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Dep. Medical physics

Third Stage

Lec 8

Photodynamic therapy

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Photodynamic therapy (**PDT**) is a treatment that involves light-sensitive medicine and a light source to destroy abnormal cells. It can be used to treat some skin and eye conditions, as well as certain types of cancer.

What is photodynamic therapy?

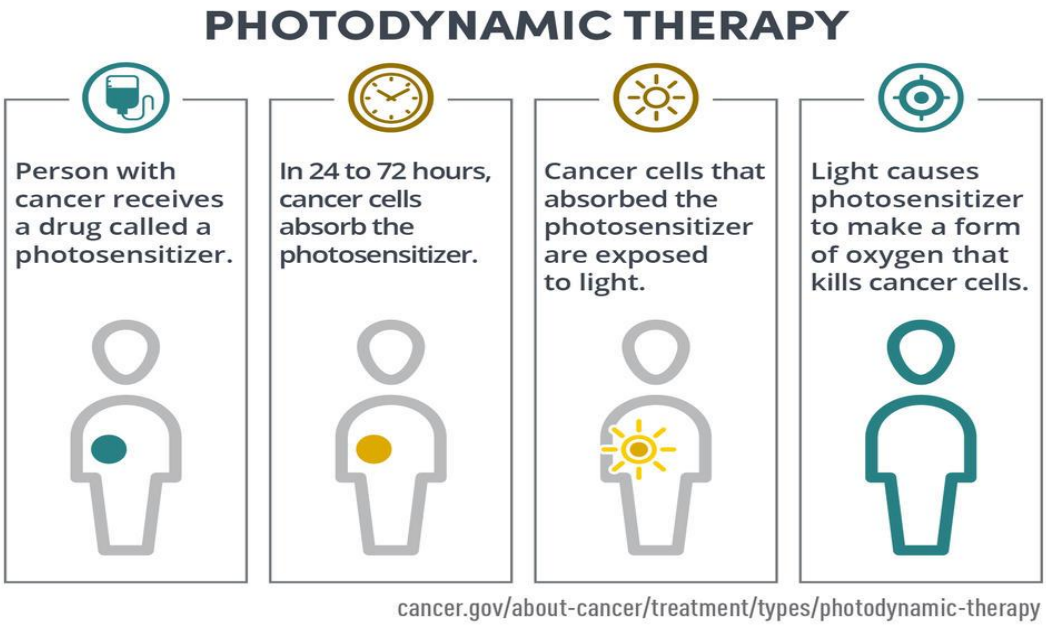
Photodynamic therapy uses a drug that is activated by light, called a photosensitizer or photosensitizing agent, to kill cancer cells. The light can come from a laser or other source, such as LEDs. Photodynamic therapy is also called PDT.

Photodynamic therapy is most often used as a local treatment, which means it treats a specific part of the body.

Why it's done ?

Photodynamic therapy is used to treat a variety of conditions, including:

- Pancreatic cancer.
- Bile duct cancer, also known as cholangiocarcinoma.
- Esophageal cancer.
- Lung cancer.
- Head and neck cancers.
- Certain skin diseases, including acne, psoriasis, nonmelanoma skin cancer and precancerous skin changes, known as actinic keratosis.
- Bacterial, fungal and viral infections.



How photodynamic therapy treats cancer

When cells that have absorbed photosensitizers are exposed to a specific wavelength of light, the photosensitizer produces a form of oxygen, called an oxygen radical, that kills them.

Photodynamic therapy may also damage blood vessels in the tumor, which prevents it from receiving the blood it needs to keep growing. And, it may trigger the immune system to attack tumor cells, even in other areas of the body.

How photodynamic therapy is given

Photodynamic therapy is a two-step process. First, you will first receive a photosensitizer. The drug may be taken by mouth, spread on the skin, or given through an IV, depending on where the tumor is in the body. After 24 to 72 hours, most of the drug will have left normal cells but remain in cancer or precancer cells. Then your tumor will be exposed to the light source.

How the light is applied depends on where the tumor is. For skin tumors, the light is aimed right at the cancer. For tumors in the throat, airways, and lungs, your doctor will insert an endoscope down your throat.

An endoscope is a thin, lighted tube that can help the doctor see inside the body. Once the endoscope is in place, the doctor threads a fiber optic cable that transmits light through it to reach the treatment areas.

One type of photodynamic therapy called **Extra Corporeal photopheresis** (**ECP**) is used to treat abnormal white blood cells that can cause skin symptoms in people with cutaneous T-cell lymphoma.

In **ECP**, a machine collects your blood cells, treats them with a photosensitizer, exposes them to light, and then returns them to your body through a needle in a vein.

Most often, a patient will undergo photodynamic therapy as an outpatient, meaning they go home after treatment and do not spend the night in the hospital. He may receive photodynamic therapy alone, or he may receive it in combination with other cancer treatments.

Benefits of photodynamic therapy

- Photodynamic therapy limits damage to healthy cells because the photosensitizers tend to build up in abnormal cells and the light is focused directly on them.
- Photodynamic therapy does not cause scarring, which makes it good for people with skin cancers and precancers.

Drawbacks of photodynamic therapy

- Photodynamic therapy can harm normal cells in the treatment area and cause side effects.
- The light used in photodynamic therapy can't pass through more than about 1/3-inch of tissue, or 1 centimeter. So, photodynamic therapy can only be used to treat tumors that are on or just under the skin or on the lining of internal organs or cavities.
- Because the light can't reach very far into large tumors, photodynamic therapy is less helpful in treating them.

Side effects of photodynamic therapy

Damage to normal cells is limited but photodynamic therapy can still cause burns, swelling, pain, and scarring in the treatment area. Other side effects may occur depending on the area that is treated, including:

- cough
- trouble swallowing
- stomach pain
- painful breathing
- shortness of breath
- skin problems, such as redness, stinging, swelling, or itching

A type of photosensitizer called porfimer sodium makes the skin and eyes sensitive to light for about 6 weeks. During this time, the patient should avoid direct sunlight and bright indoor light.

Extra Corporeal photopheresis (**ECP**) can cause:

- brief periods of low blood pressure
- faster than normal heart rate
- anemia
- low blood platelet count

Side effects improve once treatment is over.

Photodynamic therapy research

Researchers are looking for ways to expand photodynamic therapy to other cancers, including improving the equipment used and the delivery of the light.

Studies are underway to see if ECP may be used for other blood cancers and to help reduce rejection after stem cell transplants.

Researchers are also developing a new type of PDT called photoimmunotherapy, or PIT. In this treatment, a photosensitizer is combined with an immune protein that delivers the photosynthesizer to cancer cells. When light is applied, the photosynthesizer kills the cancer cells. This process also causes an immune response inside the tumor that can cause more cancer cells to die. Studies of PIT are going on with people with head and neck cancers. Other research is focused on finding photosensitizers that:

- are more powerful
- target cancer cells more precisely
- are triggered by light that can go through tissue to treat deep or large tumors
- cause fewer side effects

Discussion

1. What is photodynamic therapy (PDT)?

A. A treatment involving radiation

B. A light-based therapy using photosensitizers

C. A form of chemotherapy

D. A type of immunotherapy

E. A surgical procedure

Correct Answer: B

2. What activates the photosensitizer in PDT?

A. Sound waves

B. Chemicals

C. Light

D. Heat

E. Pressure

Correct Answer: C

3. What is another name for photodynamic therapy?

A. PIT

B. ECP

C. PDT

D. Immunotherapy

E. Radiation therapy

Correct Answer: C

4. Which of the following is NOT a condition PDT is used to treat?

A. Skin cancers

B. Pancreatic cancer

C. Bacterial infections

D. Diabetes

E. Actinic keratosis

Correct Answer: D

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5. What type of oxygen is produced during PDT to kill cancer cells?

A. Molecular oxygen

B. Ozone

C. Oxygen radical

D. Carbon dioxide

E. Water vapor

Correct Answer: C

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6. How does PDT damage tumors aside from killing cancer cells?

A. It increases blood flow to the tumor.

B. It damages blood vessels feeding the tumor.

C. It produces chemotherapy drugs locally.

D. It repairs tumor cells.

E. It blocks oxygen supply entirely.

Correct Answer: B

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7. What is the first step in the PDT process?

A. Exposing the tumor to light
B. Inserting an endoscope
C. Administering a photosensitizer
D. Conducting surgery
E. Applying heat therapy
Correct Answer: C

8. How is the light applied for skin tumors during PDT?

A. Through an endoscope
B. Using a fiber optic cable
C. By shining light directly on the cancer
D. By using ultrasound
E. Through radiation
Correct Answer: C

9. What tool is used to apply light to internal tumors in the throat or lungs?

A. Microscope
B. Endoscope
C. Ultrasound device
D. X-ray machine
E. Laser scalpel
Correct Answer: B

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10. What is a unique application of ECP?

A. Treating pancreatic cancer

B. Treating cutaneous T-cell lymphoma

C. Treating diabetes

D. Enhancing muscle repair

E. Diagnosing infections

Correct Answer: B

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11. What happens to the blood during ECP?

A. It is heated to kill bacteria.

B. It is collected, treated, and exposed to light.

C. It is filtered for toxins.

D. It is cooled and reinfused.

E. It is analyzed for immune cells.

Correct Answer: B

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12. Which is NOT a benefit of PDT?

A. Limits damage to healthy cells

B. Does not cause scarring

C. Treats large, deep tumors effectively

D. Can be used on outpatient basis

E. Localized treatment

Correct Answer: C

13. What is a drawback of PDT?

A. It damages all cells in the body.

B. It is extremely painful for all patients.

C. Light can't penetrate deep into tissues.

D. It requires long-term hospitalization.

E. It is ineffective for skin tumors.

Correct Answer: C

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14. What is a common side effect of PDT?

A. Reduced appetite

B. Nausea and vomiting

C. Sensitivity to light

D. Kidney failure

E. Hair loss

Correct Answer: C

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15. How long does light sensitivity from porfimer sodium typically last?

A. 1 week

B. 2 weeks

C. 6 weeks

D. 6 months

E. Permanently

Correct Answer: C

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16. Which side effect is specific to ECP?

A. Skin scarring

B. Anemia

C. Cough

D. Shortness of breath

E. Painful breathing

Correct Answer: B

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17. What is photoimmunotherapy (PIT)?

A. PDT combined with an immune protein

B. Chemotherapy using immune cells

C. Radiation therapy with photosensitizers

D. A type of skin cancer surgery

E. A form of bacterial infection treatment

Correct Answer: A

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18. What does PIT aim to achieve in tumors?

A. Blocking light exposure

B. Triggering an immune response

C. Reducing oxygen supply

D. Increasing tumor size

E. Removing all blood vessels

Correct Answer: B

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19. Which cancers are being studied for PIT?

A. Pancreatic and esophageal cancers

B. Lung and head/neck cancers

C. Head and neck cancers

D. Skin and bile duct cancers

E. All cancer types

Correct Answer: C

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20. What is one goal of developing new photosensitizers?

A. Increasing patient recovery time

B. Making them less effective in cancer

C. Targeting cancer cells more precisely

D. Reducing production costs

E. Eliminating the need for light exposure

Correct Answer: C

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21. How far can the light used in PDT penetrate tissue?

A. 5 cm

B. 1 cm

C. 10 cm

D. 15 cm

E. Less than 1 mm

Correct Answer: B

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22. Which of the following is NOT a side effect of PDT in the throat or lungs?

A. Cough
B. Trouble swallowing
C. Stomach pain
D. Increased appetite
E. Painful breathing
Correct Answer: D

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23. Why is PDT considered a local treatment?

A. It affects only specific areas.
B. It impacts the entire body.
C. It is used alongside chemotherapy.
D. It improves immune function everywhere.
E. It targets only bacterial cells.
Correct Answer: A

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24. What type of cancer is ECP most commonly used for?

A. Breast cancer
B. Cutaneous T-cell lymphoma
C. Liver cancer
D. Colon cancer
E. Prostate cancer
Correct Answer: B

25. What ongoing research aims to improve PDT?

A. Making photosensitizers non-toxic to all cells

B. Increasing light exposure without side effects

C. Developing light sources for deep tumors

D. Eliminating immune responses

E. Avoiding combination therapies

Correct Answer: C
