# Hyperthermia Therapy in Cancer Treatment

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## Abstract:

*Hyperthermia is a type of cancer treatment in which body tissue is exposed to high temperatures (up to 42°C) to damage and kill cancer cells. Hyperthermia is almost always used with other forms of cancer therapy, such as radiation therapy and chemotherapy. Several methods of hyperthermia are currently under study, including local, regional, and whole-body hyperthermia. Many clinical trials (research studies) are being conducted to evaluate the effectiveness of hyperthermia*

*The aim of this paper is to study the role of hyperthermia therapy in cancer treatment and to study the contribution of this therapy in minimizing the side effects of other treatments for cancer patients.*

## I. Introduction

Hyperthermia therapy is a type of medical treatment in which body tissue is exposed to high temperatures to make cancer cells more sensitive to the effects of radiation and certain anti cancer drugs. In very few cases this therapy damages and kills the cancer cells. Hyperthermia is generally used as a supplementary treatment with the other treatments such as chemotherapy, radiotherapy etc. It helps to increase the effectiveness of these treatments.

There are many techniques by which heat may be delivered. Some of the most common involve the use of focused ultrasound (FUS or HIFU), infrared sauna, microwave heating, induction heating, magnetic hyperthermia, infusion of warm liquids or direct application of heat such as through sitting in a hot room or wrapping a patient in hot blankets.

**Figure 1. Hyperthermia treatment**

## II. Role of Hyperthermia Therapy

Hyperthermia may kill or weaken disorganized tumor cells having compact vascular structure which have difficulty in dissipating heat. It helps cancerous cells to undergo apoptosis as a direct response to applied heat. Even this therapy is given in smaller doses the cancerous cells become more susceptible to ionizing radiation therapy or to certain chemotherapy drugs.

Because of having low oxygen carrying capacity, high acid concentration, insufficient nutrient supply, cancerous cells have significantly less tolerance to the stress of added heat than a healthy cell in a normal tissue. Hyperthermia increases blood flow to the warm area and doubles the perfusion in tumors. This enhances the delivery of medications. Hyperthermia also increases oxygen delivery. It helps to damage and kill cancerous cells and also prevent their repair during the radiation session. Intense heating will cause denaturation and coagulation of cellular proteins which results into rapid killing of cells within a tumor. More subtle changes are seen by providing prolonged moderate heat. As a response to the heat shock, many biochemical consequences

such as slowed cell division and increased sensitivity to ionizing radiation therapy occur within the cell.

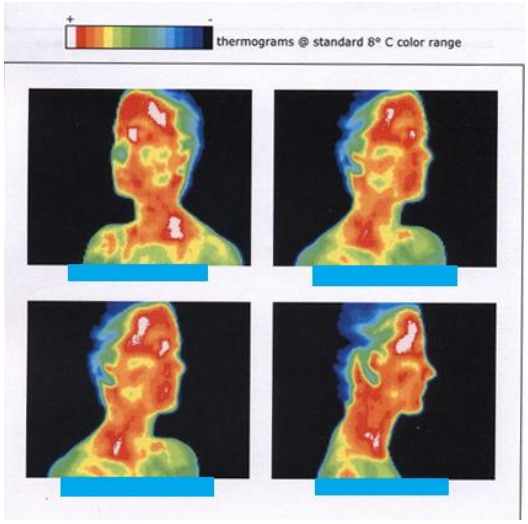


**Figure 2. Thermograph**

**Mild hyperthermia** provides temperature equal to that of naturally high fever. It may stimulate natural immunological attacks against the tumor, as a part of a natural physiological response called thermotolerence.

**Moderate hyperthermia** heats cells in the range of 40 to 42°C. It damages the cells directly and makes them radiosensitive. In addition to this it increases the pore size to improve the delivery of large molecules chemotherapeutic and immunotherapeutic agents such as monoclonal antibodies and liposome-encapsulated drugs.

**Very high temperatures**, above 50°C are used for ablation of some tumors. This involves inserting a metal tube directly into the tumor and heating the tip until the tissue has been killed.

## III. Application Techniques

### A. Local hyperthermia:

In local hyperthermia the goal is to kill the tumor. This is done by heating a very small area or the tumor itself. Depending on the location of the tumor, the heat may be applied to the respective part of the body. One relatively common type is radiofrequency ablation of small tumors. This is easiest to achieve when the tumor is on a superficial part of the body, which is called superficial hyperthermia, or when needles a probes are inserted directly into the tumor, which is called as interstitial hyperthermia.

### B. Regional hyperthermia:

Regional hyperthermia heats the larger part of the body, such as an entire organ or limb. Its main goal is to weaken cancer cells so that they are more likely to be killed by radiation and chemotherapeutic medications. It uses the same technique as local hyperthermia treatment but it more relies on blood perfusion. In blood perfusion, the patient's blood is removed from the body, heated up, and returned to the blood vessels that lead directly through the desired body part.

### C. Whole-body hyperthermia:

Whole-body hyperthermia heats the entire body to temperatures of about 39 to 41°C. It is used to treat metastatic cancer. This include infrared hyperthermia dome in which the whole body, apart from the head is kept in a very hot room or wrapped in hot and wet blankets.

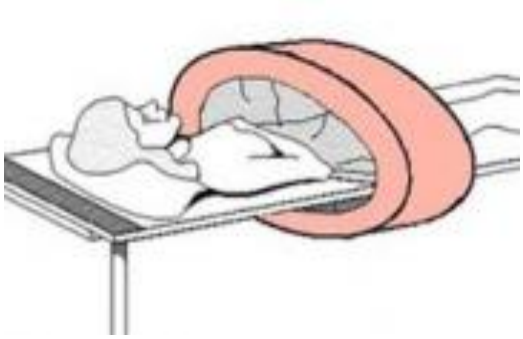

**Figure 3. Whole body hyperthermia**

## IV. Heat Sources

### A. High intensity focused ultrasound:

It is a highly precise medical procedure which uses high intensity focused ultrasound medical device to heat and destroy pathogenic tissue rapidly. The major application of high intensity focused ultrasound is tissue ablation, hyperthermia treatments and the activation or enhanced delivery of drugs.

## B. Induction heating:

Induction heating is mainly applicable in local hyperthermia. It is a process of heating a metal rod by electromagnetic induction. Due to the action of eddy currents or hysteresis losses the metal rod gets heated and helps in damaging the tumor cells.

**Figure 4.Induction heating device**

## C. Magnetic hyperthermia:

In magnetic hyperthermia the nanoparticles which are subjected to an alternating magnetic field, produce heat. As a consequence, if magnetic nanoparticles are put inside a tumor and the whole patient is placed in an alternating magnetic field of well chosen amplitude and frequency, the tumor temperature would raise. This could kill the tumor by necrosis if the temperature is above 45°C, or could improve the efficiency of chemotherapy if the temperature if raised around 42°C.

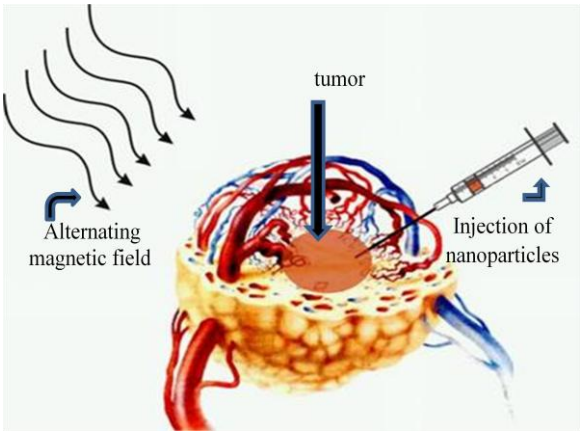


**Figure 5.Penetration of nanoparticle in tumor**

In moderate hyperthermia treatment, the temperature is maintained for about an hour. The schedule for treatments depends on the effects desired. After being heated, cells develop resistance to heat. This condition persists for about three days which reduces the cytotoxic effect of heat on the cells. In this case the treatment can be given to the patient twice a week only. However, if the amount of applied heat is increased, the poorly oxygenated tumors can be killed directly

**Figure 6. Hyperthermia treatment on cancer patient**

In thermal therapy it is very important to deliver the appropriate amount of heat to the correct part of the patient's body. For this technique to be effective, the temperatures must be high enough and must be sustained long enough, to damage or kill the cancer cells. While controlling temperatures, to lower the side effects, we must apply the heat to a smaller place for a shorter time. It is very important to keep local temperatures under 44°C to avoid damage to surround tissues and the whole body temperature under 42°C.

## V. Adverse Effects

External application of heat cause blisters as well as burns. Blisters generally heal quickly while burns do not. All techniques may result in pain or fatigue. Perfusion and moderate or high levels of hyperthermia can cause swelling, blood clots and bleeding. Whole-body hyperthermia, which is the riskiest treatment, usually results in diarrhea, nausea, vomiting, fatigue and other

symptoms of sunstroke; it may also cause cardiovascular problems.

**Figure 7. Blisters due to hyperthermia treatment**

## VI. Effectiveness

Only hyperthermia treatment is generally ineffective in cancer therapy. Very few patients show its long lasting benefit. However its effectiveness is significantly high when used as a supplementary treatment to the other treatments.

When combined with radiation, hyperthermia is particularly effective at increasing the damage to acidic and poorly oxygenated parts of tumor. Hyperthermia treatment is most effective when provided at the same time, or within an hour, of the radiation.

Though whole body hyperthermia is not so effective when used with radiation, it is more useful for chemotherapy and immunotherapy.

## VII. Future Challenges

There are two measure technological challenges which make hyperthermia therapy complicated. The first one is to achieve a uniform temperature in a tumor, while using hyperthermia therapy and second is to monitor the temperatures of both- the tumor and the surrounding tissues.

## VIII. Conclusion

After studies results were better in the in the case of radiofrequency plus hyperthermia treatment rather than only in the radiofrequency treatment. However, hyperthermia is only useful for certain kinds of cancer and is not in widespread use. Hyperthermia is most effective when use alongside conventional therapies, so it is normally used as an adjuvant therapy. Cancerous cells are not inherently more susceptible to the effects of heat. When compared in *in vitro* studies, normal cells and cancer cells show the same responses to heat.

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