Imaging Issue: Part I

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When asked to assemble a collection of interesting case reports showcasing the impact of medical imaging upon the diagnosis and treatment of a variety of medical conditions, I wanted to focus on some new and cutting edge applications of imaging as well as show a gamut of interesting cases that would be of interest to physicians from all walks of life. After soliciting submissions from those both inside and outside of our department, I was initially overwhelmed by the eagerness of those wishing to share their favorite cases as well as the sheer number of cases submitted for publication. Rather than brutally paring down the number of excellent cases to a number than can be printed in a single issue, the editors have graciously allowed us to bring most of these beautiful cases to you in the form of a special double issue of which this is the first. In this issue, we touch upon the use of high-field 3.0 T MRI as well as advanced applications of CT including CT colonography and coronary CT angiography, microwave ablation for oncologic intervention, the use of MR in pregnant and pediatric populations, stroke intervention, as well as the public health issue of bisphosphonate-related insufficiency fractures. A few of the other cases not included in this double issue will also be shared as future "Images in Medicine" in the year to come. It is my hope that a few of these interesting case reports will raise your awareness of some of the new and exciting applications and interventions that medical imaging has to offer.

Like many other medical subspecialties, the field of medical imaging has undergone significant changes over the past decade. The **picture archival and communications system (PACS)** has allowed for instantaneous access to images for not just Radiologists but any referring physician. Voice recognition reporting software has resulted in near instantaneous reporting and notification. As a significant majority of imaging is now performed purely in the digital space and transmitted over electronic networks rather than transported in film jackets, film and paper reporting has increasingly fallen by the wayside. With federal incentives now in place for an even stronger push towards the all-encompassing electronic medical record, PACS and **health and radiology information systems (HIS/RIS)** can serve as a pioneering model to guide hospitals around the country towards this greater goal of digitizing the remainder of the patient's medical information.

With the speed and efficiency gains made by diagnostic imaging, it often seems as if obtaining an imaging exam results in a quicker result than ordering a simple lab test (and in many cases, this is likely true). However the rapidity of radiologic testing can be a double-edged sword. We should not let imaging preclude a proper cost-effective clinical workup. A clinical history and physical exam should always precede an imaging exam. CT should not be ordered before a serum amylase or lipase in the workup of acute pancreatitis or before a urinalysis in someone with flank pain and hematuria. A CT angiogram of the pulmonary arteries shouldn't be used to diagnose pneumonia.

Likewise, the widespread availability of PACS and an instantaneous report turn-around-time should not preclude referring physicians from directly consulting with a radiologist face-to-face or phone-to-phone when needed in managing the care of their patients. Radiologists are here not only to interpret imaging studies, but to act as the "consultant's consultant" in deciding if, when, and how best to use imaging to reach a diagnosis as well as help guide treatment. It is rare when direct consultation with a radiologist does not result in a more relevant radiology report and, ultimately, better management of a patient's care.

Nowhere is this truer than when trying to weigh the risks and benefits of the use of ionizing radiation in medical imaging, especially as it relates to the use of CT, X-ray, fluoroscopy, and mammography. While high dose radiation exposure (on the scale of Hiroshima, Nagasaki, Chernobyl, and perhaps even Fukushima) is well known to be associated with adverse health effects including an increased long term risk of developing cancer, when it comes to the low levels of radiation associated with medical imaging, the exact risks to long term health remain difficult to quantify. According to the latest position statement of the Health Physics Society, "below 5-10 rem (50-100 mSv), risks of health effects are either too small to be observed or are nonexistent."[1] It is likely the fear and resultant avoidance of undergoing medically-indicated imaging studies has on aggregate done more harm than the theoretical dangers associated with the low levels of radiation related to CT and X-ray. To put the radiation risk into perspective, a single typical CT scan exposes a patient to approximately the same amount of radiation encountered as background environmental exposure over the course of one year (5-10 mSv). The associated estimated lifetime risk of developing a fatal cancer from this scan is 0.05%. When compared to the overall lifetime risk of developing a fatal cancer from all causes of 22.8%, it is easy to see that the risk attributable to imaging radiation is infinitesimally incremental.[2] This risk is also very much dependent on patient age as a younger population is more sensitive to the long term effects of radiation than an older population. For the older screening population, this lifetime risk of a fatal cancer from a CT scan is below 0.02%.[3] Thus, when an examination is medically indicated, the risk-benefit ratio is very much largely in the favor of a net benefit. Another way to think about the risk-benefit balance is to consider whether the risk of not performing the examination outweighs the theoretical risks associated with the exam.[4]

Regardless of the difficulty of accurately quantifying radiation risks associated with medical imaging, many appropriate steps have already been taken to further decrease the amount of radiation associated with CT in keeping with the radiation biology principle of maintaining ionizing radiation **ALARA (as low as reasonably achievable)**. A myriad of technological advances in the last few years have included automatic dose modulation, iterative CT reconstruction techniques, bismuth body shielding, prospective ECG-gating, decreased kVp, and improved fluoroscopy techniques (including pulsed fluoroscopy). Other practical changes have included a reduction in the number of scan phases for multiphase contrast studies, tailoring of CT protocols for sensitive patients (such as children and pregnant or reproductive-age women) and for specific indications (renal stone protocol, screening CT colonography, etc.), as well as consideration of alternative nonionizing imaging techniques such as ultrasound and MRI. At our own hospitals alone, application of many of these strategies have resulted in a roughly 50-80% reduction in radiation dose over the past five years depending on the scanner and type of examination performed. In addition to advances in imaging technique, an evolving electronic health record has also seen incorporation of cumulative data on the number and types of radiological studies performed over the course of a patient's medical history to allow referrers to better weigh the cumulative risks of multiple scans against the benefits.

In the end, it is the ordering physician who can best balance the cost, benefits, and risks of obtaining an imaging study or procedure. The diagnostic imaging community is always ready and willing to be consulted regarding how best to gauge these risks and benefits, whether there are better or lower-risk imaging options, as well as how to best perform these tests to answer the question at hand. While imagers would be the first to admit that over-imaging is a major concern in this climate of rising health care costs, let us not lose sight of the fact that medical imaging has vastly revolutionized the way medicine has been practiced over the last century. The benefits of an indicated study and its contribution to modern medical care cannot be overstated.

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