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The WCC Note™

Reported by Margaret D. Phillips, M.D.; Presented by Stephen J. Pomeranz, M.D.

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Your Weekly Guide To Harmonizing Clinical Trial Imaging

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2009: Looking Back and Ahead in Imaging

Last summer while reviewing literature for this newsletter, I spent an afternoon on a porch elevated alongside an Idaho road. While mountains made a diaphanous blanket of color in the distance, and breezes prickled through tree leaves that flickered and shuffled like molecules in entropy, it occurred to me that our understanding of disease processes, due to our ability to image them, has altered fundamentally since I entered radiology 20 years ago. Rather like a J.D. Salinger's Glass family member, I felt a kind of epiphany, as silly as that sounds, sitting in a lawn chair among the plants withering in the mountain heat. And yet, it is this kind of realization about our profession – that it does not and will not stand still – that makes us so lucky to be a part of it.

As the panorama spreads before us of molecular, *in vivo* cellular, and micro environmental imaging, along with a continuing stream of new technologies that fire out of laboratories with so many endless possibilities, it is our great fortune to work in a profession that allows us, at its core, to serve as fly wheels of steady utility as diagnosticians and also play a role in medical innovations that are occurring today and that will continue to do so for years to come.

This year's final issue of *The WCC Note* veers away from the mainstream of practiced radiology and takes us down less travelled roads toward some experimental imaging highlights of 2009. From Dr. Pomeranz and me, we wish you very happy holidays and a joyous and healthy new year.

– Margaret D. Phillips and Stephen J. Pomeranz

ACCOLADES FOR IMAGING ADVANCES

In 2008, the Nobel Prize in Chemistry went for the discovery of green fluorescent protein, which revolutionized the imaging of small structures, allowing *in vivo* cellular imaging. What major accolades were bestowed for imaging this year?

1. Once again, a Nobel Prize went to imaging – this time for techniques that allow digital imaging and electronic communications, such as this newsletter. These discoveries ultimately revolutionized the practice of radiology. (1,2)
    a. In 2009, the Nobel committee awarded the Physics prize for inventing an imaging semiconductor circuit, the charge-coupled device (CCD), and for developments in optical fibers that allowed communication based on transmission of light.
    b. The prize went to two U.S. researchers, Willard S. Boyle and George E. Smith, from Bell Laboratories in Murray Hill, NJ, as well as Charles K. Kao of the United Kingdom and Hong Kong, China.

c. The charge coupled device came to fruition from a desire to create a memory storage device, and it originated after a 1.5 hour discussion between Drs. Boyle and Smith one afternoon in 1969. It relied on the photoelectric effect discovered by Einstein, for which Einstein won the Nobel Prize in 1921. Attempting to make advances towards a picture phone, Boyle and Smith imagined arrays of photocells that would emit electrons in proportion to the intensity of incoming light. The electrons in the photocells would then be read and thereby make an image – changing an optical image to a digital one.

d. In an online interview, Drs. Boyle and Smith were asked what set apart Bell Laboratories, which has received seven Nobel Prizes. Their answers were freedom, intelligent management that allows pursuit of interests, an institution financially well positioned to afford appropriate equipment, and excellent people – allowing fellowship and interchange of ideas.

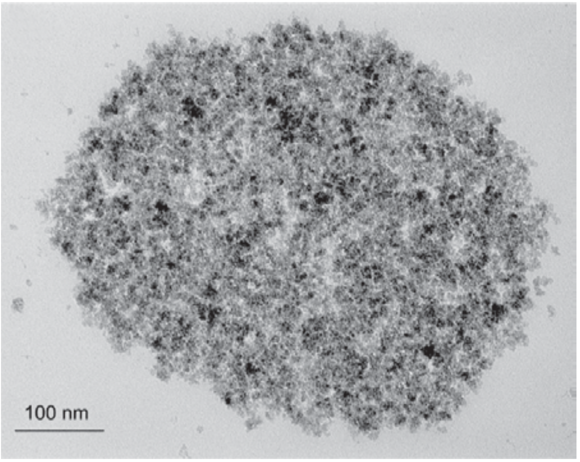
e. Dr. Kao used ultra-pure glass fibers to transmit light in 1966. Since the frequency of light waves is so much greater than electrical waves, transmission is much faster than with copper cables and radio waves.

2. The Japan Prize from the Science and Technology Foundation of Japan went to radiologist David Kuhl, M.D. from the University of Michigan. His work in the 1950s developed radionuclide emission tomography that led to, among other areas, PET scanning. (3, 4)

NEW DIRECTIONS IN IMAGING

What were some experimental or progressive techniques published in 2009 that reflect new directions or hold promise for the future?

1. The *in vivo* tracking of cells with MRI has undergone clinical study outside the United States using superparamagnetic iron oxide particles. (5)
2. Imaging atoms within an organic molecule adsorbed on a surface was performed with scanning tunneling microscopy. (6, 7)
3. Breast-specific gamma imaging with a high-resolution gamma camera was reported to show 93 percent sensitivity in 28 biopsy-proven known lobular carcinomas, in a retrospective multicenter study. (8)
4. Molecular imaging of the breast underwent review with description of, among others, the gene array analysis of tumors, phenotypic imaged tumor differences, MR tumor spectroscopy, and fluorescent probe imaging. (9)
5. Atherosclerotic plaque was imaged *in vivo* at the molecular level by using the MR contrast agent P947 that targets matrix metalloproteinases in plaque. (10,11)
6. Using infrared imaging guidance, researchers caused subtotal ablation of mice tumors, which resulted in T-cell immune responses and tumor regression. (12,13)
7. Minimally invasive autopsy to detect cause of death as an alternative to conventional autopsy was reported to show 93 percent of overall findings and 94 percent of major findings. The technique used whole-body CT, MR, and ultrasound-guided 12-gauge needle biopsy of the heart, both lungs, liver, both kidneys, and spleen. (14)
8. Apoptotic (early cell death) processes underwent time-lapse imaging in live cells. Researchers used a polarity-sensitive biosensor with switchable fluorescence states that allowed only the apoptotic cells to be detected. (15)
9. Reporter gene imaging of human mesenchymal stem cells implanted in porcine myocardium was performed with PET-CT. (16)
10. A single atom could be imaged by detecting electrons emerging from its surface using an aberration-corrected electron microscope. (18)



Ultra-small super paramagnetic iron oxide have crystalline cores of magnetite 5nm in diameter surrounded by a shell of dextran. After injection, they accumulate at sites of inflammation and the disease state can be imaged non-invasively by MRI to determine if surgical intervention is needed. (19)

CONCLUSION

***Conclusion:* The year 2009 saw Nobel Prizes awarded for techniques that ultimately brought about digital imaging and filmless teleradiology; the Japan Prize given for radioisotope tomography leading to PET; and a myriad of experimental imaging science that increasingly refined and exploited visualization of small structures – down to the atomic level.** ■

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- *Research and Reporting:* Margaret D. Phillips, M.D. (newsletter@wcclinical.com)
- *Reviewer and Publisher:* Stephen J. Pomeranz, M.D. (newsletter@wcclinical.com)
- *Managing Editor:* Shannon Roeper
- *WorldCare Clinical Editorial Advisors:* Richard C. Walovitch, Ph.D.; Vanessa Conde
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