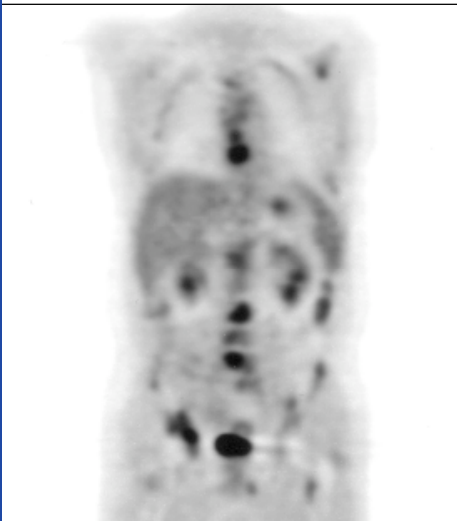


# Lymphoma:

## Using PET for Diagnosis and Treatment Response

A complex cancer of the immune system, lymphoma affects both children and adults and can take many different forms, including Hodgkin's and non-Hodgkin's lymphoma (a grouping of approximately 30 types of lymphoma). Lymphoma occurs when the lymphocytes—white blood cells that normally protect the body against infection—form abnormally and reproduce too quickly. Lymphoma takes advantage of the lymph system's extensive



PET scan of an adult with lymphoma

network of nodes, vessels, and organs to spread throughout the body. Unfortunately, lymphoma can be difficult to initially diagnose. The primary indications are relatively common symptoms—such as fever, swollen glands, unexplained weight loss, and lack of energy—that can be associated with a range of conditions.

In recent years, Positron Emission Tomography (PET) has emerged as a key tool in the effective diagnosis and management of lymphoma. PET scans reveal metabolic activity in the body by measuring levels of glucose uptake. Before undergoing a PET scan, patients receive

an injection of a tracer that attaches to glucose in the body. While all cells require glucose for energy, cancer cells consume additional glucose in order to rapidly expand and multiply. These areas of increased glucose consumption appear on the PET scan as “hot spots.” Scans typically take less than 30 minutes and the tracer is easily absorbed and eliminated by the body.

“While a tumor biopsy should provide the definitive diagnosis of lymphoma, PET scans can help to confirm that diagnosis and to stage the disease. By revealing the extent and location of the cancer, PET can help guide treatment decisions, including where to obtain the biopsy and what form of treatment the patient needs,” says **Ronald L. Van Heertum, MD**, *Director, Columbia Kreitchman PET Center, and Professor of Radiology, Columbia University Medical Center.*

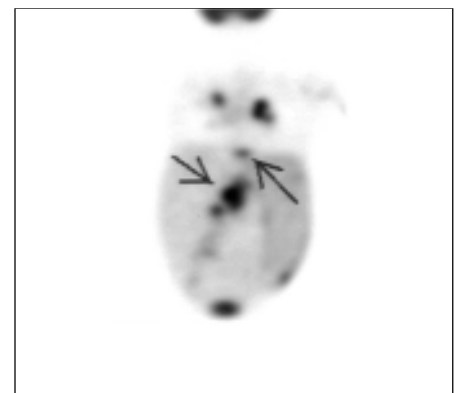
After the initial scan for diagnosis and staging, follow-up PET scans track the level of treatment response and help shape the treatment plan. “Since some lymphomas are curable, we are anxious to demonstrate a complete biological response to treatment. Suppose we see a patient with swollen glands in the neck and a biopsy shows lymphoma. We would do both a PET and a CT scan of whole body—the PET scan to show the extent of the disease, and the CT for more precise anatomical detail, particularly in the liver and spleen. We would also run blood tests and maybe a bone marrow test,” explains **Gregory Mears, MD**, *Clinical Professor of Medicine.*

“After four cycles of chemotherapy we repeat the PET scan. Chemotherapy can cause increased inflammation or scarring

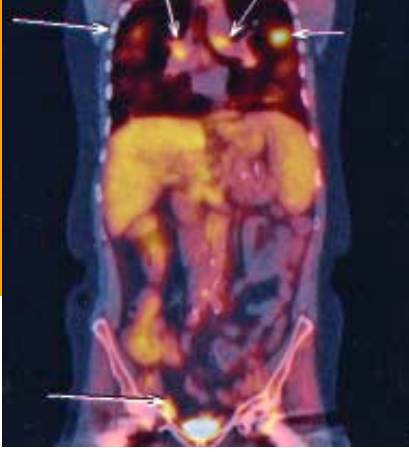
in the involved nodes. This enlargement will appear on both a CT and PET scan. PET, however, uniquely allows us to determine whether the swelling is treatment-related or shows remaining active disease,” he continues. “If the PET is negative (indicating that the enlargement stems from the chemotherapy), then only two more cycles are needed to best assure complete eradication. If the PET remains positive, I would conclude that a partial response has been achieved and that the patient would probably need four more cycles of chemo to better achieve a complete eradication.”

### PEDIATRIC LYMPHOMA

As the third most common type of pediatric cancer, lymphoma is proportionally more common in children than adults. Fortunately, most pediatric lymphomas can be successfully treated. “We use PET routinely in all our pediatric patients as part of diagnosing and treating lymphoma,” reports **Michael A. Weiner, MD**, *Professor of Clinical Pediatric Medicine.* “Determining the anatomic extent of the disease is very important for initial staging when treating both Hodgkin's and non-Hodgkin's lymphoma. We've also learned that the



PET scan of a pediatric patient with lymphoma.




PET/CT image of a lymphoma patient. The arrows point to specific tumor sites.

rapidity of response is very relevant to our patients' success. We typically repeat PET scans after every two to three cycles of chemotherapy to assess their response and to determine whether there is remission, complete or partial."

Dr. Weiner points out that some unique challenges exist in diagnosing and treating children with lymphoma. Children have swollen glands much more frequently than adults. These glands may appear as hot spots on PET scans even if they are not cancerous. In addition, children and teenagers who are diagnosed and treated for lymphoma often experience "thymic rebound," or a sharp boost in the immune system as it reconstitutes itself. While this rebounding is a good monitor of the child's recovery, it can also lead to false positives on PET scans. These challenges underscore the importance of having skilled physicians conduct careful readings of all PET findings.

#### THE ROLE OF PET/CT

Drs. Mears and Weiner are interested in learning more about the potential benefits of PET/CT, which combines PET and CT imaging in a single scanner. The goal of PET/CT is to effectively fuse the metabolic data of PET with the anatomic accuracy of CT. Dr. Weiner hopes in particular that PET/CT will be able to address the issue of false positives, by revealing if a physical tumor mass is associated with increased metabolic activity. "We hope to achieve enough specificity and sensitivity with fused PET/CT images to eliminate the need for separate scans on separate days in some cases," says Dr. Van Heertum. 

#### PERSONAL STORY:

### A Challenging Diagnosis Finds a Successful Treatment

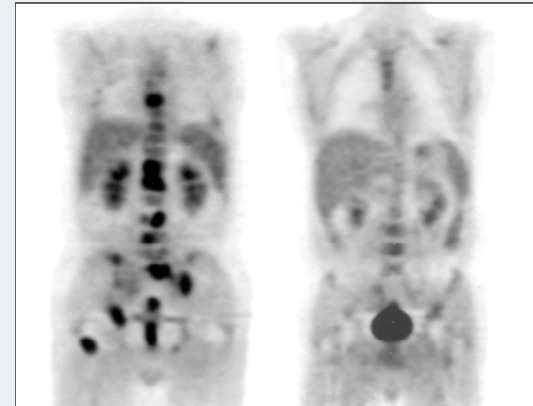
When William Friedman started feeling extreme lower back pain in late 2003, he assumed it was due to poor posture, too many hours at his desk, and too little exercise. The 61-year-old real estate developer took action by seeing a physical therapist, but the pain never went away.

By the spring of 2004, with his pain and fatigue still failing to improve, Mr. Friedman's friend and neighbor, **Linda Lewis, MD**, *Clinical Professor of Clinical Neurology* at Columbia University Medical Center, became increasingly concerned. "She was very uncertain that this was a muscular or bone problem," recalls Mr. Friedman. Based on the results of some additional tests, Dr. Lewis immediately put Mr. Friedman in the hospital and under the care of **Gregory Mears, MD**, *Clinical Professor of Medicine* and a specialist in adult lymphoma at Columbia University Medical Center.

Even once hospitalized, Mr. Friedman's diagnosis remained unclear. An initial biopsy was inconclusive, as were MRI and PET imaging studies. He went home, but was monitored closely. Dr. Mears suspected *indolent lymphoma*—a slow growing form of lymphoma. Six weeks later, Mr. Friedman's pain recurred and he came back in for more tests. This time a PET scan and biopsy both clearly indicated lymphoma. "They couldn't diagnose me initially because I had been given drugs that masked the disease," Mr. Friedman explains. Prednisone, a powerful anti-inflammatory medication, had shrunk his tumors, making them difficult to detect.

With the lymphoma diagnosis firmly established, Dr. Mears prescribed a chemotherapy regimen. "As soon as I started on chemotherapy, I felt less pain. And after the second treatment, I had another PET scan that showed remarkable elimination of the tumors," says Mr. Friedman. "Once I had completed all six cycles of chemo, I had a PET scan that showed no tumors, as did a follow-up PET/CT scan two months later."

Mr. Friedman has only positive things to say about his treatment at the Columbia Kreitchman PET Center. "I felt like the staff had a good attitude. They had a sense of humor and were very professional." As for undergoing the scans, "the best thing I can say about a PET scan is that it does not take that long and there is no pain, although the position is a bit uncomfortable," he reports. "And it wasn't until my last scan that I finally remembered to bring a favorite CD."



(Above left) A full body PET scan of Mr. Friedman taken on July 7, 2004 shows extensive lymphoma, with darkened regions corresponding to the increased glucose consumption of tumor sites. (Above right) A post-treatment scan, taken on August 16, 2004, reveals that the disease is in remission. The darkened region corresponds to healthy bladder activities.