

At the Netherlands' Maastricht Clinic, high technology and unique software (below and center) help cancer specialist Prof. Philippe Lambin (bottom left) make increasingly accurate decisions.



biomarker analyses. Remind analyzes and links more than 100 of these parameters.

In this research project, Remind then computes the likelihood of two year survival, and the risk of side effects, for various treatment options for a patient. The intention is to help physicians select the optimal treatment for each individual patient.

Combining Diagnostics and Treatment.

Maastricht physicians can use state-of-the-art Siemens technology for their diagnoses and treatments. For instance, a combined positron emission tomography (PET) and computer tomography (CT) scanner makes it possible to obtain 3D images of the lungs in spite of breathing-related movement — a must in the case of lung cancer patients. The PET unit uses a low-radiation marker substance to provide cross-sectional images that depict biochemical and physiological processes, while the CT details the anatomy and location of the tissue being studied.

The combination of both technologies provides doctors with information on the type of tumor they're dealing with, as well as its precise shape and position. When it comes to treatment, one of Lambin's preferences is adaptive radiotherapy. This Siemens solution

ters such as radiation dose, treatment time, concomitant chemotherapy, and the concentration of white blood cells. The intention is that such a tool helps doctors to recognize early signs of esophagitis, thus avoiding premature discontinuation of therapeutic treatment.

The next step in the research project will be to include the costs of potential complications associated with the therapy in question. Lambin's primary goal for 2008 is to broaden the system's database. "To make a fairly accurate prediction of the survival rate after a specific therapy, we need to have at least 500 to 1,000 patients in our database," he says. "We also need an external dataset to validate the predictions — that's the bottleneck."

The Maastricht research database now contains data on approximately 1,000 patients, 500 of whom were diagnosed with lung cancer. In order to expand this database, the Maastricht Clinic has plans to establish a digital network link with hospitals in Leuven and Liège in Belgium, and in Groningen in the Netherlands. Due to data security considerations, however, Maastricht's Remind system will only be given anonymous parameters via the link; the data itself will remain in other clinics. The resulting broader research database will make a com-

Digital Decision Support

Medical diagnostic procedures are overwhelming physicians with data. In response, doctors are turning to computer programs that help them assess and interpret results. Newly-developed software is now providing fast, accurate decision support.

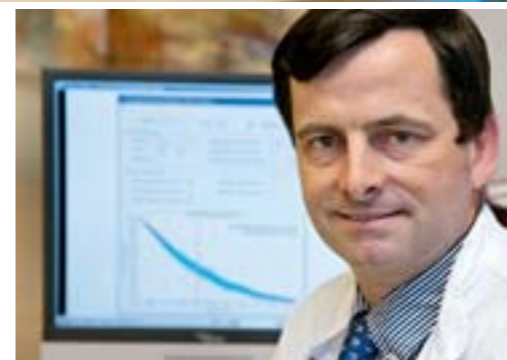
The Maastricht Clinic is a leading cancer treatment facility located in the vicinity of Maastricht University in the Netherlands. The clinic's Radio Therapy section has a friendly reception area where patients referred from numerous other Dutch hospitals await cancer screenings, follow-up treatments, and treatment simulations. To provide the best possible treatment for these patients, and improve cancer research, the facility houses an interdisciplinary team of radiation therapy specialists, biologists, physicists, and computer scientists, as well as experts from Siemens Healthcare, all of whom have access to high-tech medical equipment and state-of-the-art software.

A key member of the team is Professor Philippe Lambin, a radiation oncologist who is medical director of the Maastricht Clinic. "We're conducting research on a computer-aided decision-support system for personalized treatment of patients with lung cancer," Lambin explains.

"We're doing this because a study carried out by Maastricht University revealed that most doctors are unable to reliably assess how well their treatments are working, and therefore have difficulty in choosing the right treatment. We plan to improve predictions of the effectiveness of radiation therapies with the help of sophisticated software." The software Lambin is referring to is based on Remind, a data mining

tool from Siemens (*Pictures of the Future*, Spring 2006, p. 9).

Remind (Reliable Extraction and Meaningful Inference from Nonstructured Data) statistically analyzes all types of medical information, including everything from physicians' letters to medical images and laboratory diagnoses, and then identifies specific patterns. A research prototype system tested at the Maastricht clinic is able to predict the two year survival rate of lung cancer patients with high accuracy. The two-year survival rate is used by doctors to assess the success of individual radiation treatments. At the moment, 47 percent of all lung cancer patients survive for the first two years after diagnosis, if their cancer is detected at an early stage.



The first commercial application of Remind is Soarian Quality Measures software, which can measure quality of care from patient records based on established standards. At the Maastricht Clinic, however, Remind is being optimized for cancer research in a research project that calls for Siemens experts to work with clinic specialists on site.

The system requires as much medically relevant patient data as possible to issue statistically meaningful prognoses. Such data includes sociological information on the individual in question, measurements taken with imaging methods, and biological data such as cell division capability and radiation sensitivity, which can be determined through gene and blood

provides oncologists with a 3D data set of the patient, which allows them to optimally adapt a radiation procedure to the position and size of the tumor in question.

Here too, Remind supports physicians with prognoses and treatment planning assistance by assessing the results from a database of post-treatment examinations. Lambin describes this combination of diagnostics and treatment therapy as "computer-aided theragnostics."

Another aspect of this research project is to configure Remind to predict the relative probability of typical radiation therapy side effects, such as esophagitis (perforation of the esophagus). This is achieved on the basis of param-

pletely new type of clinical research possible. This is because specialists in Maastricht plan to use the data to simulate clinical studies, much in the same way the pharmaceutical industry uses machine-learning-based software to simulate experiments.

Digital Radiology. Dr. Marco Das works in the Department of Diagnostic Radiology at Aachen University Hospital, which is located around 40 kilometers from the Maastricht Clinic. The focus of his work is the detection of growths in the lungs, such as cancers, metastases, and benign tumors. The clinical routine here involves using CT to create 3D data sets of the lung, after which Das searches for suspicious-looking

structures in digital images. Das examines 30 to 40 patients this way every day, meaning that he only has a couple of minutes for each diagnosis.

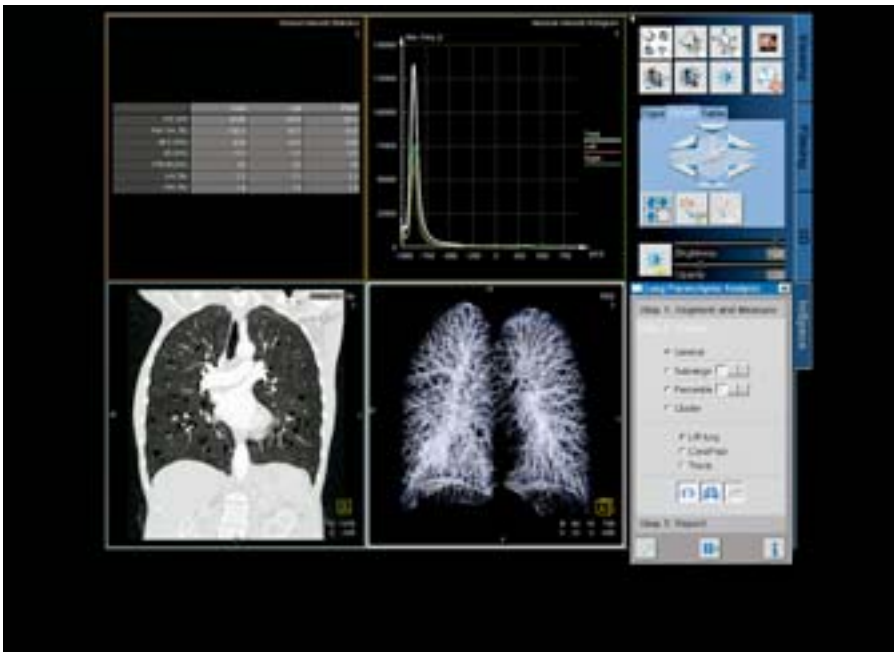
To raise the probability that no tumor is overlooked, a second radiologist double-checks all of his findings. Das also utilizes CAD (computer-aided detection) software that may eliminate the need for a second radiologist, as is already the case at many hospitals. CAD is a technology based on pattern recognition and not on artificial intelligence. CAD systems for lungs analyze differences in thickness in lung tissues and compare these with stored images of typical lung tumor patterns. They are therefore able to recognize such patterns in other CT images as well.

tive effect on the accuracy of radiologist diagnoses," says Das. The system does make errors, however. These take the form of false-positive diagnoses, which, according to Das, don't cause any major problems, since they can quickly be spotted by an experienced radiologist.

"CAD programs are very good as second readers, but they'll never replace radiologist diagnoses because a doctor's experience is the key to evaluating results," says Das. An additional advantage offered by the new *syngo* CT Oncology software — which includes *syngo*

Such measurements are also often used on patients with emphysema, a disease usually caused by smoking that destroys the alveoli in the lungs. Here, *syngo* InSpace4D Lung Parenchyma Analysis software from Siemens measures density distribution throughout the entire lung, whereby a diseased lung will, due to its burst alveoli, have more free air in its tissue (and will therefore be less dense) than a healthy lung. "This software solution makes it possible for the first time ever to quantify the early stages of emphysema and thus to effectively monitor treatment," says Das. "This used

It takes a digital radiology program only around four minutes to check 700 image slices.



Siemens software supports accurate diagnostic decision making regarding lung tumor characteristics.

Tumor Marker. "All of this functions very well in practice," says Das, who uses *syngo* Lung-CAD software from Siemens. The system examines lungs for tumors even before a radiologist has finished making his or her assessment. It takes the software only around four minutes to check up to 700 image slices, each of which is one millimeter thick — and it works even faster with thicker layers and a correspondingly lower number of images.

After Das completes his diagnosis, he analyzes the results produced by the software, which means there's no waiting time in between. The software automatically marks suspicious areas with red circles. "All studies to date show that CAD software has had a posi-

LungCAD functionality — is that it helps to accelerate diagnostic decision making, according to Das. For instance, doctors need to measure changes in tumor size in order to determine whether a treatment is working. Until recently this was done by manually calculating a tumor's diameter onscreen. Such measurements are extremely imprecise, however, and can vary from doctor to doctor. *Syngo* CT Oncology, on the other hand, improves measurement accuracy by automatically calculating the volume of all different types of tumors. It also enables doctors to determine tissue density — a measurement that cannot be performed manually. Tissue density, in turn, provides an initial indication of whether or not a tumor is malignant.

to be an extremely difficult process requiring several indirect tests."

Virtual Colonoscopy. Colon cancer screenings are another application where computer-aided detection is very helpful. Dr. Anno Graser from the Institute for Clinical Radiology at Munich University Hospital uses *syngo* Colonography with PEV (Polyp Enhanced Viewing) software to review the results of virtual colonoscopies. Unlike physicians in Aachen, Graser does not have a second radiologist and therefore relies on PEV software for a second opinion.

"The program, which can be used by any doctor, delivers very good results, as long as the colon has been properly cleansed beforehand," says Graser, who also tested the software in several studies. He's not only satisfied with the program's accuracy, but also happy that "the software simplifies and accelerates the entire process." In Graser's institute, it only takes four minutes, in fact, for the program to calculate the PEV results — about as long as it takes a gastroenterologist.

Graser has been screening one or two patients per day with the system since he concluded his clinical studies of the software. But there is still some resistance to the new technology. "Health insurance companies in Germany only pay for conventional colonoscopies, unless you have a situation where an intestinal infection or obstruction would not allow for such a procedure," he explains.

Nevertheless, patients prefer the virtual procedure because it's much shorter than the conventional one. Another major benefit is that its polyp detection software is extremely sensitive, thus improving the chances of early detection. "These benefits are going to help the system achieve a major breakthrough in terms of acceptance," says Graser. ■ *Michael Lang*