Introduction to Photodynamic Therapy (PDT)

Photodynamic therapy (PDT) is a treatment that uses light to damage malignant or abnormal tissues. PDT is FDA-approved for providing relief of obstruction caused by esophageal cancer or non-small-cell lung cancer (NSCLC); treatment of microinvasive endobronchial NSCLC in patients not recommended for surgery or radiotherapy; treatment of Barrett's Esophagus and high grade dysplasia; actinic keratosis; and age-related macular degeneration.

PDT requires a light source, such as a laser, combined with a drug that makes the tissues light-sensitive, which is known as a "photosensitizer." When the light and photosensitizer are combined, oxygen-free radicals that are able to destroy cancer cells are released. Photosensitizers are taken up in greater amounts by cancer cells compared to normal cells.

A photosensitizing drug is given to the patient orally, by an intravenous (IV) line, or topically (specifically to treat skin lesions) a few hours to days prior to the light exposure, but the drug is not activated until it is exposed to a particular wavelength of light. When the light is directed at the area of the cancer, the photosensitizer is activated and the cancer cells are destroyed. This wavelength determines how far the light can travel into the body. Typically, the depth of penetration is on the order of millimeters. Therefore, PDT is generally not used to treat large tumors, because the light cannot reach the necessary depth to treat those tumors. Different photosensitizers are activated by different wavelengths of light; therefore, depending on the area of the body to be treated, there are different photosensitizing drugs and different wavelengths of light that can be used.

How does PDT work?

PDT is a multistep treatment process. First, the photosensitizer is administered to the patient. The drug takes a certain amount of time to be absorbed by the body; exactly how much time is needed is dependent on the type of photosensitizer that is used, but typically takes a few days. The drug gets absorbed by cells all over the body, however, it stays in cancer cells longer than normal cells. Second, the physician directs a laser light source at the cancer cells. In the case of esophageal and bronchial lesions, this is done using an endoscope or bronchoscope. The amount of time that the laser is used will vary from patient to patient, according to the amount of disease present. In the presence of light from the laser, the photosensitizer will act on and damage the cancer cells. Since the photosensitizing drug is retained longer in the cancer cells, the cancer cells sustain more damage than the healthy cells that have already cleared the drug.

In PDT, cell death occurs through multiple mechanisms. There can be direct damage to cells via interaction between oxygen and the cancer cells. There are also indirect effects, including damage to blood vessels that supply the tumor, both during the treatment and after the treatment is over. Damage to the tumor blood supply during or after PDT will deprive tumor cells of oxygen/nutrients, thereby enhancing responses. Finally, PDT also stimulates the host immune system to attack the cancer cells.

How PDT is used?

PDT may often be done as an outpatient procedure, depending on the site that is to be treated. PDT may also be repeated and may be combined with other treatments, such as surgery, radiation, or chemotherapy.

Researchers are currently studying ways to improve PDT. In addition to more widespread uses of PDT to treat early stage or pre-invasive skin, lung, and esophageal cancers, studies are evaluating the use of PDT for cancers of the brain, skin, prostate, head and neck, cervix, ovaries, liver, anus, and the pleural and peritoneal cavities. Photosensitizers with fewer side effects or improved depth of penetration are in development. Researchers are also investigating ways to improve the delivery of the light.

What are the side effects of PDT?
Photosensitizers make the body sensitive to light. The period of time over which a patient is sensitive, and therefore should avoid light exposure, varies according to the type of photosensitizer used, but can last up to 6 weeks after treatment. Patients are given light precautions, including avoidance of direct sunlight and bright indoor light for the period of sensitivity. If light precautions are not followed, there is the possibility of sustaining burns, swelling, and pain. Other side effects of PDT are related to the area that is treated and can include coughing, trouble swallowing, stomach pain, painful breathing, local swelling, and/or shortness of breath.