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Optical biophysics can cure lung cancer

Precise detection and treatment of tumors using laser light are already saving 100,000 lives a year in the United States.

Recent developments in medical technology will soon be able to cure the majority of patients with lung cancer. First, it is now possible to detect the tumor much earlier than previously, while it is less than one millimeter in diameter and has not yet spread. Second, definitive treatment of the small tumor with laser light can destroy the cancer without harming normal surrounding lung tissue. This technology, based on optical biophysics, will save more than 100,000 lives in the United States annually.

Lung cancer is the leading cancer in men and will soon be the same for women, accounting for approximately 130,000 new cases in the United States annually, and an equal number of deaths. Current treatments are nearly always ineffective, with a five-year survival rate of less than 5% after detection of the tumor.

Up to now, the main problem in treatment is early detection. Once the tumor is large enough to be seen on chest x-ray or CT scan (approximately one centimeter in diameter), in more than 75% of cases it has already spread so far that it is inoperable; and chemotherapy or radiation therapy treatments have only a short term palliative effect.

Detection has been significantly improved recently with the development of better screening for the presence of cancer cells in sputum samples. In the past five years, this technology has been brought up to a level comparable with the PAP test for cervical cancer. The PAP test is widely recognized as having had a dramatic improvement effect on cervical cancer survival rates. The sputum test involves breathing in a mist aerosol, then coughing up a sample of bronchial mucous, which is then examined for cancer cells which have sloughed off a tumor in the lung. The pioneer of this technology, Dr. Geno Saccomanno at St. Mary's Hospital in Grand Junction, Colorado, stated that the technique can pick up lung cancers several years or more before they show up on a standard x-ray, while they are still in the size range of one millimeter. At this stage, there is much less likelihood that they have spread by metastasis to other lung areas or invaded neighboring tissues.

The sputum test can be done easily on a mass scale in an outpatient setting and is harmless to the patient. Dr. Saccomanno states that routine screening of the population would pick up more than 100,000 of the 130,000 new cases of lung cancer annually, at this early, treatable stage.

The second component of the therapy, precise localization of the tumor, as well as the third stage, definitive treatment, are both made possible by laser biophysics. This new modality is termed photodynamic therapy (PDT). Dr. Oscar Balchum, the head of Pulmonary Medicine at the University of Southern California School of Medicine in Los Angeles, so far has treated more than 200 patients, with an apparent cure rate of 100% for localized tumors. Although these patients have been followed after treatment for up to several years with no recurrence, Dr. Balchum cautions that the proof of long-term efficacy will require an additional 5 to 10 years of monitoring, as in any treatment.

Although 95% of lung tumors start in the lining of the airway tubes, the bronchi, and are therefore accessible by a fiber-optic bronchoscope (inserted through the mouth and down the airway tube), the tumors in the early treatable stage are small and difficult to distinguish from normal tissue. To improve the visualization of the tumors, Dr. Balchum has the patient take a dye, chemically related to hemoglobin, termed photofrin II (abbreviated HpD), which selectively localizes in tumor cells. To increase the visibility of the dye, he illuminates the bronchi with a Krypton-ion blue laser fitted into the fiber-optics of his bronchoscope, which makes the HpD-laden cells fluoresce red, so they stand out clearly against the background tissue. In 60-70% of those patients whose sputum shows cancer which cannot be seen on normal light bronchoscopy, Balchum reports that the tumor can be found with the HpD technology.

The third component is definitive treatment. Once the tumor is located in the sights of the bronchoscope, Dr. Balchum switches to another laser frequency, produced by a red ruby laser, and focuses the laser on the tumor. This frequency is differentially absorbed by the HpD-containing tumor cells, causing the HpD dye to photoexcite, which then causes a variety of destructive changes, which slowly kill the tumor.