Introduction to Physical Agents Part II:
Principles of Heat for Thermotherapy

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Objectives

After studying this lecture, the students must be able to;

- Define and classify the physical agents modalities.
- Describe physical principle of thermal agents modalities
- Differentiate between methods of heat transfer.
- Understand the physiological effects of thermotherapy.
- Offer guidelines for use of therapeutic modalities include
  - Indications and contraindications of thermotherapy
  - Precautions and adverse effects of thermotherapy

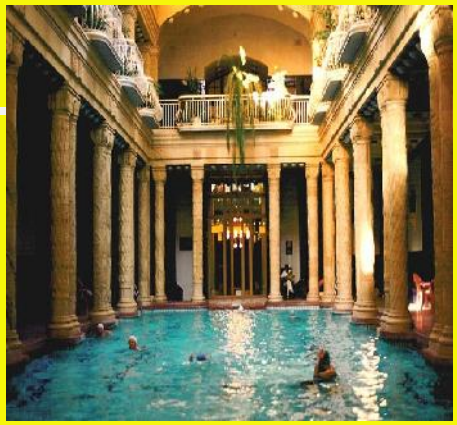
Outlines

- Introduction and history of physical agents (PA)
- Classification of physical agents modalities
- Modes of heat transfers
- Physiological effects of thermotherapy.
- Therapeutic uses (indications) of thermotherapy.
- Contraindications of thermotherapy.
- Precautions & dangerous of thermotherapy

Physical Agents Modalities (PAMs)

- Physical agents modalities (PAMs) are external form of energy (e.g. heat, cold, light, electricity, electromagnetic, sound) applied to the patients to assess in the rehabilitation process.

History of physical agents



Ancient Rome and Greece used heat and water (steam rooms, hot & cool pools) to treat ailments

Late 19th Century Europe – natural hot springs

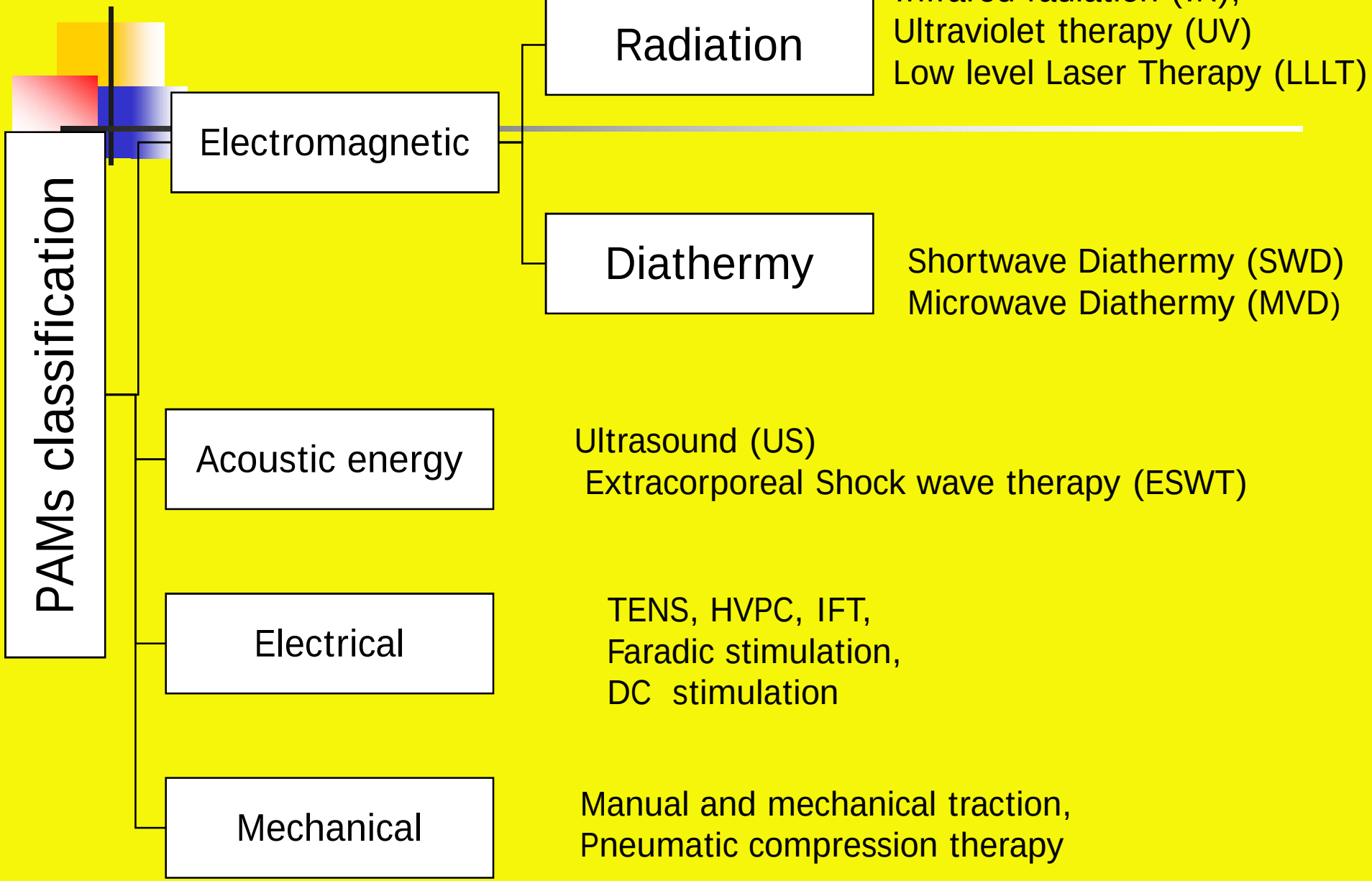
400 B.C. Torpedo fish were used to apply electrical shock to treat headache and arthritis.

Sunlight was used to treat TB, bone & joint diseases, dermatological problems & infection

Role of physical agents in rehabilitation

- Modalities alone DO NOT constitute a skilled treatment.
- Modalities should be used in conjunction with other therapeutic techniques to reach an established goal of rehab.
- Use of physical agents as a component of rehabilitation involves the integration of appropriate interventions.
- It can be used before, during or after a therapy session, to enhance the effects of other interventions

Categories (classifications) of Physical Agents



Thermal Agents

Thermal agents are physical agents that causes an increase or decrease in tissue temperature.

Thermotherapy is a therapeutic application (uses) of heating modalities

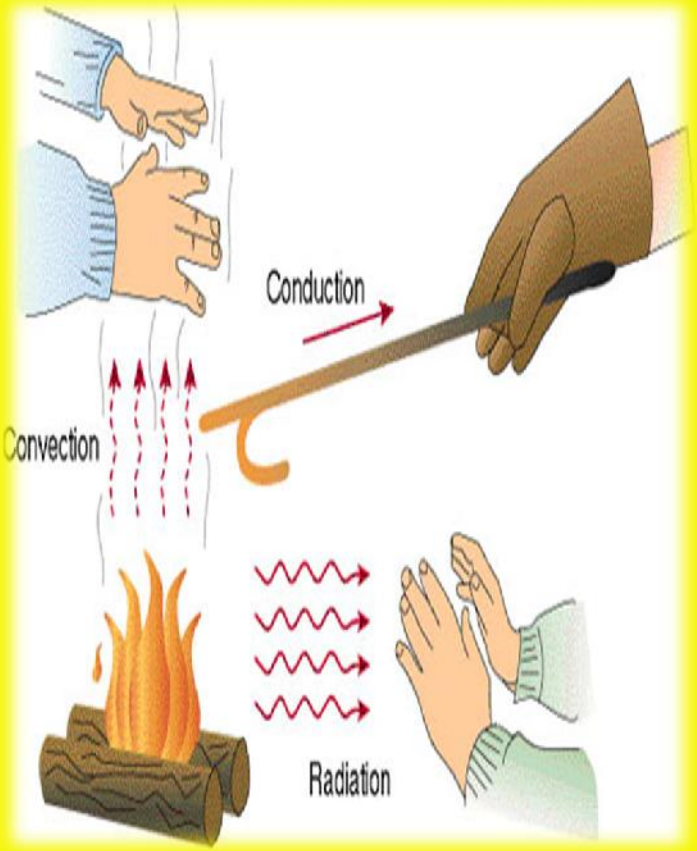
Examples
Hot packs, infrared, ultrasound
Short wave diathermy
Microwave diathermy
Whirlpool, paraffin wax

Therapeutic heating modalities (Superficial and Deep) heating agents increase the skin temperature within the therapeutic range (104 -113°F) to induce physiological effects for therapeutic benefits

Modes of energy (Heat) transfer

Objective

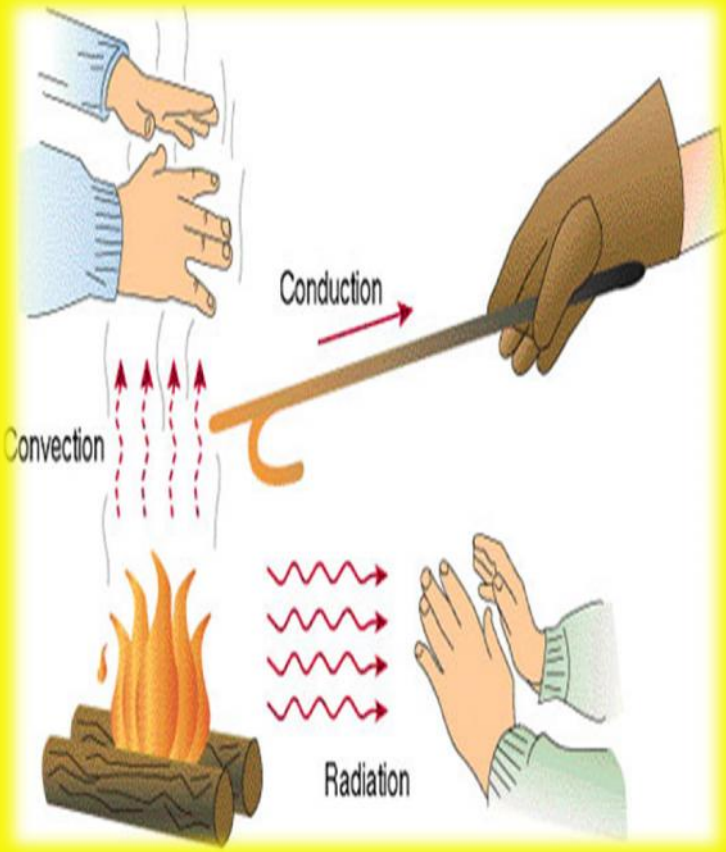
- **Discuss the basic principles & physiological effects of transferring heat to & from patients using superficial and deep heating modalities**



Modes of energy (Heat) transfer

Modes of heat transfer

- **Radiation**
- **Conduction**
- **Convection**
- **Conversion**
- **Evaporation**



Modes of energy (Heat) transfer

Conduction is a direct transfer of energy (heat) between two objects in physical (direct) contact with each other.

- Ice packs
- Hot packs
- Paraffin
- Ultrasound

Rate of energy (heat) transfer by conduction is dependent on

1. Temperature difference between materials
2. Thermal conductivity (Metal > water > bone + muscles > fate)
3. The total contact area
4. Tissue thickness

Modes of energy (Heat) transfer

Radiation is a direct transfer of energy (heat) from higher temperature to lower temperature without the need for an intervening medium (**No-contact).**

- Shortwave diathermy
  - Microwave Diathermy
  - Laser
  - Infrared & laser
  - Ultraviolet therapy

Rate of energy (heat) transfer by radiation is dependent on

1) Density, thickness , and type of radiating tissues
2) Law governing radiations
3) Intensity and size of radiation
4) Distance from radiation source
5) Duration of radiation

Modes of energy (Heat) transfer

Convection

- is a transfer of heat through direct contact between circulating medium (air/ water) and another material of different temperature .
- Fluidotherapy
- Whirlpools
- Blood circulation

Modes of energy (Heat) transfer

Conversion

- is a conversion of non-thermal form of energy (mechanical, electrical and / or chemical) into heat.
  - Ultrasound
  - Shortwave diathermy (SWD)
  - Microwave diathermy (MWD)

Modes of energy (Heat) transfer

Evaporation

- Heat is absorbed by the liquid on the skin surface and cools the skin as it turns into a gaseous state.
  - Vapocoolant sprays
  - Alcohol
  - Sweating

Modes of energy (Heat) transfer

Heat transferring

- Conduction
- Radiation
- Convection
- Conversion
- Evaporation





Non-thermal form of energy being converted into heat, => Ex: Mechanical, electrical or chemical energy; Diathermy, Ultrasound

a) Conduction
b) Conversion
c) Convection
d) Evaporation

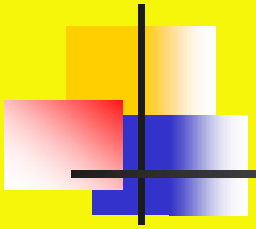
Vapocoolant spray is a form of energy transfers by Radiation

True false

Adipose acts as insulator, thus slowing down temp change while Muscle contains water has faster conduction of heat

True false

Effects of physical agents



Modifications of tissue inflammation and healing

Modification of tone abnormalities

The application of physical agents primarily results in

Relief of pain

Alternation of collagen extensibility and motion restrictions.

Bio-Physiological Response (Effects) of Heat

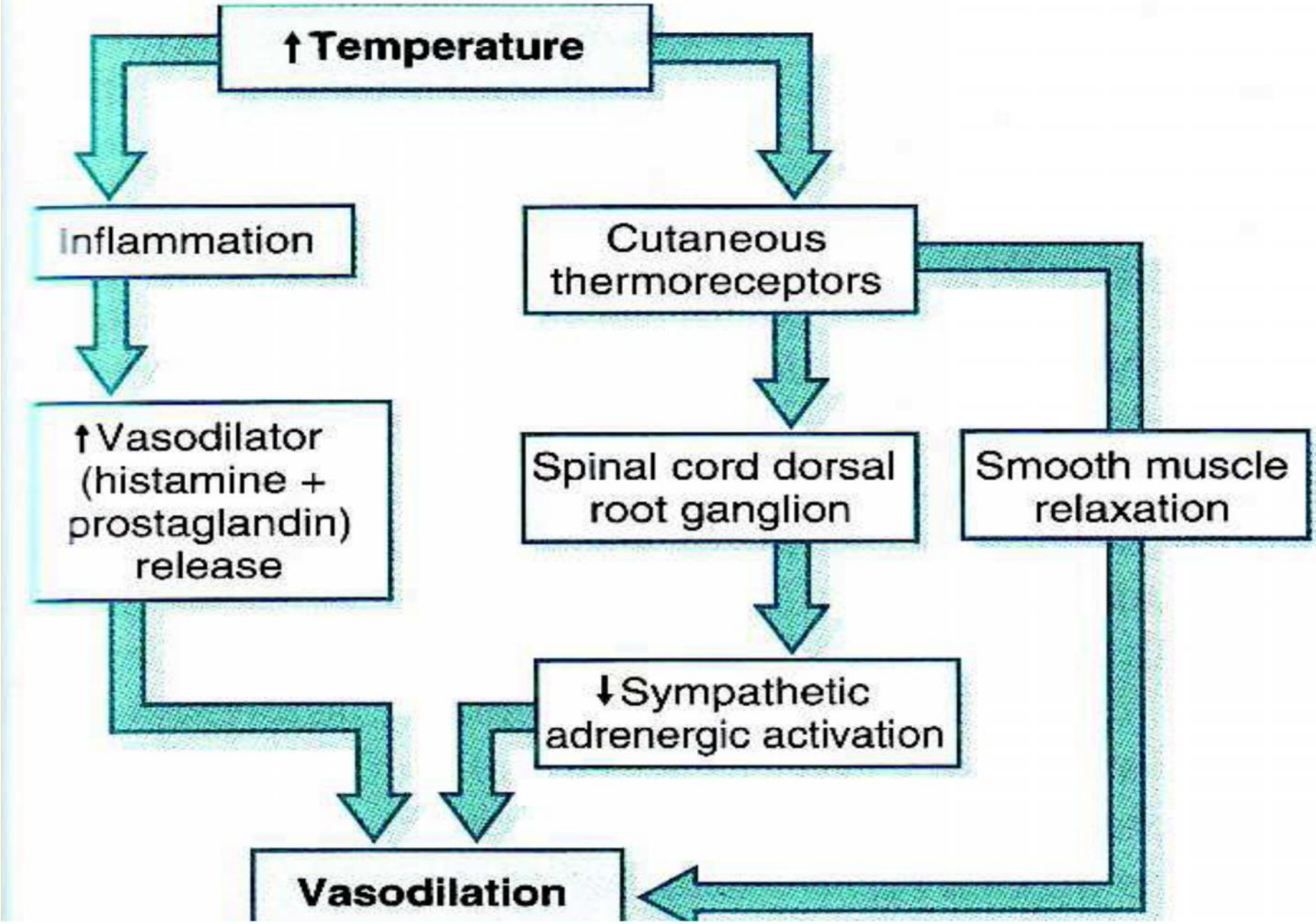
I • Hemodynamic effects

II • Neuromuscular effect

III • Tissue Extensibility

IV • Metabolic effect

Hemodynamic Effects: Vasodilation



Cellular & Blood/Fluid Responses

- Cellular –

For every 18°F (10°C) increase in skin temperature "the metabolic rate increased by factors of 2-3"

  - ↑ temperature → ↑ cell metabolism → ↑ O_2; cell waste ↑ excreted
  - ↑ temperature → blood hemoglobin releases O_2 (106°F = twice as much O_2 released)
  - ↑ temperature → (104°-113°F) plastic deformation of collagen-rich tissues occurs more easily
- Blood & Fluid Dynamics –
  - ↑ b. flow → ↑ edema, but ↑ b. flow removes wastes, etc.
  - Triggers release of bradykinin

II-Neuromuscular Effects

1. Decreased pain and muscle spasm
2. Increased pain threshold
3. Increase nerve conduction velocity
4. Decrease conduction latency (sensory &motor).
5. Change muscle spindle firing rates

Changes in muscle strength

Muscle strength and endurance found to decrease for initial 30 minutes following heat application (superficial/deep heating)
Gradually recovers then increases for next 2 hours
Measuring muscle strength (before heat application Not after)

III-Altered Tissue Extensibility

Increase extensibility of collagen tissues (tendon, ligament, capsule) at (40-45°C) resulting in

- Relaxation of tension,
- Increase length of soft tissue,
- Increase ROM

Superficial heat alone will NOT alter viscoelastic properties of tissue

- Heat + Stretch
  - Result = plastic elongation of deeper tissue such as (tendons, ligaments, joint. capsule, fascia).
  - Factors important determining treatment strategies
    - Temperature elevation (40-45°C)
    - Time must be maintained for 5-10 minutes.
    - Stretch exercises

Physiological Effects of Heat Therapy

Increased

1- Local blood flow
2- Lymphatic drainage
3-Capillary permeability
4-Metabolic rate
5-Cellular oxidation
6-Flexibility of collagen tissues
7-Respiratory rate
8-Cardiac output
9-Pulse rate

(1-6)-----Local effects
(7-9)-----systemic effects

Decreased

1-Joint stiffness
2-Pain &muscle spasm
3-Muscle torque
4-Blood supply to internal organs
5-Blood pressure
6-Stroke volume

(1-3)---- Local effects
(4-6)---- systemic effects

Considerations using Physical Agents

Indication: A condition(s) that could benefit from a specific therapeutic modality.

Contraindication: A condition(s) that could be adversely affected if a particular therapeutic modality is used.

Precautions:

A conditions in which therapeutic modalities is applied with special care or limitations.

Therapeutic Uses of Thermotherapy (Indications)

- Subacute or chronic pain and muscles spasm
- Limitation in ROM and joint contracture
- Subacute or chronic inflammatory conditions
- Accelerate tissues healing
- Before passive mobilization and exercise

Contraindications for Thermotherapy

Acute injuries

Recent or potential hemorrhage

Impaired circulation

Poor thermal regulation

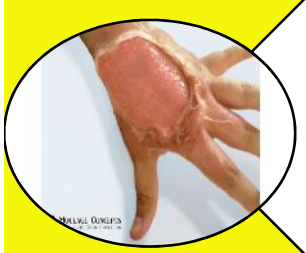
Over or around neoplasms (malignant tumor)

Over or around infected area

Precautions to Thermotherapy

- Never apply heat directly to eyes or the genitals.
- Never heat the abdomen during pregnancy.
- Very young and very old patients.
- Mental retard patients.
- Cardiac insufficiency.
- areas with metal implants (higher thermal conductivity)
- Over area of topical anesthesia
- Dermatological anomalies.

Adverse Affects of Heat Applications



Burns:

- Poor technique
- Patients' inability to dissipate or detect heat
- Treatment over areas of implanted metal or open wounds

Bleeding: In acute trauma or hemophilia

Fainting: peripheral superficial vasodilatation and decrease blood pressure .

How to Avoid ?

MCQ- Questions

1-Hemodynamic - Neuromuscular - Metabolic

a) Biophysiological Effects
b) Metabolic Effects
c) Neuromuscular Effects
d) Hemodynamic Effects

2-Increases nerve conduction velocity - increases collagenous tissue extensibility - increases pain threshold - decreases muscular strength

a) Neuromuscular Effects
b) Metabolic Effects
c) Biophysiological Effects
d) Hemodynamic Effects

3-Hot packs - Fluidotherapy - Paraffin - Whirlpool - SW Diathermy - US

a) Therapeutic Dosage
b) Hemodynamic Effects
c) Deep Heat Modalities
d) Types of Thermal Agents