# Introduction to Three Different Kinds of Anti-cancer Therapies

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**Abstract:**

In the TED videos, three different kind of anti-cancer therapies are introduced. All of them have certain features and can complement some shortcomings of traditional methods of treating cancers.

Antiangiogenic therapy utilizes the mechanism of human angiogenesis, by controlling this elaborate human angiogenic system, we target at vessels that are feeding the cancer cells, cutting off the blood and oxygen supply of them. It has a cutting edge from chemotherapy or radiation, because it's highly selective and won't affect other tissues. What's more, further studies show that many kinds of food contain naturally antiangiogenic element, so we can "eat to starve cancer", and it's able to kill cancer when it's not dangerous.

Color-coded surgery applies fluorescent with specificity to stain tissue and color-code the surgical field. It changes the way surgeries used to be conducted. Through the magic of fluorescence, surgeons can see what they currently can't see, distinguish between different tissues, detect early cancers, avoid inadvertent injury of nerves and determine whether there's tumors uncut after a surgery more easily. All of these will result in surgeries with a better outcome and fewer complications.

Tumor Treating Electric Fields make use of the effect of electric field on charged protein called Tubulin, once exerted, the cell cycle of cancer cells is disrupted, and then the cancer cells are driven into a programmed cell death. Compared with traditional therapy, Tumor Treating Fields have no effect on normal undividing cells, which minimize the side effects. Even better, synergies are observed between chemotherapy, radiation and Tumor Treating Fields.

## 1. Antiangiogenic therapy

### 1.1 Brief introduction to human angiogenesis and its mechanism

Angiogenesis refers to the process that our bodies use to grow blood vessels. Typically, there's 60,000 miles worth of vessels in an adult. End to end, that would form a line that would circle the earth twice.

As adults, blood vessels don't normally grow except in some special circumstances like pregnancy or injury. That's because the body can regulate the amount of blood vessels. For example, in conditions the number of vessels is beneath the baseline, the human body are able to grow more blood vessels, until it get back to its normal levels.

The human angiogenesis is an elaborate system of checks and balances. And it is regulated through stimulators and inhibitors of angiogenesis. The stimulators are proteins called angiogenic factors, which can stimulate new blood vessels to sprout. And the inhibitors of angiogenesis can play the reverse role.

### 1.2 Relationships between cancer and the angiogenesis system

Angiogenesis is a hallmark of cancer. At first, cancers didn't start out with a blood supply, which lead to insufficient oxygen and nutrients. Therefore, they can only form into microscopic nests of cells, which is only one half a cubic millimeter in size.

Such tumor is quite common, in fact, almost 100 percent of us will have microscopic cancers growing in our thyroid when we have reached our 70s. However, without a blood supply, most of these cancers will never become dangerous.

However, through mutation, cancer cells can gain the ability to produce angiogenic factors, which helps the blood vessels to penetrate the tumor. What's worse, the growing vessels that are feeding tumors can also allow cancer cells to exit into the circulation as metastases, accelerating the spread of cancer cells in the body.

### 1.3 Antiangiogenic therapy for cancer treatment and its advantages

From above, we can learn that angiogenesis is a critical point between harmless and harmful, then one major part of the angiogenesis revolution is a new approach to treating cancer by cutting off the blood supply, which is called antiangiogenic therapy.

It has a cutting edge from chemotherapy, because it selectively aims at the blood vessels that are feeding the cancers. This is feasible because tumor blood vessels are different from normal, healthy vessels in normal tissues -- they're abnormal, poorly constructed. So, they're highly vulnerable to treatments that target at them.

### 1.4 Prospect of antiangiogenic therapy

As often the case, we're treating cancer too late——not until it has become dangerous, established, already spread or metastasized. However, by preventing angiogenesis, the cancers could never become dangerous——killing cancers in the first place.

In the study, many foods and beverages and herbs with naturally occurring inhibitors of angiogenesis are discovered. By adding these naturally antiangiogenic elements to our diet, we could boost the body's defense system, and prevent the forming of those blood vessels that are feeding cancers, which means that we can "eat to starve cancer". And beside fighting cancers, we can also use it to fight obesity by cutting off the blood supply of fat cells.

## 2. Color-coded surgery

### 2.1 Mechanism of color-coded fluorescent

Color-coded fluorescent is a kind of way to detect cancer. In order to achieve this function, a very clever molecule was developed. The molecule has three parts. The main part is polycation, which is sticky to human tissues. Attached to it is a kind of fluorescent molecules. Therefore, once they are injected into the patient's vein, everything's lit up.

But in order to bring in specificity, another additional component is added. The first one is a polyanionic segment, which can neutralize the molecule, and then nothing gets stuck down. However, this bond can be cut by certain molecular scissors made by cancer cells-– such as a kind of protease enzymes in certain cancer cells.

Therefore, if we inject a solution of them into the vein of the patients, normal tissue can't cut it, in which the molecule passes through and gets excreted. While specific molecular scissors in the cancer cells can break the bond and help to release the sticky polycation. In this way, the tumor labels itself and gets fluorescent.

### 2.2 Application of fluorescence in surgery and its advantages

Surgeries have close relationship with light. When an incision is made inside a patient's body, adequate light is needed to see what is going on. In other words, this technology brings an opportunity to bring in other kinds of lights -- lights that can allow us to see what we currently don't see, which is the magic of fluorescence.

Secondly, this technology can be applied to distinguish between different tissues. That's because when we have a real patient on the operating table, it is not so easy to tell the difference between different structures. And it wound be dangerous if any mistakes are made.

What's more, it can also help us in detecting early cancers or determine whether. If cancers can be caught early and taken out precisely with surgery, while knowing there's no cancer on the surgical field after the surgery, a lot of lives can be saved.

And the cool thing about fluorescence is that it's not only bright, it can actually shine through tissue. So even if the tumor is not right on the surface, we will still be able to see it. So, with the help of this technology, it is easier to determine whether there's tumors uncut after a surgery, which can save patients from unnecessary surgeries.

### 2.3 Prospect of Color-coded surgery

In surgery, it's important not only to know what to cut out. but to preserve tissues that are important for function. The inadvertent injury of nerves is an annoying problem in traditional surveys. Once injured, it can cause paralysis or pain. And by further study of this technology, molecules that were specifically labeling nerves were found, paving out a way to see nerves with fluorescence.

There's no straightforward mechanism to develop a molecule for one-time use, which means

that the same technology can be used in various areas. By adding drugs or growth factors, multiple-use drugs can thus be developed, this can be applied in areas like killing nerves that are causing problems while not affecting the surrounding tissues, which can make this technology even better.

## 3. Tumor Treating Electric Fields

### 3.1 Mechanism of tumor treating electric fields

When cancer cells divide, their genetic material in their nucleus exist in the form of chromosomes. While in the cytoplasm, there're special proteins called Tubulin that are required for cell division. As cell division begins, the nucleus membranes disintegrates, and the chromosomes are aligned in the middle of the cell, which is called the equatorial plate. At the same time, the Tubulin are placed end-on-end to form mitotic spindles, which are then attached to the chromosomes, pulling them from the equatorial plate into two daughter-cells. And this is exactly how the cancer cells rapidly divide and lead to uncontrolled tumor growth.

The tumor treating electric fields therapy uses externally placed transducers attached to a field generator to create an artificial electric field, and then aim the transducers at tissues with cancer cells. The electric fields are a field of forces, and these forces can act on bodies that have an electrical charge.

What is important is that those Tubulin are highly charged. So, the tumor treating electric fields will act on those highly charged proteins and align them, which prevents them from forming mitotic spindles, which are necessary for pulling the genetic material into the daughter cells. Without the help of mitotic spindles, the cancer cells will form unhealthy daughter cells and enter apoptosis (programmed cell death). In this way, the uncontrolled tumor growth is inhibited.

### 3.2 Advantages of tumor treating electric fields

Traditionally, there are three weapons available to fight cancers: surgery, radiation and chemotherapy. Each of them has some drawbacks and can be made up by this therapy. For example, these Tumor Treating Fields have no effect on normal undividing cells, which minimize the side effects.

In another experiment which compares the effect of chemotherapy and tumor treating electric fields, the life expectancy of two group was the same. But importantly, the Tumor Treating Field group suffered none of the side effects which are typical of chemotherapy patients, such as nausea, diarrhea, constipation or fatigue.

Even better, tremendous synergies between chemotherapy and Tumor Treating Fields are observed, and there's a research underway now. And the work to find the synergies between Tumor Treating Fields and radiation is proved promising.