitation is the creation of gas bubbles
by the ultrasound beam and their expansion and contraction. The contraction and expansion correspond with the condensations and rarefactions of the ultrasound beam. This action is said to be stable when the bubbles expand and contract without bursting. This effect can become unstable if the bubbles burst. When that occurs it is called unstable cavitation. Unstable cavitation leads to the release of free radicals and significant increases in tissue temperature with subsequent tissue damage. The intensity commonly used clinically for therapeutic ultrasound is believed to prevent unstable cavitation. Stable cavitation contributes to the effect of microstreaming. This is the movement of fluids around the vibrating gas bubble. Acoustic streaming is a larger effect that causes a movement of fluids along cell membranes. The actions have been implicated in increasing cell membrane permeability and to increase intracellular calcium. These effects will be fully discussed in the next section on clinical applications.
Biophysical Principles of Sound

Physical Principles of Sound

- Frequency (expressed in Hz)
- Sound velocity.
- Wavelength.

Condensations and Rarefactions
Wave Types

- Longitudinal waves.
- Transverse waves.
- Standing waves
Standing Waves

- Reflected waves that are superimposed on the incident wave.
- Causes cell stasis.
- Endothelial destruction.
  - Major reason for movement of the sound head.

Sound Intensity and Attenuation

- Intensity is energy per unit of time per unit of area of the sound head.
- Sound is scattered and absorbed by matter causing attenuation of the sound beam.

Intensity

- The rate of energy delivered per unit of area (W/CM²).
- Spatial average intensity.
- Temporal average intensity. (important in pulse wave settings)
Intensity

- Spatial average intensity-average intensity over the area of the transducer.
- Spatial peak intensity-strongest point in the beam.

BNR

- BNR (beam non-uniformity ratio) is the ratio representing the even distribution of the sound energy.
  - The ratio of the spatial peak intensity to the spatial average intensity.
  - Lower the BNR, the more even the distribution.
  - BNR should always be between 2:1 & 6:1.
Temporal Intensity

- Spatial average temporal peak intensity.
  - The average of the beam during the on time.

- Spatial average temporal average intensity.
  - The average intensity over both the ontime and the off time.

Scattering

- The diffuse reflection or refraction of US from irregular surfaces or in homogeneities within the tissues
  - Reflection: the reversal of the direction of propagation of the ultrasound wave
  - Refraction: the reflection of energy from a straight path when passing obliquely from one medium to another

Attenuation

- Absorption.
  - Generates heat.
  - Increased friction at higher frequencies.
  - Higher frequency=decreased depth of penetration/higher intensity of heat generation.
Exponential Attenuation

Quantity of Ultrasound (strength of waves being further propagated)

Tissue depth

The quantity of the ultrasound beam decreases as the depth of the medium (tissue) increases.

Attenuation

Tissue H2O content

Attenuation

Tissue protein content

Attenuation

Attenuation of 1 Mhz. US Beam.

- Blood: 3% / cm
- Fat: 13% / cm
- Muscle: 24% / cm
- Skin: 39% / cm
- Tendon: 59% / cm
- Cartilage: 68% / cm
- Bone: 96% / cm
The Piezoelectric Effect

- Direct effect: the generation of voltage across the face of a crystal when the crystal is compressed.
- Indirect effect: the contraction and expansion of a crystal in response to an applied voltage.
- Transduction: the conversion of one form of energy into another.

Biophysical Effects

- Thermal Effects:
  - Increased collagen extensibility.
  - Alteration in blood flow.
  - Changes in nerve conduction.
  - Increased pain threshold.
  - Changes in the contractile activity of skeletal muscle.
Ultrasound Absorption

Blood - Fat - Nerve - Muscle - Skin - Tendon - Cartilage - Bone

Increasing Absorption of Ultrasound Energy
(after Frizzel and Dunn 1982)

Non Thermal Effects

• Cavitation: the vibrational effect on gas bubbles from the ultrasound beam.

• Acoustic and micro streaming: the movement of fluids along the boundaries of the cell membrane.
  – Increased membrane permeability.
  – Stimulation of tissue repair.
Summary Points

• Thermal agents have neurological and musculoskeletal effects.

• Ultrasound can be used to produce thermal effects at a deeper tissue level.

Summary Points

• The ultrasound beam is produced by a piezoelectric effect.
• The beam is not uniform and uniformity is measured by the BNR of the machine.
• Ultrasound energy attenuates and is absorbed.

Summary Points

• The non-thermal effects of ultrasound are thought to be related to cavitation and microstreaming.
  – Cavitation is the contraction and expansion of gas bubbles.
  – Microstreaming is the movement of fluids along the cell membrane.
Evidenced Based

Ultrasound

Parameter Standardization

  - RCT evidence is of limited value due to the numbers of dosages that are available. RCT's by definition will be dose specific.
  - Main dosing variable seems to be frequency of application: Longer durations and daily application are consistent in papers demonstrating positive effects. PW appears to have more consistent positive effects than CW. No specific dosing is provided.
Wound Healing

• Fu et al (2010)
  – LIPUS promotes repair during the early phases (days 4, 14, 28) through increased expression of COL1A1 and COL1A3. These substances increase collagen synthesis.
  – LIPUS will suppress production of Decorin and Biglycan which are proteoglycans that regulate anchoring of collagen in the ECM. Repair weakens at 4 weeks

LIPUS
Low Intensity Pulsed Ultra Sound

Wound Healing

• Jeremias (2011)
• LIPUS leads to increased tensile strength in repaired tendon (Rat model)
• Bashardoust (2012)
  • LIPUS Leads to increase crossectional area of repaired tendons and increased tensile breaking strength.
Wound Healing:

- Ng (2003)
  - Standard clinical US at .5 w/cm² increases tendon breaking strength in rats. CW is superior to PW.

Wound Healing

Current Practice Principles

- Watson (2008)
  - Adding medication to gel is not supported when using phonophoresis. Administer the medication to the technique. Then use a PW setting to improve flow through cavitation and streaming.
  - US is transmitted through wound dressings. Hydrogel will allow US transmission.
Phonophoresis

Watson (2008) Continued

• Healing rates in Non Diabetic wounds and venous stasis wounds have increased healing rates when exposed to US.

• High protein content tissues absorb US the best, High water content tissue the worst, Therefore US is best used on ligament fascia, joint capsule and scar tissue.

Watson (2008) continued

• CW ultrasound has not been demonstrated to be consistently effective in raising tissue temperature above the 40 degree C mark for 5 min.

• CW and PW US cause temperature rise in tissue however; PW rise is minute.

• PW US:
  - US does NOT inhibit inflammation. It is stimulatory to mast cells and leucocytes and therefore is thought to facilitate an efficient inflammatory phase.


• Proliferative Phase:
  - Increased efficiency from fibroblasts, myofibroblasts and endothelial cells.
  - Increased angiogenesis has not been clearly demonstrated.

- Remodeling phase:
  - Assists with transition from type III to type 1 collagen.
  - Enhance longitudinal orientation of newly formed collagen fibrils.

Calibration/Infection control

- Yearly checking leaves up to 30% of US units out of calibration.
- Gel bottles can colonized opportunistic organisms such as staph.
- Dosing remains a careful clinical decision with no consistently proven desirable dosage.
Phonophoresis

  – CW and PW were superior to sham.
  – PW is superior to CW.
    • Mechanism for PW is speculated to be through cavitation as cavitation is noted to change the lipid bilayers of the stratum cornea.
    • CW through vasodilation.
Phonophoresis:

- Silceira et al (2010)
  - PW US (.8 W/cm² 50% PW @ 1 MHz for 6 min. 7 sessions over 5 days)
  - Only the phonophoresis group had presence of DMSO in tissues with decreased oxidative stress in muscle (rat model)

LIPUS for fracture healing

- Bashardoust et al (2012)
  - Moderate level evidence for management of fresh fractures with weak evidence for delayed and non-union situations.
  - Parameters: Trend is for lower intensities due to concern for tissue damage
Chapter 6: Biophysical Principles of sound:

1. Q: Can you please explain REFRACTION and give some examples or photos. Can you explain for dummies?

   A: This is answered in talking points chapter 6. Refer to figure 5 for clarity.

2. Q: Why do you call u/s a transition modality and why do you categorize portions of u/s into thermal category and some categorize as an electrical modality? Some think just because there is a cord that plugs into the wall it justifies it as an “electrical” modality. What are your thoughts?

   A: While U/S uses electricity to produce the sound wave due to the principle of piezoelectric crystals, it is not considered an electrical modality because the biophysiological effects are produced by sound not electrical currents. Another way to think of it is the way a fluidotherapy machine uses electricity to produce convection heating; the effects are from the heating not the electricity used to produce the heat.

3. Q: You mentioned that bone can be over heated. In reference to overheating the bone here are some questions:
   a. Can you damage the bone? If yes what type of damage? Is the damage permanent?
   b. If you realize you burnt the bone, what should the therapist do during that session and beyond?
   c. Would you document operator (therapists) malfunction? Or would this be per facilities policy and procedures and how one would deal with an incident report.

   A: Let’s answer these questions in reverse order. Causing a thermal injury with ultrasound is an adverse effect. This should ALWAYS be documented and this should be done within the policy and procedures outlined by the facility or company that employs the clinician. Any other action by the clinician is unethical.

   In regard to parts a & b the answers are yes bone can be burnt. This was shown in a study of rabbit femurs where osteocyte necrosis was noted for a depth of 1 cm and the damage progressed over a 28 day period. (1) The permanent effect cannot be determined as the subjects were euthanized for tissue assessment. The burning of bone however, will not occur in non-thermal (pulsed) interventions and will also not occur if the sound head is moved during thermal applications. A final consideration is that it is much more likely to overheat the periosteum. This presents as a deep, aching pain that would cause the patient to report symptoms.

4. Q: In reference to spatial peak intensity – does this mean if you have a DX of supraspinatus tendonitis vs. a PIPJ collateral ligament injury do you want to use 3mhz or does that not matter?

   A: The MHZ setting is irrelevant to spatial peak intensity. SPI refers to the uniformity of the beam and is related to discussions of BNR. Depth of target tissue is the variable that determines MHZ settings. Generally, if the tissue is less than 2 cm. deep, use 3 MHz, 2-5 cm. deep, 1 MHz.
5. **Q:** Does the size of the head matter when using it on a shoulder vs. PIPJ? Yes or No and why?

**A:** The transducer must be in contact with the coupling medium at all times. Therefore in considering head size the irregular nature of the treated surface must be considered as the first variable. If the surface is quite small, a larger head size can be used if the underwater method of coupling is employed. The next consideration is the size of the area to be treated. To determine the appropriate head size, the Effective Radiating Area (ERA) must be known. This area is always smaller than the transducer head size. The treatment area can generally be double the ERA.

a. Most clinics only have one size applicator. If it matters would you recommend purchasing a variety of applicator head sizes? If yes, what would you recommend in order of importance for a clinic that treats from heat to toe? Refer to talking points chapter 6. The section on piezoelectrical properties addresses this issue.

b. If you use a applicator that is not a pin-point (one that is 5cm diameter let’s say) and you are applying this 5cm diameter head to a PIPJ.

i. Would you crack the crystal with the portion of the applicator that is not in contact with the finger? If it were not in contact with coupling medium, it could potentially damage the crystal.

ii. How does a therapist know if the crystal in the head is damaged? Place the transducer in water and turn the machine on. There should be a visible wave formation if the transducer is producing an ultrasound beam.

iii. Do you have any tips or tricks for applying to small areas with a larger applicator? See chapter 7 of talking points and refer to the section on coupling.

6. **Q:** In reference to U/S you mentioned you want a low BNR. Why?

**A:** A lower BNR means a more uniform beam. The “hot spots” within the beam are more diffuse.

7. **Q:** If I have a BNR that is a higher BNR 6:1 vs. 2:1 --- does this mean I may not see the same clinical results?

**A:** Most U/S machines available in the United States have a BNR between 5:1 and 6:1 so it is unlikely that one would encounter a 2:1 BNR. However, even if one did it would not necessarily impact on clinical effectiveness. BNR is related more to safety concerns of over radiating one area and under radiating other areas. Movement of the sound head averages the intensity over the area treated making this the most effective method for dealing with variable BNR.

8. **Q:** In reference to pulsed U/S, does this make the u/s a thermal modality? Yes/ or no why?

**A:** Pulsing an ultrasound beam does not take away the thermal aspects of the beam. The amount of heat is reduced by the percentage of the duty cycle. Consider the following equation:

1 W/CM2 x’s 20% duty cycle = .2 W/CM2 intensity.

What this means is that a 20% pulsed wave setting delivers 80% less heat intensity that a continuous wave setting of the same intensity. So while there is always heat generated in an
ultrasound intervention, it is negligible in pulsed wave settings. 20% is recommended as it produces the most negligible heat effect.

9. Q: Can scattering be minimized by using a:  
   a. 3MHz vs. 1MHz  
   b. A small head over large head regardless of MHz?

A: Scattering cannot be “minimized”. It is a function of the frequency of the U/S beam and directly affects the depth of penetration of the beam. As previously stated, one should use 3 MHz for superficial target tissues and 1 MHz setting when target tissue is at a depth of greater than 2 cm.

10. Q: What does high absorption mean in regards to U/S?

A: Absorption refers to the energy lost to the tissue. Each structure in biological tissue has a different absorption potential for U/S energy. To influence the tissue, the energy must be able to be absorbed by that tissue. Collagen has a high absorption coefficient and skin/adipose tissue a low coefficient. Therefore the U/S beam will pass through skin and adipose tissue with little loss of energy and influence the deeper target tissues. Please refer to talking points chapter 6 for more information.

11. Q: When using light as a modality skin pigmentation is a consideration when considering the treatment dose. Does skin pigmentation matter when using u/s?

A: It doesn’t. Skin color or tattoos do not affect the transmission of U/S.

12. Q: Can you explain cavitation for dummies?

A: It is simply the expansion and contraction of gas bubbles that are created in the U/S field. Microstreaming is the eddying and movement of fluids around these bubbles. The cavitation is said to be stable is the bubbles do not burst and unstable if they do. Unstable cavitation is dangerous to soft tissues causing free radical release. Intensities used clinically in the United States should not produce unstable cavitation.

13. Q: You advocated not to use u/s if the patient/client has or had cancer less than 5 years. I have read and I have heard that if someone had cancer you can treat at a remote site.

   a. Example breast cancer you can treat the PIPJ
   b. Skin cancer on the nose you can use u/s on the CMCJ or Carpal canal

**QUESTION**: Is it your opinion based on being careful because of legal issues not to administer u/s on cancer patients as in the above scenarios? If no, can you provide any research to support NOT using u/s on clients that have or had cancer if using in a remote area?

A: This is a contraindication that is based on animal research not on opinion. Mouse tumors that were exposed to 1.0 w/cm2 CW U/S for 2 weeks demonstrated increase in the size and the weight of the tumors. Additionally, the treated mice developed increases in metastases in the lymph nodes. (2) Therefore it is not recommended that human tumors be exposed to U/S and the patient should be cancer free for 5 years before using this intervention.
14. Q: You mentioned to avoid treating children with u/s especially over the growth plate.
   a. What can happen to the growth plate?
   b. Would the adverse effects happen if therapists treated this area once or would you need to have a cumulative effect?

   A: This is a controversy in the literature with conflicting reports. Current recommendations are to avoid high dose ultrasound over the open epiphysis.
Chapter 7: The Clinical Applications of Ultrasound

Ultrasound has been shown to have different effects on tissue and cells at different phases of the wound healing process. The structure of this chapter is to review the effects that have been noted during each phases of wounding and repair and consider possible clinical approaches to enhances resolution of inflammation and promotion of tensile strength in healed wounds.

Inflammatory phase effects

In pulsed settings with low intensities, ultrasound has been shown to produce mast cell degranulation. Further, macrophage activity has been shown to increase, cell membrane permeability increases and there is an increase in chemotactic factors that influence the attraction of fibroblasts (probably as a result of the influence on the macrophage). The increased cell membrane permeability allows an increased influx of intracellular calcium. Calcium stimulates cellular activity resulting in increased protein synthesis.

Proliferative phase effects

Fibroblast in vivo that are subject to low intensity, pulsed wave ultrasound produce more collagen that those that do not receive ultrasound. This is due to increase protein synthesis seen in the treated fibroblasts. By increasing the effectiveness of fibroblastic activity more collagen is deposited thereby theoretically increasing wound tensile strength. The process of angiogenesis has also been shown to be accelerated by exposure to low intensity pulsed ultrasound.

Scar remodeling phase effects

Since collagen has a high ultrasound absorption coefficient, it can be selectively heated by ultrasound. In this phase collagen extensibility can be improved by using continuous wave ultrasound for a selective heating effect. This intervention is most effective when combined with exercise and or splinting program designed to remodel collagen in a lengthened position.

Therefore the following recommendations can be advanced:

Acute inflammatory conditions may be treated with pulsed wave ultrasound, generally using the 20% duty cycle setting. This is most likely to attain the cellular effects without significant heat generation. The generation of heat is not desired in this phase as it can possibly increase and prolong the inflammatory response.

Conditions of soft tissue restriction and spasm benefit from the thermal effects of ultrasound to increase collagen extensibility. The advantage of ultrasound is that is can target tissue more selectively and are different tissue depths than can be reached with superficial agents.
**Phonophoresis**

This is the use of ultrasound to enhance the effectiveness of transdermal drug delivery. In rehabilitation settings this generally applies to the use of topical corticosteroids to reduce inflammation in tissue both locally and through a systemic effect. Early theories of Phonophoresis called for a primary heating effect to the outer most layer of the skin called the stratum cornea. The application of thermal settings of ultrasound has been shown to create a heating effect in this aspect of skin tissue thereby increasing the permeability of this layer to the drug being delivered. The skin pores have been shown to increase suggesting this as a possible mechanism of diffusion through the stratum cornea. However, recent work has shown that cavitation may also contribute to this process and that the non-thermal effects of ultrasound may be in play. Comparative studies of heating agents and ultrasound demonstrated that heating agents and ultrasound increased the amount of medication diffused from a non-enhanced model of transdermal delivery. However, the ultrasound group had the highest concentration of the drug; therefore it is reasonable to believe that the non-thermal effects of ultrasound played a role in drug diffusion. Further studies have shown that higher frequencies of ultrasound for short durations are as effective as lower frequencies applied for longer durations. The final consideration is the well documented effect that occurs when using a drug in an emollient base such as 10% hydrocortisone in a cream base. Topical applications such as these have been shown to prevent the transmission of ultrasound through the skin interface resulting in absorption and reflection of the ultrasound beam. The salient point is that the medication used should be formulated in such a way that the transmission of ultrasound will occur readily through the skin to allow penetration to enhance the transdermal delivery effect. Settings suggested are 3 Hz CW ultrasound when a heating effect can be tolerated in addition to the non-thermal effect, however, if an acute inflammatory condition were to be the indication, a 20% pulsed setting would still enhance drug delivery but not facilitate the inflammatory response through heating.

As in other systems of transdermal drug delivery, the therapist must carefully consider the effect of the drug being administered and the possible systemic side effects of that medication. As previously stated, the most common rehabilitation application has been with the use of corticosteroids. Delivery of these medications has been shown to increase blood sugar levels therefore; this should be considered when using this intervention with diabetic patients. Further, the therapist should refrain from using corticosteroids if the patient is already using the class of medication for another condition.

**Coupling**

Coupling refers to the use of a medium at the skin-transducer interface to prevent the introduction of air into the interface. There are 2 basic types of coupling direct and indirect. In direct coupling a gel or lotion is used to the skin directly and the transducer is applied directly to the medium. This will work quite well for larger, more regular areas. However, small, irregular areas or hypersensitive areas may result in poor direct coupling. In these cases an indirect method under water is used. The body part is immersed in a plastic basin and transducer is directed toward the area to be treated.
When considering coupling, the therapist must also consider matching the transducer size to the area being treated. The ERA is useful here. The ERA should be ½ the size of the area being treated. Therefore if a 5 cm transducer has an ERA of 4 cm the area of treatment should be in the range of 8 cm.

**Suggested Clinical Applications and Parameter Selection**

Treatment planning when using ultrasound requires answering a number of questions then considering those answers in relationship to the goal of the intervention. To determine dosage consider the following:

1) What is the nature of the clinical condition? Is it stiffness, tissue healing etc?
2) What is the target tissue and what is the depth of that tissue?
3) What is the status of the intervening tissues?
4) What is the size of the area being treated?
5) How long do I treat for (duration)?

The nature of the condition determines the duty cycle. If the condition calls for a thermal effect to selected tissues, the continuous wave setting should be used. If the condition is potentially harmed by a heating effect, the pulsed setting should be used to minimize the heating effect.

The depth of the target tissue will determine the frequency setting. Tissue that is at a depth of greater than 2 cm should be treated with a 1 MHz setting where as tissue that is more superficial requires a 3 MHz setting. The clinician should be mindful that 3 MHz settings will cause more superficial heat absorption therefore settings should be reduced by a factor of 3.

The status of the intervening tissue helps the clinician determine the coupling medium to be used.

The ERA is considered when selecting the transducer size in relationship to the area of the body being treated.

The duration is generally less for higher frequency and or higher intensity applications and longer for lower frequency, lower intensity applications. The variables to consider are the ERA, the size of the area treated and the goal of the treatment. Generally, clinical treatment durations range from 5-10 minutes for upper extremity applications.

Suggested clinical applications for continuous wave ultrasound intervention include:

1) Stiffness and soft tissue shortening.
2) Pain reduction.
3) Chronic tendon inflammation/tendinosis.
4) Promotion of tendon healing.
5) Phonophoresis for non-inflammatory conditions

Suggested clinical applications for pulsed wave ultrasound intervention include:

1) Acute tendon inflammation.
2) Phonophoresis for acute inflammatory conditions.
3) Fracture healing (FDA approved units only with fixed settings)

**Precautions and Contraindications for the Use of Ultrasound in Physical Medicine Settings**

Contraindications:

1) Joint replacements that are cemented or contain plastic components.
2) Malignancies. Recommend interval is that the patient be cancer free for a period of 5 years before use of ultrasound on the affected limb. Caution must be paid to the possibility of metastatic cells therefore avoidance of the lymph nodes is recommended.
3) Infections.
4) Over the eyes.
5) Over the pregnant uterus.
6) Patients with demand type pacemakers.
7) Patients with thrombophlebitis.

Precautions:

1) Insensate areas/Charcot joints. Burn risk is significantly higher with diminished sensation. The therapist must also be aware of the report of aching pain during application. This is a sign of a possible burn of the periosteum. The intensity should be reduced or the treatment discontinued.
2) Over epiphyseal plates. This is a controversy in the literature with conflicting reports. Current recommendations are to avoid high dose ultrasound over the open epiphysis.

Documentation Sample:

The dosage should be clearly documented for replication and clarity if treatment delivered. The following expression is an example: ultrasound @ 1.0 w/cm² CW @ 1 MHz applied to the anterior capsule of the right elbow for 6 minutes to increase elbow extension. In this sample all the parameters are documented. Now consider this in context of a SOAP note:

S: my elbow is stiffer today; I cannot reach into my kitchen cabinet.

O: Passive elbow extension is 55 degree prior to treatment today. Patient pre-treated with US. @ 1.0w/cm² CW @ 1 MHz for 6 min. to the anterior capsule. This was followed by soft tissue mobilization of the anterior elbow; contract/relax exercises, AAROM into extension and a cone stacking reaching activity to facilitate elbow extension.

A: Post treatment elbow extension is 42 degrees with no loss of flexion. Intervention effective in increasing active extension however, patient continues to lack necessary extension for reaching.

Plan: Continue current treatment approach.
TRANSDERMAL Medication

Adverse reactions and severe side effects are minimal and rare when delivering medications via transdermal phonophretic transmission. However, it is important and required to know every drug, solution, or medication for patient safety. If your patients ever report unusual side effects always follow your clinic protocol. In addition, always investigate to find an answer to any concerns a patient may have relating to transdermal drug delivery. A few sources to contact may be a pharmacist, physician, manufacture, your supervisor, FDA website. Never take complaints or comments lightly and it is the law to know how a modality works and interacts. All agents must be stored in a lock-box and the key must be kept in a separate location.

Corticosteroid; Hydrocortisone Cream:

The topical steroids constitute a class of primarily synthetic steroids used as anti-inflammatory and antipruritic agents. Hydrocortisone is a member of this class. Hydrocortisone has the chemical name Pregn-4-ene-3,20-dione, 11,17,21-tri hydroxy-, (11β)−. Its molecular formula is C_{21}H_{30}O_5 and molecular

![Molecular structure of Hydrocortisone]

Hydrocortisone Cream USP, 1% (Each gram contains 10 mg of Hydrocortisone); 2.5% (Each gram contains 25 mg of Hydrocortisone); in a base containing purified water, propylene glycol, propylene glycol monostearate, mineral oil and lanolin alcohol, isopropyl palmitate, polysorbate 60, cetyl alcohol, sorbitan monostearate, polyoxyl 40 stearate, sorbic acid, methylparaben and propylparabe

Topical corticosteroids share anti-inflammatory, antipruritic and vasoconstrictive actions.

The mechanism of anti-inflammatory activity of topical corticosteroids is unclear. Various laboratory methods, including vasoconstrictor assays, are used to compare and predict potencies and/or clinical efficacies of the topical
corticosteroids. There is some evidence to suggest that a recognizable correlation exists between vasoconstrictor potency and therapeutic efficacy in man.

The extent of percutaneous absorption of topical corticosteroids is determined by many factors including the vehicle, the integrity of the epidermal barrier, and the use of occlusive dressings. Topical corticosteroids can be absorbed from normal intact skin. Inflammation and/or other disease processes in the skin increase percutaneous absorption.

Occlusive dressings substantially increase the percutaneous absorption of topical corticosteroids. Thus, occlusive dressings may be a valuable therapeutic adjunct for treatment of resistant dermatoses.

Once absorbed through the skin, topical corticosteroids are handled through pharmacokinetic pathways similar to systemically administered corticosteroids. Corticosteroids are bound to plasma proteins in varying degrees. Corticosteroids are metabolized primarily in the liver and are then excreted by the kidneys. Some of the topical corticosteroids and their metabolites are also excreted into the bile.

- Hydrocortisone topical will not treat a bacterial, fungal, or viral skin infection.

**Contraindications**

Topical corticosteroids are contraindicated in those patients with a history of hypersensitivity to any of the components of the preparation.

- Do not use this medication if you are allergic to hydrocortisone.

**Precautions**

**General**

- Increase blood sugar levels therefore consideration is indicated when administering to diabetic patients
• If using this class of medication for another condition verify with patient and referring physician that all are aware of the situation
• Systemic absorption of topical corticosteroids has produced reversible hypothalamic–pituitary–adrenal (HPA) axis suppression, manifestations of Cushing's syndrome, hyperglycemia, and glucosuria in some patients.
• Conditions which augment systemic absorption include the application of the more potent steroids, use over large surface areas, prolonged use, and the addition of occlusive dressings.
• Therefore, patients receiving a large dose of a potent topical steroid applied to a large surface area or under an occlusive dressing should be evaluated periodically for evidence of HPA axis suppression by using the urinary free cortisol and ACTH stimulation tests. If HPA axis suppression is noted, an attempt should be made to withdraw the drug, to reduce the frequency of application, or to substitute a less potent steroid.
• **Recovery of HPA axis function** is generally prompt and complete upon discontinuation of the drug. Infrequently, signs and symptoms of steroid withdrawal may occur, requiring supplemental systemic corticosteroids.
  o The following tests may be helpful in evaluating the HPA axis suppression
    ▪ Urinary free cortisol test
    ▪ ACTH stimulation test
• **Children** may absorb proportionally larger amounts of topical corticosteroids and thus be more susceptible to systemic toxicity.
  o Only treat children with the approval from the referring physician only. If your facility has a policy not to treat children with medication in the OT/PT department call the referring physician and discuss your policy and refer pediatric patient back to the physician.
  o Parents of pediatric patients should be advised not to use tight-fitting diapers or plastic pants on a child being treated in the diaper area, as these garments may constitute occlusive dressings.
  o Pediatric patients may demonstrate greater susceptibility to topical corticosteroid–induced HPA axis suppression and Cushing's syndrome than mature patients because of a larger skin surface area to body weight ratio.
- Hypothalamic–pituitary–adrenal (HPA) axis suppression, Cushing's syndrome, and intracranial hypertension have been reported in pediatric patients receiving topical corticosteroids.
- Manifestations of adrenal suppression in pediatric patients include linear growth retardation, delayed weight gain, low plasma cortisol levels, and absence of response to ACTH stimulation. Manifestations of intracranial hypertension include bulging fontanelles, headaches, and bilateral papilledema.
- Administration of topical corticosteroids to pediatric patients should be limited to the least amount compatible with an effective therapeutic regimen. Chronic corticosteroid therapy may interfere with the growth and development of pediatric patients.

- If irritation develops, topical corticosteroids should be discontinued and appropriate therapy instituted.
- In the presence of dermatological infections, the use of an appropriate antifungal or antibacterial agent should be instituted. If a favorable response does not occur promptly, the corticosteroid should be discontinued until the infection has been adequately controlled.
- FDA pregnancy category C. This medication may be harmful to an unborn baby. Tell your doctor if you are pregnant or plan to become pregnant during treatment. It is not known whether hydrocortisone topical passes into breast milk or if it could harm a nursing baby. Do not use this medication without telling your doctor if you are breast-feeding a baby. Do not use this medication on a child without a doctor's advice. Children are more sensitive to the effects of hydrocortisone topical.
  - Corticosteroids are generally teratogenic in laboratory animals when administered systemically at relatively low dosage levels. The more potent corticosteroids have been shown to be teratogenic after dermal application in laboratory animals. There are no adequate and well-controlled studies in pregnant women on teratogenic effects from topically applied corticosteroids.
Therefore, topical corticosteroids should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. Drugs of this class should not be used extensively on pregnant patients, in large amounts, or for prolonged periods of time.

- It is not known whether topical administration of corticosteroids could result in sufficient systemic absorption to produce detectable quantities in breast milk. Systemically administered corticosteroids are secreted into breast milk in quantities not likely to have a deleterious effect on the infant. Nevertheless, caution should be exercised when topical corticosteroids are administered to a nursing woman.

- Wash hands before and after each application, unless you are using hydrocortisone topical to treat a hand condition.
- Avoid using this medication on your face, near your eyes or mouth, or on body areas where you have skin folds or thin skin.
- Do not cover treated skin areas with a bandage or other covering unless the prescribing doctor agrees. If you are treating the diaper area of a baby, do not use plastic pants or tight-fitting diapers. Covering the skin that is treated with hydrocortisone topical can increase the amount of the drug your skin absorbs, which may lead to unwanted side effects.
- Follow the referring physician’s prescription and the pharmacist’s label.
- It is important to use hydrocortisone topical regularly to get the most benefit.
- Store hydrocortisone topical at room temperature away from moisture and heat.
- Avoid getting this medication in eyes, mouth, and nose, or lips. If it does get into any of these areas, wash with water. Do not use hydrocortisone topical on sunburned, windburned, irritated, or broken skin. Also avoid using this medication in open wounds.
- Avoid using skin products that can cause irritation, such as harsh soaps or shampoos or skin cleansers, hair coloring or permanent chemicals, hair removers or waxes, or skin products with alcohol, spices, astringents, or lime. Do not use other medicated skin products unless you have discussed with the referring physician and/or pharmacists
Cortisone - Hydrocortisone Topical Side Effects

Hydrocortisone may cause local irritation at the site of administration. Allergic reactions are rare but may result in rash, itching, swelling, and trouble breathing. Hydrocortisone should not be used by patients with hypersensitivity to Corticosteroids. Long-term use of Hydrocortisone can result in suppression of the adrenal glands, which may lead to catabolism of muscle, tendon, bone, and other collagenous parts of the body. Corticosteroids have the potential to raise blood glucose levels. Using a topical formulation decreases systemic absorption and should result in less side effects. Due to the way topical corticosteroids reduce inflammation, they may potentially suppress the HPA axis.

When using phonophoresis at higher frequency wavelengths, tissue damage can occur. If a patient experiences muscle weakness, slowed wound healing, thin, fragile skin, unusual bruising, red or purple spots or patches under the skin, hives, rash suppressed reactions to skin tests, he or she should tell his or her doctor or pharmacist.

- Signs of an allergic reaction: hives; difficulty breathing; swelling of your face, lips, tongue, or throat.
- Stop using hydrocortisone topical and call the referring physician and/or emergency room if your patient notices any of these serious side effects:

  It is a good idea to educate your patients of possible side effects and inform them of your facility protocol if any are noted:
  - blurred vision, or seeing halos around lights;
  - uneven heartbeats;
  - sleep problems (insomnia);
  - weight gain, puffiness in your face; or
  - feeling tired.

Less serious side effects may include:

  - skin redness, burning, itching, or peeling;
  - thinning of your skin;
  - blistering skin; or
  - stretch marks.
Here is another presentation of the adverse effects for your quick reference:

**Adverse Reactions**

The following local adverse reactions are reported infrequently with topical corticosteroids, but may occur more frequently with the use of occlusive dressings. These reactions are listed in an approximate decreasing order of occurrence:

<table>
<thead>
<tr>
<th>Burning</th>
<th>Hypertrichosis</th>
<th>Maceration of the skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Itching</td>
<td>Acneiform eruptions</td>
<td>Secondary infection</td>
</tr>
<tr>
<td>Irritation</td>
<td>Hypopigmentation</td>
<td>Skin Atrophy</td>
</tr>
<tr>
<td>Dryness</td>
<td>Perioral dermatitis</td>
<td>Striae</td>
</tr>
<tr>
<td>Folliculitis</td>
<td>Allergic contact dermatitis</td>
<td>Miliaria</td>
</tr>
</tbody>
</table>

**What other drugs will affect hydrocortisone topical?**

It is not likely that other drugs taken orally or injected will have an effect on topically applied hydrocortisone. But many drugs can interact with each other. You have received a prescription from the referring physician to administer this drug via transdermal delivery and most likely the physician has completed an appropriate drug interaction evaluation. However, for your safety purposes you should always ask about your patient’s prescriptions and it would be highly recommend before administering any medication that you perform an oral and documented evaluation you ensure your patient has informed their doctor of all of their medications including all over–the–counter medications, vitamins, minerals, herbal products, and drugs prescribed by other doctors.
Carcinogenesis, Mutagenesis, and Impairment of Fertility

Long-term animal studies have not been performed to evaluate the carcinogenic potential or the effect on fertility of topical corticosteroids. Studies to determine mutagenicity with prednisolone and hydrocortisone have revealed negative results.

Overdosage

Topically applied corticosteroids can be absorbed in sufficient amounts to produce systemic effects (see PRECAUTIONS).

Hydrocortisone Cream Dosage and Administration

Topical corticosteroids are generally applied to the affected area as a thin film from two to four times daily depending on the severity of the condition. Occlusive dressings may be used for the management of psoriasis or recalcitrant conditions. If an infection develops, the use of occlusive dressings should be discontinued and appropriate antimicrobial therapy instituted.

How is Hydrocortisone Cream Supplied

Hydrocortisone Cream USP, 1% in 28.35 g tubes NDC 51672–3004–2
Hydrocortisone Cream USP, 2.5% in 20 g tubes NDC 51672–3003–0 28.35 g tubes NDC 51672–3003–2
Store at 20°–25°C (68°–77°F)[see USP Controlled Room Temperature]. Protect from freezing.
Dispense in tight containers, as specified in the USP.
Mfd. by: Taro Pharmaceuticals Inc., Brampton, Ontario, Canada L6T 1C1
Dist. by: Taro Pharmaceuticals U.S.A., Inc., Hawthorne, NY 10532
Revised: September 2004   PK-4245-1   0904-1 134
<table>
<thead>
<tr>
<th>Product Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Type</strong></td>
</tr>
<tr>
<td><strong>Route of Administration</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INGREDIENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name (Active Moiety)</strong></td>
</tr>
<tr>
<td>Hydrocortisone (Hydrocortisone)</td>
</tr>
<tr>
<td>water</td>
</tr>
<tr>
<td>propylene glycol</td>
</tr>
<tr>
<td>propylene glycol monostearate</td>
</tr>
<tr>
<td>mineral oil</td>
</tr>
<tr>
<td>lanolin alcohol</td>
</tr>
<tr>
<td>isopropyl palmitate</td>
</tr>
<tr>
<td>Ingredient</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>polysorbate 60</td>
</tr>
<tr>
<td>cetyl alcohol</td>
</tr>
<tr>
<td>sorbitan monostearate</td>
</tr>
<tr>
<td>polyoxyl 40 stearate</td>
</tr>
<tr>
<td>sorbic acid</td>
</tr>
<tr>
<td>methylparaben</td>
</tr>
<tr>
<td>propylparaben</td>
</tr>
</tbody>
</table>

### Packaging

<table>
<thead>
<tr>
<th>#</th>
<th>NDC</th>
<th>Package Description</th>
<th>Multilevel Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>51672-3004-2</td>
<td>1 TUBE In 1 CARTON</td>
<td>contains a TUBE</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>28.35 g (GRAM) In 1 TUBE</td>
<td>This package is contained within the CARTON (51672-3004-2)</td>
</tr>
</tbody>
</table>
# hydrocortisone cream

## Product Information

<table>
<thead>
<tr>
<th>Product Type</th>
<th>HUMAN PRESCRIPTION DRUG</th>
<th>NDC Product Code (Source)</th>
<th>51672-3003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route of Administration</td>
<td>TOPICAL</td>
<td>DEA Schedule</td>
<td></td>
</tr>
</tbody>
</table>

## INGREDIENTS

<table>
<thead>
<tr>
<th>Name (Active Moiety)</th>
<th>Type</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocortisone (Hydrocortisone)</td>
<td>Active</td>
<td>25 MILLIGRAM In 1 GRAM</td>
</tr>
<tr>
<td>water</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>propylene glycol</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>propylene glycol monostearate</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>mineral oil</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>Ingredient</td>
<td>Status</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>lanolin alcohol</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>isopropyl palmitate</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>polysorbate 60</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>cetyl alcohol</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>sorbitan monostearate</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>polyoxyl 40 stearate</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>sorbic acid</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>methylparaben</td>
<td>Inactive</td>
<td></td>
</tr>
<tr>
<td>propylparaben</td>
<td>Inactive</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Product Characteristics</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Color</strong></td>
<td>Score</td>
<td></td>
</tr>
<tr>
<td><strong>Shape</strong></td>
<td>Size</td>
<td></td>
</tr>
<tr>
<td>#</td>
<td>NDC</td>
<td>Package Description</td>
</tr>
<tr>
<td>---</td>
<td>-----------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>51672-3003-0</td>
<td>1 TUBE In 1 CARTON</td>
</tr>
<tr>
<td>1</td>
<td>51672-3003-2</td>
<td>20 g (GRAM) In 1 TUBE</td>
</tr>
<tr>
<td>2</td>
<td>51672-3003-0</td>
<td>1 TUBE In 1 CARTON</td>
</tr>
<tr>
<td>2</td>
<td>51672-3003-2</td>
<td>28.35 g (GRAM) In 1 TUBE</td>
</tr>
</tbody>
</table>

*Contains*
Clinical Application of Ultrasound

Ultrasound Effects on Wound Healing

Inflammatory Phase
- Mast cell degranulation.
- Reduction of macrophage produced growth factors.
- Increase cell membrane permeability.

Proliferative Phase
- Increased collagen synthesis.
- Increased wound tensile strength.
- Increased angiogenesis.

Effects are attributed to pressure wave phenomena, not as a result of thermal energy.
Ultrasound Effects on Wound Healing
Scar Remodeling
• Energy absorption is high in collagen tissue.
• Can improve the extensibility of maturing collagen.
• Cumulative effect with exercise programs.

Clinical Applications
• Acute inflammatory conditions:
  – True tendonitis.
  – Crushing injuries with significant edema.
  – Painful neuroma.
• Pulse wave ultrasound for non-thermal effects.

Clinical Applications
• Conditions of decreased mobility and pain.
  – Joint contracture (i.e. Adhesive capsulitis)
  – Hypertrophic or immobile scar.
  – Muscle spasm.
  – Trigger point release.
• Use continuous wave ultrasound for thermal effects at a deeper tissue level.
Clinical Application

Phonophoresis

• The use of ultrasound to assist transdermal drug delivery.

• Effectiveness is controversial but the technique remains widely used.

Phonophoresis

• Medications used:
  – Anti-inflammatory drugs.
  – Salicylates.
  – Analgesics.

Phonophoresis

Techniques to Increase Effectiveness.

• Select agents that transmit ultrasound energy.
• Keep skin well hydrated.
• Pre-treat through heating or shaving.
• Use C.W. setting.
• Use post treatment occlusive.
Principles of Treatment

Coupling

• Direct Coupling.

• Indirect coupling.

• Water bag technique.
Principles of Treatment

Dosage

• Determine:
  – Type of lesion.
  – Target tissue.
  – Depth of tissue.
  – Size of area to be treated.

Principles of Treatment

Patient Positioning

• Essential to correct administration of treatment.

• Position must expose target tissue.

• Ensure patient comfort.
Principles of Treatment

General Guidelines

- Use the lowest intensity possible to obtain the desired effect.
- Select the head size to match the area to be treated.
- Select pulsed or continuous modes by wound healing stage and desired effect.
Putting it Together!

• Case example
  – 32 y/o right handed female S/P TF releases of IF and MF with subsequent flexion contractures of PIPJ of both digits.
Principles of Treatment

General Guidelines (continued)

- Select frequency by depth of target tissue.

- Select intensity and duration by the size and depth of the tissue to be treated.
Precautions and Contraindications

- Aching pain during treatment: Reduce Intensity!
- Infections.
- Malignancies.
- Osteoporosis.
- Demand pacemakers.

Precautions and Contraindications

- Pregnant uterus.
- Thrombophlebitis.
- Insensate tissue.
- Charcot joints.
- Epiphyseal areas.
Chapter 7: Clinical application of Ultra-sound:

1. Q: Can you use ice or heat prior or post u/s and or phonophoresis?
   A: Comparative studies of heating agents and ultrasound demonstrated that heating agents and ultrasound increased the amount of medication diffused from a non-enhanced model of transdermal delivery. However, the ultrasound group had the highest concentration of the drug; therefore it is reasonable to believe that the non-thermal effects of ultrasound played a role in drug diffusion. Since the heating agents also increased diffusion they could be employed to enhance delivery (3) by pre treating with a moist heat pack.

2. Q: How do you hydrate the skin before phonophoresis?
   A: Typically with a moist heat pack.

3. Q: I have heard that the white based creams do not allow good delivery of the drug? Have you heard this?
   a. If the answer is yes, how would you approach the referring physician if he/she prescribes hydrocortisone in a white based cream?
   A: The issue here is the selection of a drug medium that will allow the transmission of Ultrasound. This was researched by Cameron (4) and she demonstrated that cream based hydrocortisone cream absorbed ultrasound energy and did not permit transmission through to the skin. Most compounding pharmacies are aware of this and are now compounding these medications in an aqueous base.

4. Q: Do you have physicians that refer for phonophoresis using hydrocortisone?
   A: Yes. I use 10% compounded in a gel base.

5. Q: Have you heard any issues relating to PT/OTs administering drugs such as Dexamethasone via the iontophoresor or phonophoreor method?
   A: The FDA has not commented on physical medicine professionals administering iontophoretic or phonophoretic treatment. There are individual state issues that have appeared recently. All professionals are governed by their state’s individual practice act and it is the responsibility of the clinician to be aware of any controversies within their own state.

6. Q: You mentioned to use the lowest intensity possible to obtain the desired effect?
   a. How do you choose the lowest possible intensity?
   b. How do you know if you are achieving the desired effects?
   c. When do you determine you adjust your settings or discontinue the modality (u/s) as it is not achieving the desired results?
   A: The question really refers to how one selects appropriate parameters for treatment and then how does one determine effectiveness or ineffectiveness of treatment? Intensity selection is a function of the size of the area to be treated, the goals of the treatment and
the depth of the target tissue. The area size is generally twice the ERA of the transducer. The frequency is determined by the depth of the target tissue and the intensity is determined by the goals of treatment. Generally, lower intensities are used for higher frequencies (.5-.8 w/cm2) and higher intensities are used for lower frequencies (1.2-2.0 w/cm2). Duration is a function of frequency where high frequencies require lower durations and lower frequencies require longer durations. If the goals are thermal effects, the patient should feel a mild warmth during the treatment and this will be an indication to you that you are achieving your desired effect.

As to when to discontinue, that is a more difficult question to answer with certainty. Generally, I treat for 4-6 sessions before determining if I need to change parameters or discontinue the treatment altogether. Of course, if there are any negative effects, I would discontinue treatment immediately.

References for FAQ

Case Study #1
N.R. is a 43-year-old right dominant male who fell running for a train and landed on his right elbow four weeks ago. He sustained a right radial head fracture which was treated with ORIF of the fracture with the placement of a lag screw. There was no fracture of the olecranon. The patient reports no significant past medical history.

He now presents to you for AROM exercises. On evaluation you note that AROM is 45-100 extension to flexion and supination/pronation is 45-80. There is only minimal edema but there continues to be pain at the fracture site to palpation.

What are the precautions for this patient?

What are the potential complications that can develop with fractures of the elbow? What structure or structures are causing the patient's limited motion?

Formulate the treatment plan. Include selection of thermal agents and the rationale for their selection.
Case Study #2

J.Y. is a 34 y/o right dominant female. She is referred to you with a diagnosis of right thumb pain. She reports a gradual onset which has progressed to severe pain. In her history, she reports that she has a 2-month-old child at home and no significant past medical history.

You have completed your evaluation and feel she has acute DeQuervain’s tendonitis with tendon crepitation.

Treatment Planning Questions

1. What thermal agent would you recommend for this patient and what is the rationale for your choice?

2. Are there splinting needs for this patient? If so what are the options?

3. What activity needs to be modified to facilitate the resolution of her problem?
Patient/Family Education Guidelines
For the Use of Physical Agent Modalities

**Superficial Heating Agents**

**Purpose:**

Heating agents have been recommended for you or your family member to reduce stiffness and pain while you attempt to regain movement. These agents have both risks and benefits and this guideline will outline each for you.

**Benefits:** The benefits of heating agents are that they improve movement and decrease pain in stiff joints.

**Risks:** The most common risk is skin burns. Most of these burns are quite superficial however; if you or your family member have decreased sensation due to previous injuries or diabetes there is a significant risk of deep tissue damage. Proper application of the agent will prevent any skin issues. Other conditions that increase burn risk include: circulatory deficiencies, steroid dependent people and people with thin, friable skin.

Patients with thrombophlebitis and acute inflammatory conditions should not use heating agents.

The following agents may be used at home:

**Paraffin baths:** These can be purchased at most home retailers or through professional catalogues.

Application: Wash body part prior to use. Dip and remove the body part into the wax. Allow the body part to stop dripping. Repeat 7-10 times. Wrap in plastic and then in toweling. Leave wax in place for 10 minutes. Remove the wax and replace it into the bath.

**Hot Packs:** A special consideration for hot packs is to avoid lying on the pack. This increases the chance of getting a burn.

Application: Wrap the pack in the appropriate layers of toweling. 6-8 towel layers is the most recommended number. More or less may be needed. It is recommended that treatment begins with excessive layers to guard against burns. Secure the pack adequately so that there is maximum conformity. You must remove the pack and add more towels if the pack becomes too hot. Apply for 20 min.
**Cold Agents**

Purpose: Cold agents have been recommended for you or your family member to reduce inflammation and decrease pain following your injury. These agents have both risks and benefits and this guideline will outline each for you.

Benefits: Cold agents are helpful in controlling pain, inflammation and assists with reduction of swelling.

Risks: The most common risk is cold insensitivity. The typical response is local and seen only at the site of the application. If you notice a raised patch of skin that is white or a deep red color in addition to the raised skin, discontinue the application and re warm the skin. Itching may develop during rewarming. Other symptoms of cold insensitivity include itching, increased pain and muscle spasms.

The following agents can be applied at home:

**Ice Massage**

This is the use of ice directly over the skin of an inflamed tendon. As the ice is applied, you may become uncomfortable. This discomfort will last for 3-5 minutes until cold induced anesthesia is attained. The treatment should last for no more than 10 minutes to avoid the risk of thermal injury. Ice cups or popsicles are the standard application methods.

Application: Prepare the skin by washing and drying the area. Prepare the area with adequate toweling to absorb water produced by the melting ice. Using moderate to firm pressure, apply the ice with small transverse strokes across the tendon proper or over the enthesis. Continue for 5-10 minutes.

**Cold Packs**

If ice is incorporated into a home exercise program, a slushie with alcohol can be made. The patient can place water and alcohol in a freezer bag at a 4:1 ration of water to alcohol and place this in their home freezer. This recreates the properties of a reusable ice pack in the home.

Application: Wrap the cold pack in a moist thin towel. The moisture will improve conductivity. Ice packs can be wrapped in a thin, dry towel to provide a layer of insulation. A pillow case is often useful. Apply to the desired area for 10 minutes. Ensure that the pack is secure. Inspect the skin to ensure no negative effects.
Diathermy

Principles and application

- Application of shortwave or microwave radiation to produce heat in biological tissues.
- Creation of physiological changes within the selected biological tissue.
Diathermy: Frequencies

- **Shortwave**: 1.8 - 30 MHz
  
  3 - 200 m wavelength. This is in the radiofrequency.

- **Microwave**: 300 MHz - 300 GHz 1mm-1m wavelength. Not manufactured in USA.
**Diathermy: Modes**

- **Continuous**
  - Generates heat in the body.
  - Same physiological heating effects as seen with US
  - Heats deeper tissues than superficial agents and heats a wider area than U.S.

- **Pulsed (PSWD)**
  - Non-Thermal Effects
  - Alteration of cell membrane function.
  - Increased microvascular perfusion

---

**Diathermy: Properties**

- Consider:
  - Strength of the magnetic field.
  - Tissue perfusion.
  - Tissue type.
- SWD: No reflected waves
- MWD: Reflected waves at tissue interfaces. Can lead to standing wave formation
Diathermy

Diathermy: Inductive coils

- AC current flows through the coil.
- Produces a perpendicular field to the coil.
- Creates eddy currents.
- Oscillating charged particles.
- Heat from friction

Diathermy Inductive Coils

- Distance of the coils to the tissue determines the strength of the magnetic field.
- Tissue type: Electrical conductivity + strength of the magnetic field = strength of the eddy currents
- Heating by magnetic fields.
Tissue conductivity

- Muscle: High
- Organs: High
- Bone: Low
- Fat: Low
- Collagen: Low

Diathermy: Capacitive Plates

- AC current flows through the patient in between the 2 pads or plates.
- Charged particles oscillate causing frictional heat Thereby increasing tissue temperature.
- Heating by electrical field.

Diathermy: Capacitive Plates

Relationship between strength of field and tissue conductivity.
Current always takes least resistant path.
Result is heating of superficial tissues as opposed to inductive coils which heat deeper tissues.
Magnetron: MWD

- High frequency AC in an antenna.
- Produces an electromagnetic field.
- Field is directed to a small area and generate heat in tissues with high conductivity.

Magnetron: MWD

- Standing waves.
- Shallow depth of penetration.
- Reflection at all interfacing tissue.
- High risk of superficial burns.
Clinical Application: Thermal Mode (CSWD)

- Same physiological effects as superficial heating.

- Can make stretching routines more comfortable however; no proven increase in length can be attributed to CW SWD.
Clinical Application: Non Thermal Mode (PSWD)

- Soft tissue healing.
- Pain control.
- Bone healing.
- Osteoarthritis.

Therapist Precautions

- Therapists can be exposed to this radiation.
- Negative effect on pregnancy.
  - Stay 3-6 ft. away from CSWD.
  - Stay 1.5 feet away from PSWD.
  - Avoid beam of MWD

Contraindications/Precautions

- Contraindications
  - Cardiac and neural implanted stimulators.
  - Pregnancy.
- Precautions
  - Electronic or magnetic equipment.
  - Obesity.
  - Copper intrauterine devices
  - Pregnancy
  - Open epiphyses
Contraindications

- Thermal
  - Eyes
  - Testes
  - Open epiphyseal plates
  - Metal implants
  - Malignant tumors

- Non-Thermal
  - Internal organs
  - Pacemakers
  - Substitution for conventional therapy

Recent Evidence

- Cetin, et al 2008: SWD enhances effectiveness of exercise in women with knee OA more effectively than US.
- Boyaci, et al 2013: Comparison of US, ketoprofen phonophoresis and SWD. All were better than placebo and none were more effective than the others.

Recent Evidence

- Akyol, 2010: SWD does not enhance the effectiveness of exercise in knee OA and is not recommended.
- Draper, 2004: SWD with hamstring stretching is more effective than stretching alone.
Recent Evidence

- Laufer 2012: Meta-analysis of effectiveness of SWD inducing a thermal effect in knee OA. Small effects noted but variations in the study protocols prevent a conclusion.
- Draper 2004: Case report of ORIF of the elbow regaining full motion when SWD was introduced to a standard program.

Recent Evidence

- Akyol: 2012 MD was ineffective in addressing pain and dysfunction with shoulder impingement.
- Rabini 2012 MD is superior to moist heat packs in relieving OA pain of the knee.
TENNESSEE OTs

TN General Rules Governing the Practice of OT rule 1150-2

**Electrical Stimulation Certification:** Committee approved course (EHT/Treatment2Go is committee approved) that consists of a total of 25 contact hours. TN participants will be required to submit documentation, to the Board of Occupational Therapy, of having completed their clinical treatments to qualify for certification (see attached clinical form for TN participants).

**Thermal Agents Certification:** Committee approved course (EHT/Treatment2Go is committee approved) that consists of a total of 20 contact hours. TN participants will be required to submit documentation, to the Board of Occupational Therapy, of having completed their clinical treatments to qualify for certification (see attached clinical form for TN participants).

**Note:** EHT/Treatment2Go courses consist of 45 didactic contact hours; clinical laboratory treatments are required and counted separately. Once you have completed your clinical laboratory treatments you will have the requirements for TN certification. You must submit your certificates and clinical treatments to:
(Note: it is the responsibility of the TN Licensees to verify address)

State of Tennessee
Department of Health
Bureau of Health Licensure and Regulations
Division of Health Related Boards
227 French Landing; Suite 300
Heritage Place Metro Center
Nashville, TN 37243

Phone: 800.778.4123
Tennessee.gov/health
Exploring Hand Therapy, Corp d/b/a Treatment2Go  
Physical Agent Modalities Certification  
Clinical Application for the state of Tennessee

Must complete in accordance with TN Certification in the use of physical agent modalities

**Qualified Supervisor defined as:**
1. A Physical Therapist currently licensed in the United States
2. Licensees who hold certification in Thermal Agent and/or Electrical stimulation

Questions or specifics refer to the General Rules Governing the Practice of OT Chapter 1150-2-.04

Thermal Agent Certification Treatments: Required 10 Treatments plus 5 hours of clinical practice = 5 treatments U/S & a minimum of one superficial heat, one cryotherapy, & deep heating

<table>
<thead>
<tr>
<th>Modality</th>
<th>DATE</th>
<th>Intensity (ie .8W/cm²)</th>
<th>Power (ie. 3 MHz)</th>
<th>Duration (ie. 8 minutes)</th>
<th>Area or DX (ie. basal joint)</th>
<th>Supervisor Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>U/S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U/S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U/S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U/S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep heating</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial heat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cryotherapy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Electrical Stimulation Certification: Required 5 Treatments = minimum 1 NMES, 1 TENS, 1 Edema, 1 Ionto

<table>
<thead>
<tr>
<th>Modality/Category</th>
<th>Date</th>
<th>Power (i.e. 150/80 MHz)</th>
<th>Time/duration (i.e. 20 minutes)</th>
<th>Intensity &amp; area (i.e. TFCC @ level 20 intensity)</th>
<th>Supervisor Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TENS (pain)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EDEMA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionto</td>
<td>Date</td>
<td>Medicine</td>
<td>Dosage</td>
<td>Intensity</td>
<td>Supervisor Signature</td>
</tr>
<tr>
<td>hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By signing this form I, ___________________________________________ certify completion of EHT’s Committee-approved training PAM course and clinical practical requirements to satisfy the Tennessee Occupational Therapy Board for PAM certification.

__________________________________________
Tennessee Licensee Signature

Keep for your records
Some states require supervised clinical application experience to complete PAMs requirements. For your convenience Exploring Hand Therapy has developed a general form for documentation of your supervised clinical application experience.

Not all states require clinical “hands on” documentation. However, to ensure you have completed your State’s requirements please contact your State’s Occupational Therapy Board for specifics.
The purpose of this document is to certify that __________________________ has completed Exploring Hand Therapy’s Course on Modalities for ___________ Contact Hours and has successfully completed the course exam(s). Each participant is required to keep all course certificates and this clinical application form.

**NOTE TO PARTICIPANT:** Do not send this form to your state. This is for your documentation. Keep permanently for your records for proof of completion. Each state may have different clinical application requirements. Contact your state for specifics.

**Basic Clinical Requirements:** Participant must complete five (5) qualified supervised ultrasound applications, five (5) electrical modalities applications and three (3) Iontophoresis applications.

*A qualified supervisor is any person who is one of the following:*
- registered physical therapist
- certified hand therapist
- PAM certification for 2 or more years

### Ultrasound Parameters:

<table>
<thead>
<tr>
<th>Date</th>
<th>Intensity (i.e. .8W/cm²)</th>
<th>Power (i.e. 3 mHz)</th>
<th>Duration (i.e. 8 minutes)</th>
<th>Area or DX (i.e. basal joint)</th>
<th>Supervisor Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Electrical Modality Parameters:

<table>
<thead>
<tr>
<th>Date</th>
<th>Modality: IFC, HVGC, NMES</th>
<th>Power (i.e. 150/80 mHz)</th>
<th>Time/duration (i.e. 20 minutes)</th>
<th>Intensity &amp; area (i.e. TFCC @ level 20 intensity)</th>
<th>Supervisor Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Iontophoresis Parameters

<table>
<thead>
<tr>
<th>Date</th>
<th>Area (i.e. Basal Joint)</th>
<th>Medicine (i.e. dexamethazone)</th>
<th>Dosage (i.e. 40 miliAmps)</th>
<th>Intensity (to patient comfort)</th>
<th>Supervisor Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By signing this form I, __________________________ certify completion of EHT’s course and clinical practical requirements to satisfy the state of __________________________ Occupational Therapy Board for PAM certification.

Clinician’s signature

List of qualified supervisors names (please print)

Facility of Supervisor
# PHYSICAL AGENT MODALITY DOCUMENTATION COMPLIANCE LOG

**Name:** ____________________________________  **License Number:** ____________________

*The following documentation is a record of compliance with the Code of Maryland Regulations (COMAR) 10.46.06 for the use of an electrical physical agent modality.*

Modality Type: __________________________________

A. Didactic Education (15 hours for each specific electrical modality):

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity Description</th>
<th># of Hours</th>
<th>Certificate of Completion Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hours must total 15.

B. Patient Treatments (5 patient treatments for each specific electrical modality):

<table>
<thead>
<tr>
<th>Patient</th>
<th>Treatment Description</th>
<th>Instructor Initials &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To maintain licensure records, complete this compliance log. Documentation must be maintained for the duration of the licensee’s professional career in occupational therapy. For additional information, please reference COMAR 10.46.06 Competency Requirements for Physical Agent Modalities. You may also contact the Board office at (410) 402-8560 or www.mdotboard.org.
Chapter 2 Wound Healing


Chapter 3 Principles of Hydrotherapy


Chapter 4 & 5 Thermal Agents


Chapter 6 & 7 Therapeutic Ultrasound


