# Photodynamic Therapy

## What is photodynamic therapy?

Photodynamic therapy (PDT) is a treatment that uses special drugs, called *photosensitizing agents,* along with light to kill cancer cells. The drugs only work after they have been activated or “turned on” by certain kinds of light. PDT may also be called *photoradiation therapy*, *phototherapy*, or *photochemotherapy*.

Depending on the part of the body being treated, the photosensitizing agent is either put into the bloodstream through a vein or put on the skin. Over a certain amount of time the drug is absorbed by the cancer cells. Then light is applied to the area to be treated. The light causes the drug to react with oxygen, which forms a chemical that kills the cells. PDT might also help by destroying the blood vessels that feed the cancer cells and by alerting the immune system to attack the cancer.

The period of time between when the drug is given and when the light is applied is called the *drug-to-light interval*. It can be anywhere from a couple of hours to a couple of days, depending on the drug used.

## Pros and cons of PDT

Studies have shown that PDT can work as well as surgery (/treatment/treatments-and-side-effects/treatment-types/surgery.html) or radiation therapy (/treatment/treatments-and-side-effects/treatment-types/radiation/radiation-therapy-guide.html) in treating certain kinds of cancers and pre-cancers. It has some advantages, such as:

- It has no long-term side effects when used properly.
- It’s less invasive than surgery.
- It usually takes only a short time and is most often done as an outpatient.
- It can be targeted very precisely.
- Unlike radiation, PDT can be repeated many times at the same site if needed.
- There’s usually little or no scarring after the site heals.
- It often costs less than other cancer treatments.

But PDT has limits, too:

- PDT can only treat areas where light can reach. This means it’s mainly used to treat problems on or just under the skin, or in the lining of organs that can be reached with a light source. Because light can’t travel very far through body tissues, PDT can’t be used to treat large cancers or cancers that have grown deeply into the skin or other organs.
- PDT can’t be used to treat cancers that have spread to many places.
- The drugs used for PDT leave people very sensitive to light for some time, so special precautions must be taken after the drugs are put in or on the body.
- PDT can’t be used in people who have certain blood diseases, such as any of the porphyrias (a rare group of diseases that affect the skin or nervous system) or people who are allergic to porphyrins. This allergy is rare, but it may happen in those who have gotten porphyrins in the past.

# What is PDT used for?

PDT can be used in people with certain types of cancer to help them live longer and improve their quality of life. Although PDT works and causes few long-term problems, it's not widely used to treat cancer today. Still, it is offered in some treatment centers, and is being studied in many clinical trials (/treatment/treatments-and-side-effects/clinical-trials.html). It's becoming more widely recognized as a valuable treatment option for localized cancers (cancers that have not spread far from where they started).

PDT is also used to treat pre-cancers of the skin (/cancer/skin-cancer.html), and is being tested against pre-cancers in the mouth and other places.

# PDT drugs approved in the US to treat cancer

Several photosensitizing agents are currently approved by the US Food and Drug Administration (FDA) to treat certain cancers or pre-cancers.

## Porfimer sodium (Photofrin®)

Porfimer sodium is the most widely used and studied photosensitizer. It's activated by red light from a laser. It's approved by the FDA to treat patients with:

- Cancer of the esophagus (/cancer/esophagus-cancer.html) (the swallowing tube) to relieve symptoms when a tumor totally blocks the esophagus or partly blocks the esophagus and can't be treated with laser therapy alone
- Barrett's esophagus with dysplasia, a pre-cancerous condition that may lead to esophageal cancer in people who don't have surgery
- A type of non-small cell lung cancer (/cancer/non-small-cell-lung-cancer.html) that affects the lining of the large breathing tubes (bronchi) called *endobronchial* cancer. PDT can help to shrink tumors that are blocking the bronchi. It's used if there is very little spread of the cancer cells (the cancer is micro-invasive). PDT can help those who can't have other types of treatment, such as surgery or radiation therapy.

## Aminolevulinic acid (ALA or Levulan®)

Aminolevulinic acid is a drug that's put right on the skin. It's used to treat actinic keratosis (AK), a skin condition that can become cancer, and is used only on the face or scalp. A special blue light, rather than laser light, is used to activate this drug.

## Methyl ester of ALA (Metvixia® cream)

Methyl ester of ALA is one of several other forms of ALA that have been developed. A disadvantage of the older forms of ALA is that they do not get into the cancer cells very easily. Newer ester forms, like this one, do. It is approved for treatment of some types of actinic keratoses of the face and scalp. Again, these are skin conditions that can become cancer. Methyl ester of ALA is activated with a red light.

# Newer PDT drugs

Researchers are looking for new PDT drugs, and many are being studied. Photodynamic therapy is also being tested for use against several other types of cancer. See "The future of photodynamic therapy" section below.

# Uses and side effects of specific PDT drugs

## PDT using porfimer sodium

### What is treatment like?

Porfimer sodium (Photofrin) is given through a vein (IV). It travels through the bloodstream and is absorbed by both normal and cancer cells all over the body. The normal cells get rid of most of the porfimer sodium over a couple of days. But a lot of the drug stays in the cancer cells, with less in normal cells.

Porfimer sodium alone does not destroy cancer cells. It must be activated or “turned on” with light. This is done about 2 or 3 days after the drug is given. (This gives normal cells a chance to get rid of the drug.) The doctor directs a laser light at the area of cancer cells using a very thin fiber-optic glass strand.

To treat esophageal cancer or Barrett’s esophagus, the fiber-optic strand is passed down the throat through a thin, flexible tube called an *endoscope*. For lung cancer treatment, the strand is passed through a *bronchoscope*, which is an endoscope designed to go into the lungs.

The laser used is a low-power light so it does not burn. It causes little or no pain. The light is applied for 5 to 40 minutes, depending on the size of the tumor. Any dead tissue left in the treated area is removed about 4 or 5 days later during endoscopy or bronchoscopy. The treatment can be repeated if needed.

### Who should not get treated with porfimer sodium?

Porfimer sodium is **NOT** recommended for people with:

- A fistula (abnormal opening) between the esophagus and the windpipe (trachea) or one of the lower large breathing tubes (a bronchus)
- A tumor that’s spreading into a major blood vessel
- Enlarged veins in the stomach or esophagus, or ulcers in the esophagus
- Porphyria, or an allergy to porphyrins

### Possible side effects

The major possible side effects from porfimer sodium are *photosensitivity* reactions (reactions triggered by light) and swelling in the treated area. Swelling may cause pain or trouble swallowing or breathing. Other minor side effects are possible, too.

**Photosensitivity reactions:** As soon as porfimer sodium is put into the bloodstream, it starts to collect in the cells of the body. Some of it will stay in the cells for several weeks. The skin and eyes become very sensitive to light during this time. If exposed to sunlight or other forms of bright light, the skin can quickly become swollen, sunburned, and blistered. It takes only a few minutes for this to happen, so it’s very important to protect the eyes and skin during this time.

After you get porfimer sodium, you should take precautions (see below) for at least 30 days to prevent reactions. Sensitivity to light can last as long as 3 months, but the length of time is different with each person. If you have a reaction, call your doctor right away.

You should try to avoid bright lights and direct sunlight, but you don’t have stay in dark rooms. Some indoor light is important because it will help to slowly break down the drug in your skin. As this happens, your skin becomes less sensitive to light over time. Ask your doctor when and

how you should test your skin for photosensitivity. This is usually done no sooner than 30 days after you get the drug.

You can help prevent a photosensitivity reaction if you prepare before treatment and use precautions after it. Here are some ways to do this:

- Before going to your doctor's office or hospital for treatment, close the shades and curtains on the windows in your home. Be sure windows and skylights are fully covered.
- Bring dark sunglasses, gloves, a wide brimmed hat, long pants, socks, shoes, and a long-sleeved shirt to wear after your appointment. Clothing should be light in color and the fabric should be tightly woven.
- Do not count on sunscreen to protect you. Most sunscreens only protect against ultraviolet (UV) light, and they will **not** prevent a photosensitivity reaction.
- For at least 30 days after you get the drug, limit your time outdoors, especially when the sun's rays are strongest (between about 10 am and 4 pm). Cover your skin when you do go outside, even on cloudy days and when you are in the car.
- Try to do your daily errands after sundown.
- Do not expose your skin to reading lamps or exam lamps (like those used in a dentist's office).
- Don't use helmet-type hair dryers (such as those found in beauty salons). High heat can activate any drug left in your scalp and cause redness or burning. If you use a hand-held hair dryer, use a low heat setting.

**Swelling:** Swelling in the treated area can lead to pain in the chest or back. If the esophagus is treated, it may lead to narrowing (stricture) of the esophagus, which could cause problems swallowing. Treatment of the breathing tubes or lungs could lead to trouble breathing. If you notice any of these problems, let your doctor know right away.

**Other possible side effects:** Side effects depend on the part of the body being treated. If the esophagus is treated, possible side effects include nausea, vomiting, fever, dehydration, headache, scarring and narrowing of the esophagus, hiccups, trouble swallowing, and fluid collecting around the lungs. In people treated for lung cancer, possible side effects include shortness of breath, coughing up blood, fever, pneumonia, and bronchitis.

If you are treated with porfimer sodium, ask your doctor which side effects you might expect and which you need to report right away. Get the phone number to call if you have problems after regular office hours.

# PDT using aminolevulinic acid (ALA)

## What is treatment like?

Aminolevulinic acid (Levulan Kerastick) is a solution that's put right on the spots (called *lesions*) of actinic keratosis. Unlike porfimer sodium, it does not reach other parts of the body. This means the lesions are sensitive to the light but the rest of the body is not.

The drug is left on the affected skin for about 14 to 18 hours, usually until the next day. At that time your doctor will expose the area being treated to a blue light for about 15 minutes. During the light therapy you and the doctor will wear protective eyewear. You may feel stinging or burning once the area is exposed to the blue light, but it should go away within a day or so. The treated area may get red and scale and crust for up to 4 weeks before healing. If a lesion does not completely go away after treatment, it can be treated again 8 weeks later.

## Who should not get treated with aminolevulinic acid?

Aminolevulinic acid is **NOT** recommended for people with skin sensitivity to blue light, people with porphyria, or anyone with an allergy to porphyrins.

## Possible side effects

**Photosensitivity reactions:** Reactions caused by light can show up on the skin where the drug is applied. They usually involve redness and a tingling or burning sensation. For about 2 days after the drug is used, you should take care to not expose treated areas of your face and scalp to light.

- Stay out of strong, direct light.
- Stay indoors as much as possible.
- Wear protective clothing and wide-brimmed hats to avoid sunlight when outdoors.
- Avoid beaches, snow, light colored concrete, or other surfaces where strong light may be reflected.

Sunscreens will not protect the skin from photosensitivity reactions.

**Skin changes:** The treated skin will likely turn red and may swell after treatment. This usually peaks about a day after treatment and gets better within a week. It should be gone about 4 weeks after treatment. The skin may also be itchy or change color after treatment.

Talk to your doctor about what you should expect your treated skin to look and feel like. Also ask about which side effects you should report right away and what phone number to call if you have problems after regular office hours.

# PDT using methyl ester of ALA

## What is treatment like?

Methyl ester of ALA (Metvixia cream) is used very much like aminolevulinic acid. It's a cream that's put on the skin of the face or scalp to treat actinic keratosis lesions. The doctor will likely first scrape the area with a small, sharp blade. The lesions where the cream is applied will become sensitive to light, but the rest of the body will not. (This drug does not reach other parts of the body.) The cream should not be left on the skin for more than 4 hours.

The cream is applied and covered with a bandage. About 3 hours later the doctor will take off the bandage, wash off the cream, and expose the area to a red light source for 5 to 20 minutes. During the light therapy you and the doctor will wear protective goggles. You may feel stinging or burning when light reaches the area. Two treatment sessions are usually done 7 days apart. The treated area may turn red, blister, scale, and crust for up to 10 days before healing. The doctor will look at the lesion about 3 months after the last treatment to see whether it worked.

## Who should not get treated with methyl ester of ALA?

Methyl ester of ALA is **NOT** recommended for those with:

- Skin sensitivity to light
- Allergies to peanuts or almonds (these oils are used to make the cream)
- Immunosuppression (a weakened immune system)
- Porphyria, or an allergy to porphyrins

Methyl ester of ALA cream has not been studied for more than 2 treatment sessions.
Information regarding more treatments done after 3 months for remaining or new AK lesions is not available.

## Possible side effects

**Photosensitivity reactions:** These are reactions triggered by light. They can happen at the area where the drug was applied, and usually involve redness and stinging or burning. You should stay out of the sun, away from bright indoor lights, and avoid extreme cold after the cream is applied and before the light treatment is done. For about 2 days after the light treatment, you should take care to keep the treated area away from any light.

- Keep the treated area covered.
- Stay out of strong, direct, bright indoor light.
- Stay indoors as much as possible.
- When outdoors, wearing protective clothing and wide-brimmed hats to avoid sunlight.
- Avoid beaches, snow, light-colored concrete, or other surfaces where strong light may be reflected.

Sunscreens will not protect the skin from photosensitivity.

**Skin changes:** The skin being treated will likely turn red and may blister and swell after treatment. Burning and stinging are common. The skin may also be itchy, scaly, or change color after treatment. These side effects should get better with time and should be gone by 3 weeks after treatment. If they get worse or are not gone in 3 weeks, call your doctor. Ask what other side effects should be reported to the doctor and what phone number you should use if you have problems after regular office hours.

**Allergic reactions:** Repeated exposure to methyl ester of ALA cream can cause sensitization, or development of allergy to the cream. Rashes such as eczema and hives (raised itchy bumps) can appear at the area of contact within a few hours after exposure to the cream. Very rarely, more serious allergic reactions can happen.

# The future of photodynamic therapy

Photodynamic therapy may be used to treat other cancers and diseases in the future. Studies are now being done to test the use of PDT for many types of cancer and pre-cancerous conditions, including cancers of the:

- Skin (/cancer/skin-cancer.html)
- Cervix (/cancer/cervical-cancer.html)
- Bladder (/cancer/bladder-cancer.html)
- Prostate (/cancer/prostate-cancer.html)
- Bile duct (/cancer/bile-duct-cancer.html)
- Pancreas (/cancer/pancreatic-cancer.html)
- Stomach (/cancer/stomach-cancer.html)
- Brain (/cancer/brain-spinal-cord-tumors-adults.html)
- Mouth (/cancer/oral-cavity-and-oropharyngeal-cancer.html)
- Larynx (/cancer/laryngeal-and-hypopharyngeal-cancer.html) (voice box)
- Vagina (/cancer/vaginal-cancer.html)
- Vulva (/cancer/vulvar-cancer.html) (the outside part of a woman's genitals)

PDT is also being tested for other cancers that can be reached with a light, such as malignant pleural mesothelioma and mycosis fungoides, a type of skin lymphoma (/cancer/skin-lymphoma.html). Some doctors may use PDT for these and other conditions, even though

those uses are not approved by the FDA (see our document *Off-Label Drug Use* (/treatment/treatments-and-side-effects/treatment-types/chemotherapy/off-label-drug-use.html) for more on this).

# New and better drugs

Newer photosensitizing drugs now being studied may have advantages over the ones used today:

- They may be able to treat tumors that are deeper under the skin or in body tissues.
- They may be more selective for cancer cells as opposed to normal cells.
- They may collect in cancer cells more quickly, reducing the time needed between getting the drug and the light treatment.
- They may be removed from the body more quickly, reducing the time people need to worry about photosensitivity reactions.

An example of one of these new drugs, Photochlor®, is now being used in clinical trials. Photochlor, or HPPH, is a second-generation photosensitizer. It's being studied in the treatment of esophageal, lung, skin, and mouth and throat cancers. So far, studies have shown that photosensitivity lasts a much shorter time, and the drug is removed from the body much faster than porfimer sodium (Photofrin).

Studies are also being done to try to make PDT work better and have fewer side effects. Scientists are looking at things like using ointments containing ferrous or cobalt ions and using hydrogen peroxide on the treated area to improve PDT outcomes, but these studies are in their early stages and more research is needed.

# Other light sources

Researchers are also looking at different types of lasers and other light sources. Some newer agents may respond to small doses of radiation as well as to light. This could allow doctors to use smaller amounts of radiation than the doses used in standard radiation therapy, which could lead to fewer side effects.

# Combining treatments

Another exciting area of research is looking at the use of PDT along with other therapies to make it more effective.

One example of this is to use PDT during surgery to help keep cancer from coming back on large surface areas inside the body, such as the pleura (lining of the lung) and the peritoneum (lining of the belly or abdomen). The light treatment can be given while these areas are already exposed during the surgery. Cancers that start in the pleura or peritoneum are called *mesotheliomas*. These are also common sites of spread for some other types of cancer.

# Interstitial treatments

Someday PDT may be used to help treat larger solid tumors, too. A technique known as *interstitial therapy* involves using imaging tests (such as CT scans) to guide fiber optics directly into tumors using needles. This may be especially useful in areas that would require major surgery. Early results of studies of interstitial therapy in head and neck, prostate, and liver tumors have been promising.

# Better understanding of PDT

Researchers are also looking more closely at how PDT works and how the cancer cells respond to its effects. Understanding how cells respond to PDT may allow doctors to enhance those effects that promote cancer cell death and suppress or counteract those that protect the cancer cells. There may also be ways to pre-treat the tumor to make it more susceptible to certain PDT treatments.

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