INSIGHTS

The Future of Medical Imaging

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Medical imaging has played a major role in clinical diagnosis and treatment for years, allowing doctors to examine specific sections of the human body without resorting to invasive surgical procedures. Techniques such as radiography, magnetic resonance imaging (MRI), positron emission tomography (PET), and ultrasound have changed the way medicine is practiced. And they are just the tip of the iceberg when it comes to what is possible (or nearly possible, at this point) through the development of new medical imaging technologies. The increasing popularity of teleradiology and telemedicine, the widespread use of computer-aided diagnosis (CAD), the increased quality of current medical imaging technologies, and the development of new medical imaging technologies—specifically in the field of molecular medical imaging—seem certain to reshape the medical landscape once more. However, with these new technologies and practices come daunting challenges that must be overcome.

Traditionally, the utility of medical imaging has been strictly in-house diagnostics and treatment: technicians took an image, radiologists examined it and presented their conclusions, and then the image was archived. If a patient was undergoing long-term treatment, the image could be retrieved a few weeks or months later to be used as a reference to chart a patient’s progress. For many years, these medical images were taken and stored on film, though that has changed over the last two decades. The 2009 American Recovery and Reinvestment Act has catalyzed the process of digitizing medical records—including medical images—by providing $19 billion in financing, but as of late 2009, “less than 10 percent of U.S. hospitals have adopted electronic medical records even in the most basic way.” As a result, many medical images are manually catalogued and retrieved, a costly process, especially considering the additional educational and administrative uses of medical images such as “teaching a trainee, producing a formal report, [or] justifying an examination to a third party.”

Despite the low rate of hospitals with electronic medical records (EMRs), some doctors have already begun to take advantage of having electronic medical images. Teleradiology is but one example. Teleradiology is the digital sharing of medical images between radiologists for the purpose of collaboration or interpretation, and has already been of enormous benefit to patients. An example of the use of teleradiology might look like the following:

“two patients arrive in the emergency department of a Maine hospital at midnight. The first has a presentation consistent with pulmonary embolism; the second, appendicitis… Today, both of these patients and hundreds of others like them would receive middle-of-the-night CT scans, taxing the hospital’s radiologists. But midnight in Bangor, Maine, is 10:30 a.m. in Bangalore, India. There — and in Switzerland, Australia, and Israel — sit teams of radiologists ready to read the scans and fax their findings back to the United States.”

This practice has already caught on throughout the U.S. As of 2007 (the most recent year for which data are available), 44 percent of U.S. radiology practices utilize external, off-hours teleradiology services (EOTS). Teleradiology has the potential to improve patient-care even further, by transmitting medical images to those with subspecialty expertise, allowing patients to have the “most appropriate faculty” review images, regardless of geographical boundaries. As the digitization of medical images continues and transmission speeds of large images improve, look for teleradiology to expand even further.

A related field that seems poised to expand is telemedicine. Telemedicine is simply the interaction of doctors and patients through videoconferencing, sometimes coupled with medical imaging devices. Telemedicine offers the ability to decrease the cost of healthcare delivery and increase access to care—especially in rural communities—by allowing patients to “access expert care that might otherwise be unavailable,” thereby improving quality of life.

Computer-aided diagnosis (CAD) is a fast-growing research field at present that offers a way to make medical image interpretation much more efficient. CAD works by using different learning software to compare new medical images to past ones that have already had abnormal markers or lesions identified by radiologists. The software then reports its conclusions as to whether the new medical image contains an abnormal marker or lesion, and this conclusion is used as a “second opinion” by a radiologist. CAD has already been successfully implemented for a number of different cancers including breast, lung, and melanoma, as well as vertebral fractures and intracranial aneurysms.

The future of CAD software most likely lies in software packages that will be incorporated directly into the viewing display of radiologists. Thus radiologists will be able to view the “CAD opinion” and relevant statistics concurrently with the medical image in question. Related or similar images can be linked to the viewing display as well, allowing radiologists to instantly examine past conclusions of similar images. In addition, there has been recent progress in developing CAD that would differentiate between diseases or between benign or malignant lesions or markers, rather than simply identifying

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lesions or markers. Some researchers even believe that the software packages will be web-based, allowing a radiologist to simply upload a medical image and then have the areas of concern highlighted.

The improvement and increased portability of current medical imaging technologies will probably be the most widespread and transforming development of medical imaging in the near future. As has been the case throughout many fields in the 21st century, the continually decreasing cost of electronics has allowed devices that were once reserved for hospitals, CT scans for example, to move into medical practices. Cheaper and more portable new technologies are emerging to compliment tried and true methods. TechEn’s Continuous Wave 6 (CW6) provides an example. CW6 is a quarter of the cost of an MRI and takes up less than 30 square feet (as opposed to the 300 square feet of an MR-Imager), which makes it extremely useful in situations where “portability and frequent follow-up measures are called for.”

Increases in resolution and quality of medical images are likewise expected to continue. For example, CT scans will continue to improve their “slice counts,” allowing for large volumes to be visualized in a single-pass. This allows for faster CT scans, but also higher image quality. The fields of 3D medical imaging and molecular imaging are also expected to develop and grow, largely thanks to technological advancement. 3D medical images allow “clinicians to view high quality 3D images in real time and help them make clinical decisions with accuracy.” Advances in molecular medical imaging will expand imaging probes to target “all the body’s major systems and associated disease types,” and will also be used to determine the effectiveness of certain drug treatments before they are administered. For example, “radiopharmaceuticals will be used to create diagnostic images which visually indicate whether cancer patients are susceptible to multi-drug resistance.”

With the promise of future medical imaging comes significant hurdles yet to be overcome. First and foremost is the issue of the electronic transmission and sharing of medical images, both within hospitals, to different domestic hospitals, and to different hospitals around the world. Electronic transmission of medical images is vital to teleradiology, telemedicine, and for certain CAD applications. During transmission, there are many opportunities for medical images to fall into the wrong hands, whether it be by human error or a network security breach. In the U.S., the unauthorized release of patient health information (PHI) is a federal offense, and therefore will require significant attention from both legal and computer experts. In order for teleradiology, telemedicine, and remote CAD software to be realized, this challenge must be addressed.

The second major hurdle impeding the advancement of medical imaging is storage capacity and retrieval times of medical images. A CT scan image—as of 2008—could be up to 1GB, meaning that the retrieval of a CT scan within the same hospital could take up to 15 minutes. Furthermore, such large images, and the increasing rates and numbers at which they are being taken, presents a major storage problem. The storage needs for medical facilities are growing by “at least 50 percent a year, with 60 to 90 percent of the storage capacity being consumed by image storage.” In order to deal with this explosion in data storage requirements, larger and cheaper storage and greater network bandwidth is going to be required.

Despite these challenges, the future of medical imaging appears auspicious. Over the next decade, medical imaging technology will become more portable and produce higher quality images, and, coupled with the technology of the information age, will allow for the continued development of teleradiology and telemedicine. In addition, the continued study and refinement of CAD promises to improve radiologists’ efficiency and accuracy in diagnosis. Just as in other fields, technological improvements are heralding in a new age in medical imaging. In the case of medical imaging, this change is sure to improve the diagnosis and treatment of patients, while reducing geographical barriers and overhead.

References