Will Chipotle's food poisoning scare and Fukushima rethink help society overcome radiation phobia?

E. coli outbreaks traced to Chipotle fast food outlets in Oregon and Washington could, and should, bring food irradiation into public discussion, but such discussion may be complicated by fears and misconceptions concerning radiation biological effects.

Hype about radiation dangers is ever present, as we live in a radiation phobic society, but the recent scares could lead to a perfect storm, given that a story also has been brewing in connection with the Fukushima nuclear power plant accident of 2011.

Nuclear technology is like the unloved, underachieving, yet brilliant, child, who gets noticed only after doing something wrong. Seven decades into the nuclear era, more than 400 commercial nuclear power plants are operating around the planet, powering civilization with an energy density a million times that of fossil fuels. There is minimal carbon footprint and when operating correctly nuclear plants put out less radiation compared with power plants that burn coal, because the latter contains small amounts of uranium that is released into the air when the coal is burned.

We embrace nuclear technology, however ambivalently, but many people remain unduly frightened about using radiation to protect against food-borne life-threatening bacteria like *E. coli.* Still, it is used when food safety is particularly vital, patients who are immunocomprised, for instance, or astronauts who cannot afford to get sick on a billion dollar space mission. Irradiating food is the best way to keep it safe, so that's what's done at NASA where there's no obstacle since the people consuming the food are among humanity's most science literate. It's a pragmatic thing to do, just as it's becoming very clear that a new generation of nuclear energy plants may be the sensible approach to address our growing power needs without exacerbating global warming. In terms of selling both nuclear power and food irradiation to the general public, however, there may be some hills to climb in terms of science education, particularly related to radiation biology.

Chernobyl and Fukushima: Primer on radiation health

In 2011, an earthquake and tsunami damaged the Fukushima Daichi power plant in Japan, leading to the worse nuclear accident since the Soviet Chernobyl disaster of 1986.

Health effects from release of radiation and radioactive isotopes at Fukushima are not even close to the scale of Chernobyl, where spikes in the incidence of various cancers were documented in the years that followed. This included 6,000 cases of thyroid cancer in children and adolescents. That's partly because thyroid tissue is particularly radiosensitive, but also because of milk, contaminated with radioactive iodine.

When energetic enough, any radiation will damage DNA and produce other genetic and cellular effects. But different types of radiation affect cells differently and with different levels of severity and the importance of this concept cannot be overemphasized. Unlike beam radiation, such as neutrons, gamma rays, or X-rays, radioactive isotopes are attracted to specific tissues and organs. For iodine, this means

the thyroid, and that's why the thyroid cancer after Chernobyl was linked to contaminated milk. Like a canary in the coal mine, peaks in thyroid cancer after a nuclear accident are a sure sign that something is seriously amiss.

In the case of Fukushima, the emergency response was much better and people did not drink contaminated milk. Thus, while there were cases of acute radiation sickness in workers who went into the plant heroically to avert a more Chernobyl-like accident, for a few years the canary seemed to be in good health. No thyroid cancer could be attributed to the accident–at least until now, when things look a lot less certain.

Newly published Fukushima study must be interpreted with caution

A study published by Japanese researcher Toshihide Tsuda and several colleagues in the journal *Epidemiology* shows a sharp increase in the number of pediatric thyroid cancers diagnosed. Many of the cases were picked up initially through ultrasound screening, and since the thyroid cancer rate in the Fukushima area is now 20 to 50 times that of other regions of Japan, the authors of the study concluded that the accident was the reason.

The conclusion could exacerbate concerns about low dose radiation, but society should remain calm. Scientists are divided over Tsuda's conclusion, firstly, because it really doesn't make a lot of sense. In contrast with Chernobyl accident, people in Japan were protected from contaminated milk and other products that could have been contaminated with radioactive iodine.

To look for a connection with thyroid cancer, the new study used estimated total radiation doses in millisieverts (mSv). For people living in the Fukushima area, the exposure would have come from beam radiation emanating from the plant. It's important for people to understand how that's different from radioactive isotopes. Whether pointed at food to kill bacteria, or through a human by accident or to image the organs inside, beam radiation passes right through. It delivers energy while passing through substances, but it does not render the substance radioactive.

Beam radiation and radioactive isotopes: An important distinction

Run a radiation sensor over a delicious mango from southeast Asia, a procedure that is required for imports into this country that are irradiated. Do this before and after the procedure with a high gamma ray or electron beam dose, and you will get the same reading. That's because the energy goes through the fruit in a split second. It doesn't linger there. Nor does it render the fruit radioactive, because the effect of the gamma rays is chemical, not nuclear. The gamma rays interact only with the electrons of atoms, allowing for the break of DNA molecules, killing any insects, and, if the irradiation dose is high enough, bacteria, such as *E. coli.* But because the atoms in the food are mostly stable forms of carbon, hydrogen, oxygen, nitrogen, phosphorous and sulfur, it's physically impossible for the radiation to induce a physical change in the protons and neutrons within the nuclei of the fruit's atoms. They cannot be rendered radioactive.

Based on the elevated pediatric thyroid cancer rates, the conclusion of the authors implies causality by

radiation doses in the range of a few mSv, which is a very small dose. It's roughly what most people on Earth receive annually in natural background radiation and less than the dose of a typical computed tomography (CT) scan used diagnostically in health care. Moreover, the doses resulted largely from beam radiation emanating from the power plant, as opposed to exposure to lingering radioactive isotopes, and the doses were estimated based on locations with respect to the accident site, so they are not individualized for the thyroid cancer patients and for those who did not develop cancer.

Thus, in the same issue of *Epidemiology* that features the Tsuda study, another researcher, Scott Davis, professor at the University of Washington's School of Public Heath and Fred Hutchinson Cancer Research Center, has a paper that is critical of Tsuda's conclusions, based mostly on the idea that when the radiation doses are not individualized to actual people, we can't really draw conclusions about the effects.

This raises the question of why the pediatric thyroid cancer rate around Fukushima is so much higher compared with the rest of Japan. As with the rise in the number autism diagnoses over recent decades in Western countries that various interest groups have tried to blame on vaccines, glyphosate, aircraft chem trails, circumcision, Jupiter passing through the constellation of Leo or fill in the blank with whatever you like, the answer may turn out to be on the boring side. Rather than resulting from a biological effect of the agent in question on diagnosed individuals, the increased incidence could be the result of an environment that makes diagnosis of the condition more likely.

In the case of autism, that environment is expanded diagnostic criteria, leading more children to classified as autistic than would have been diagnosed in earlier years. In the case of thyroid cancer near Fukushima, the answer could be exactly what the Japanese government has been saying for a few years, namely that more children have been diagnosed with thyroid cancer, because health authorities have been looking for thyroid cancer more than in other areas of Japan. If everybody is given ultrasound screening, you can be fairly certain that many cases will be picked up that otherwise might go un-noticed.

We don't know yet if the Japanese government officials are correct that what's really been happening has nothing to do with the radiation. But if they are correct, here is a new perspective. Because the most common type of thyroid cancer that's being diagnosed at alarmingly high numbers is fairly treatable when detected early, it's quite possible that the Fukushima disaster could end up SAVING some children's lives, since if not for the disaster, there would be no universal ultrasound screening.

Food irradiation and nuclear energy

There are many reasons why society could be better off if it could get over its radiation phobia, one being that more people might be eager to choose irradiated foods. In the United States, only spices, plus certain produce from other countries, are nearly always irradiated. Irradiation of other foods such as beaf, pork, shellfish and domestic produce is approved by the FDA, and the management of many restaurants is prudent to use these foods. But when it comes to chains like Chipotle that have a track record of trying to attract customers with what we might called "pretend healthy" food, it's hard to get any information. Maybe they use irradiated foods and maybe they don't, but given the recent *E. coli* outbreak, together with a record of previous incidents of food poisoning, it's a fair guess that they're not serving irradiated meats

and produce, but rather the “natural” foods that they feel are a selling point. If that’s the case, then the pretend healthy attitude is what caused the outbreak. Sometimes, “natural” can be a synonym for dangerous.

For those of us who accept the overwhelming scientific consensus that humans using fossil fuels are what’s causing climate change, expansion of nuclear energy should seem like a logical option. In recent interview with the *Wall Street Journal*, Bill Gates laid out several reasons why this is so.

Firstly, over the years, far fewer deaths and injuries have resulted from nuclear accidents than from events related to fossil fuels. That includes not just oil drilling and refining and coal mining, but also explosions in the natural gas industry. But what about dangers from nuclear power to the population as a whole?

Like most civil nuclear power plants in operation today, Fukushima was only a second generation system. It used a light water system that’s fairly primitive compared with the generation-3 nuclear systems that have been built in a handful of sites around the world and which the level of safety redundancy dwarfs all generation-2 plants. On the horizon are generation-4 nuclear approaches, which will be even safer and include strategies like molten salt reactors for which melt-downs will be physically impossible. Plus there will be robot systems in place so that in an emergency everything can shut down without human workers having to be in the plant.

Gates speaks about nuclear energy, because his foundation is funding research on one type of generation-4 approach that uses uranium-238, the cheapest and most plentiful uranium isotope. In sharp contrast with other new nuclear approaches, Gates believes his researchers can have a prototype power plant running by the 2020s, which in the world of nuclear research is amazingly swift. But turning any kind of new nuclear technology into a national or global commitment requires political will, which can be hard to obtain from foodies who do not even want their food irradiated and legislators with little political backbone to stand up for science.

Currently, the social and political milieu underlies strong support for renewable energy strategies, such as solar and wind. This is wonderful, Gates emphasized in his interview, but public enthusiasm is so strong, that the limitations, and in some cases drawbacks, of solar and wind are sometimes ignored.

In terms of drawbacks, given that nuclear critics often point to the problem of waster disposal, it’s relevant to point out that in California alone production of solar power equipment currently produces 13 tons of toxic material per year that must be stored away for thousands of years to protect our environment. As for the limitations, Gates explained that for wind and solar to contribute more than 20 to 30 percent of our electrical needs, we need a breakthrough in energy storage. Current battery technology is nowhere close to meeting that requirement. There are some clever non-battery ideas for certain geographical environments, such as pumping water up mountains while the Sun shines and wind blows, then letting the gravity pull the water down through turbines at night.

In terms of safely, generation three and four should put anyone at ease, if they think scientifically. But for logical thought on the nuclear issue, society must learn to separate pretend health from real health issues,

and one major element needed to do that is gaining some perspective on radiation effects.

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