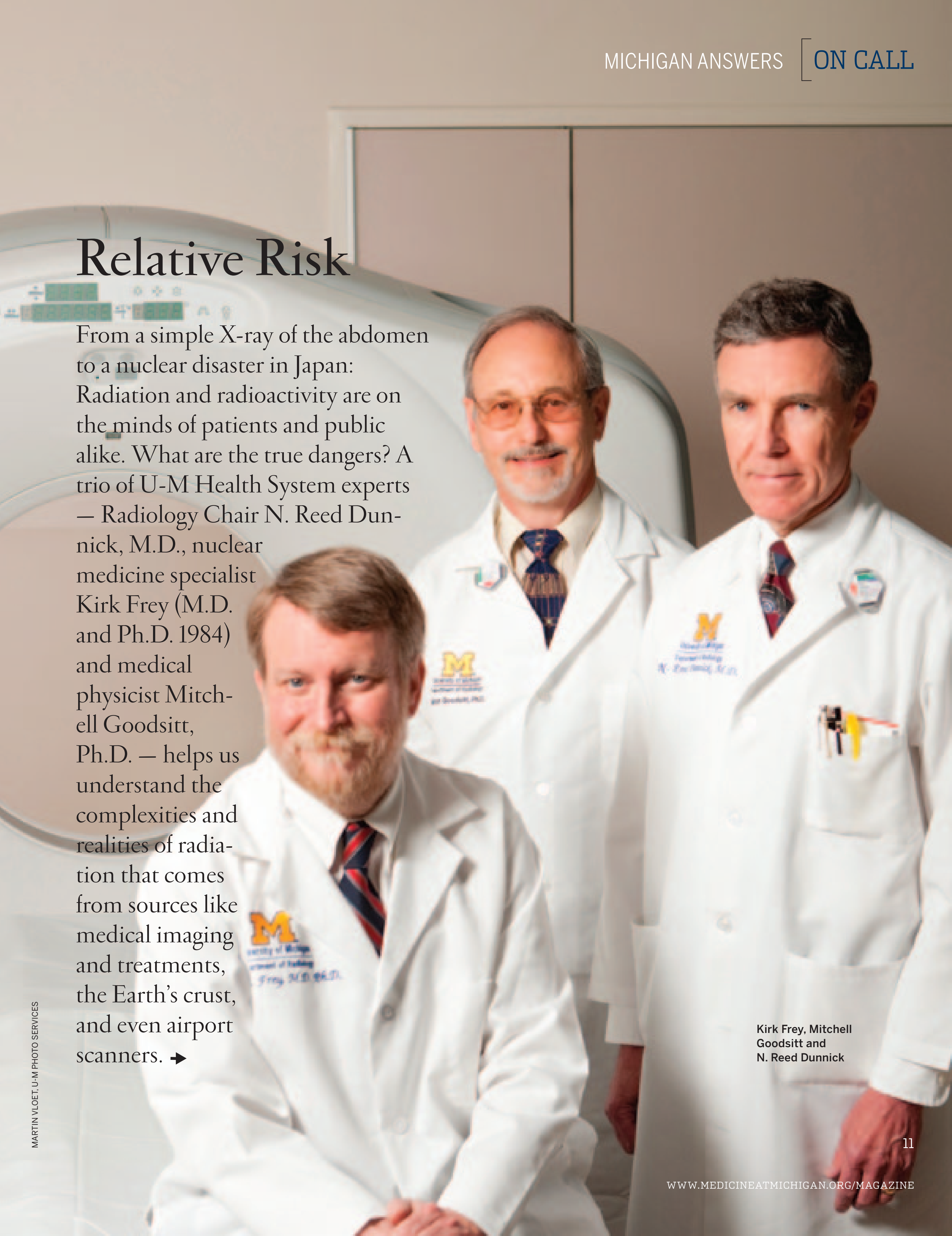
Relative Risk

From a simple X-ray of the abdomen to a nuclear disaster in Japan: Radiation and radioactivity are on the minds of patients and public alike. What are the true dangers? A trio of U-M Health System experts — Radiology Chair N. Reed Dunnick, M.D., nuclear medicine specialist Kirk Frey (M.D. and Ph.D. 1984) and medical physicist Mitchell Goodsitt, Ph.D. — helps us understand the complexities and realities of radiation that comes from sources like medical imaging and treatments, the Earth's crust, and even airport scanners. →



Kirk Frey, Mitchell Goodsitt and N. Reed Dunnick

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Q: What are the sources of radiation exposure we encounter in life?

A: We're exposed to background radiation on a daily basis: cosmic radiation; radiation from radioactive materials in the earth, such as uranium, which are greater in some geographic areas than others; radioactive materials that are in the food we eat, such as an isotope of potassium in bananas. And there's medical exposure — plain radiographs; computed tomography, or CT; mammography, which is a specialized form of X-ray; fluoroscopy for studies of motion, like swallowing and blood flow; and some medical treatments as well.

Q: Why is there so much public concern regarding radiation from X-rays?

A: People have heard about radiation and radioactivity, usually from a non-scientific source. They know it's bad, but not how bad. The range of possible radiation doses, from what you should ignore to what you should avoid, if possible, makes this confusing. People are afraid that radiation from their mammogram will cause cancer, yet the whole purpose of doing the mammogram is to detect cancer. We also have patients being treated with radiation therapy who don't want to get a diagnostic CT scan. Concerns and confusion are based upon lack of information, and it's a complex topic.

Q: Does long-term exposure to low levels of radiation cause cancer? How much is too much?

A: Physicists have debated this for a century. The information we have comes from extrapolating data from the nuclear bombing of Hiroshima and Nagasaki in 1945. Those were acute doses all at once, and we know that high doses can cause cancer. It's complicated, because you've got background exposure, which varies from location to location. If you're living in mile-high Denver, you get more cosmic radiation than we do in Ann Arbor and more dose from greater concentrations of uranium in the soil. Airplane pilots spend more of their lives at altitudes where cosmic radiation is much higher than it is for the rest of us. But people living and working in high radiation dose areas don't seem to have a detectable difference in the frequency of cancer from those living in low dose areas. Some scientists have even proposed the concept of radiation hormesis, which suggests a very low dose of radiation actually stimulates the immune system and is good for you.

Radiation is often measured in units known as sieverts. A threshold that is typically used is 100 thousandths of a sievert, or 100 millisieverts (mSv): below that, don't worry; above that, we think you're at increased risk. Average background radiation from all sources in the U.S. is about 3 mSv per year.

Q: Why is there increased concern for children?

A: First, because their cells are proliferating much more rapidly than in adults, children are more radiosensitive than adults. Second, because children have more years to live, cancer has a greater chance to develop during their lifetime. We believe that X-rays are capable of

EFFECTIVE RADIATION DOSES RELATIVE TO BACKGROUND EXPOSURE

RADIATION SOURCE	AVERAGE EFFECTIVE DOSE (MSV)*	TIME NEEDED TO GET SAME DOSE FROM BACKGROUND RADIATION (3 MSV/YR)
Airport Security Scan	0.0001	18 minutes
PA and Lateral Chest Radiographs	0.1	12 days
Head CT	2	8.4 months
Head and/or Neck Angiography	5	1.7 years
Nuclear Medicine Bone Scan**	6.3	2.1 years
Coronary Angiography (diagnostic)	7	2.3 years
Chest CT	7	2.3 years
Abdomen CT	8	2.7 years
Barium Enema	8	2.7 years

*Dose for airport security scan from: M. Mahesh, "Use of full body scanners at airports," *British Medical Journal* 2010. All others: F.A. Mettler, W. Huda, T.T. Yoshimuzi, M. Mahesh, "Effective Doses in Radiology and Diagnostic Nuclear Medicine: A Catalog," *Radiology* 2008; 248: 254-263. **(99mTc-MDP).

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causing cancer, but there is a very long lag time. If it takes 30 or 40 years to develop a radiation-induced cancer, someone in their 60s or 70s needn't be too concerned, but we expect a child to still be alive when cancer could develop. To reduce risk, the trend in the field is to find ways to make diagnostically useful images which impart less absorbed radiation per dose.

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Q: How is radiation used in patient treatments?

A: We know radiation can kill tissue, so when we find cancer, we can kill it with radiation. The challenge is to kill just the cancer and not the normal tissues around it. For that, nuclear medicine specialists in the radiology department use radioisotopes. We typically treat the thyroid gland, for instance, using iodine-131, because the thyroid concentrates iodine. A measured dose of radioiodine produces intended thyroid damage to kill the cancer, to the exclusion of other parts of the body.

Other therapies involve more complicated molecules to which a radioactive emitter is attached. The therapy used most frequently is an antibody fragment that targets malignant lymphocytes. In certain forms of lymphoma, these cells have proteins on their surfaces that uniquely distinguish them. There are two antibody radiopharmaceuticals that are designed to stick to that unique protein. The tenacious adherence of the antibody to the lymphocyte protein causes the lymphocyte to get irradiated. You couldn't possibly deliver that kind of a dose from external beam radiation therapy on a this-cell-but-not-that-cell level.

Radiation oncologists use external beams of high dose radiation, and they're getting very good at targeting just the cancer. There's also an intermediate method used in nuclear medicine, and that's to implant radioactive seeds: Put the seed on a needle, stick it into the cancer, and then remove the needle leaving the seed inside. It's not as elegant as radioactive antibodies, but it preserves the surrounding tissue while killing the cancer.

Q: How can doses of radiation be kept low?

A: As a field a number of years ago, we decided we needn't chase the best image quality; we just need an image good enough to make the diagnosis. So we try to hold the radiation dose down, especially in children. Vendors are producing CT scanners that use a process called iterative reconstruction to get the same image quality for a lower dose. We've installed General Electric's iterative reconstruction product on all of our 64-slice scanners and have reduced radiation doses by about 30 percent. The use of digital X-ray detectors, special X-ray beam filters, and other new technologies have allowed us to similarly reduce radiation doses in radiography, mammography and fluoroscopy.

Nuclear medicine imaging equipment manufacturers have developed single photon emission computed tomography (SPECT) and positron emission tomography (PET) scanners that are more sensitive, so we can use doses of radiotracers reduced as much as 50 percent.

Q: How can patients help assure their safety when getting X-rays?

A: Patients should look for an imaging facility that is accredited and physicians who are board-certified, which will increase chances for the best study at the lowest dose. Sometimes a non-ionizing exam, like MRI or ultrasound, can be an alternative. Patients always have a choice, too: They don't have to have any examination we recommend. But it's a tradeoff: If you get the examination, you get the diagnostic information that was sought; if you don't get the examination, you save the radiation, but don't get the diagnostic information.

The most important message is that of relative risk. Patients are virtually always better off having a needed imaging study than avoiding the modest radiation associated with it. [M]

Interview by Rick Krupinski