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Atomic transfiguration

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The May 3, 1947 issue of *Collier's* magazine included a special feature on “Man and the Atom: An Introduction to a Golden Age.” The section included an essay by science journalist Alfred Q. Maisel entitled “Medical Dividends.” It is illustrated by a remarkable composite photograph: a man standing up from a wheelchair, beaming exultantly in the radiation of a mushroom cloud that encircles him. (See illustration.) This is no ironic image; the article touts the forthcoming medical benefits of atomic energy. “The first benign results of atomic bomb research have been new tools for medical scientists which promise cures for hitherto incurable diseases. There have been failures, but the work is just starting and researchers are generally hopeful.” The reason for this hope? Radioisotopes. As Maisel explains, “For to scientists, radioactive isotopes are tools of power in the eternal fight against pain and death; they may be even a means of prying open the once tightly shut door to an understanding of the inner processes of life.”

This striking optimism about the healing power of radioisotopes updated and reinforced four decades of efforts to harness the therapeutic promise of radioactivity. Marie and Pierre Curie discovered radium in 1898; clinicians began using it during the first years of the new century (following, in part, the pattern set by medical uses of X-rays). Physicians used radium to treat a wide variety of conditions, from acne to hemorrhoids, but its dominant medical use was for cancer, as an alternative or supplement to surgery. Its therapeutic value found less authorized venues; radium was an ingredient in many nostrums sold in the 1920s, including a popular elixir called Radithor, which poisoned wealthy socialite Eben M. Byers. Radium entered industry as well, helping drive the price to \$180 per milligram at the time of World War I. Its widespread use in luminous paints led physicians to recognize the peril of ingesting radium, made vivid by the tragic deaths of young women dial painters.

In the 1930s, artificial radioisotopes, produced first from small neutron sources then from cyclotrons, were rapidly taken up in medical research and therapy. Physicist E. O. Lawrence declared in 1934 that radiosodium manufactured in his Berkeley laboratory had properties “superior to those of radium for the treatment of cancer.” Sodium-24, which could be produced from table salt, was also a fraction of the cost. In Lawrence's Radiation Laboratory at the University of California, Berkeley, physicians John Lawrence (brother of Ernest) and Joseph Hamilton made the first attempts at therapy with phosphorus-32 and sodium-24, both initially given to leukemia patients. In 1938, another artificially produced radioisotope, iodine-131, began to be used to treat thyroid conditions. The growing clinical demand for radioisotopes was disrupted by the Manhattan Project, which reoriented cyclotron-based physics. Nuclear reactors, built to produce plutonium, made possible the industrial-scale production of radioactive isotopes, but only select military personnel and scientists even knew of their existence.

The terrible human toll of the atomic bomb detonations over Hiroshima and Nagasaki did not lessen the prevalent hopes that novel sources of radioactivity would revolutionize medicine. If anything, the new scale of atomic energy heightened the level of expectation. As medical physicist Robley Evans asserted (without evidence) in a 1946 article in *Atlantic Monthly*: “the sober trust is that through medical advances alone, atomic energy has already saved more lives

than were snuffed out at Hiroshima and Nagasaki.” The following year, Representative Everett M. Dirksen persuaded the U.S. Congress to earmark \$5 million for the Atomic Energy Commission (AEC) to undertake cancer research, since radioactive materials comprised “the essential point in this whole cancer business.” As he put it, “if we are going to spend a few hundred million dollars in the atomic-energy field to perfect an instrumentality of death, then let us take a little of that money to develop an instrumentality to preserve life.” Radioisotopes seemed to provide a way to redeem the destructive uses of the atom.

The hope that isotopes would cure cancer was predicated on the notion that they would localize to specific tumors and deliver internal radiation. One sensational case, reported in 1947, reinforced these expectations. A patient diagnosed with adenocarcinoma of the thyroid, despite having had his thyroid gland removed twenty years earlier for hyperthyroidism, was treated with iodine-131. The radioactive iodine localized to several metastatic tumors of the thyroid adenocarcinoma, making the many tumors detectable but also, over time, shrinking their size. As Maisel put in the piece for *Collier's*: “the case of Mr. B is one of the most hopeful things that have hit the medical world in a long, long time. For it demonstrates two uses of atomic energy—as tracer detectives and as interbody medical bullets—that are finding increasing application in scores of ways in laboratories and hospitals all over the United States.” Most thyroid cancers, however, were not susceptible to radioiodine treatment.

While the quest for radioactive magic bullets continued, phosphorus-32 and iodine-131 became established treatments for non-cancerous conditions such as polycystemia vera and hyperthyroidism. Cobalt-60 began to be used as an alternative to radium in cancer treatment, but as an external source (or implanted), not localized by the body to the tumor. Radioisotopes also contributed powerfully to the development of new diagnostic tools in medicine. As contemporary observers recognized, the use of radioisotopes in clinical diagnostics was essentially an application of tracer methodology to medicine, putting small amounts of isotopes to use in measuring blood volume, assessing organ function, and detecting tumors.

The growing consumption of radioisotopes in clinics and laboratories can be directly attributed to the U.S. government, which made them accessible and inexpensive. After World War II, the facilities of the Manhattan Project were transferred to a new civilian government agency, the AEC. The AEC was charged with the peacetime development of atomic energy as well as the continuing manufacture of atomic weapons. Even before the new agency was founded, leaders of the Manhattan Project decided to make its original large-scale reactor, X-10 at Oak Ridge, a radioisotope production facility aimed at supplying civilian institutions. The first shipments of radioisotopes from Oak Ridge went out in August 1946. The British Atomic Energy Research Establishment at Harwell launched a similar radioisotope distribution program the following year. By 1955, the U.S. AEC had sent out nearly 64,000 shipments of radioisotopes to domestic and foreign purchasers.

For the AEC, interest in biology and medicine—especially cancer—was not only humanitarian, but also motivated by issues of occupational health and safety. The hazards of exposure to radioactivity in the Manhattan Project had been managed under the veil of secrecy. Inadequate knowledge about the biological effects of fissile materials (particularly plutonium) and fission products meant that safety guidelines were adapted from the regulations for radium. The U.S. government sponsored animal and even human experiments, mostly classified, to fill in gaps in knowledge. With the onset of the arms race, the AEC became responsible for protecting workers in its many industrial plants as well as civilians exposed to radioactive waste and fallout from peacetime tests. Security about safety proved elusive. After World War II, the concept of “tolerance,” based on the idea that a safe threshold existed, was abandoned in favor of a “permissible dose.” A variety of new studies demonstrated that even low-level radiation

could cause damage, and beyond somatic effects were mutations that would affect generations to come.

Scientific discussions gave way to public debates in the 1950s, as politicians, activists, and journalists became increasingly concerned about the hazards of fallout from peacetime atomic weapons testing. Public attitudes about radioactivity were irreversibly altered. The popular image of radioisotopes as “medical bullets” gave way to alarm that fission products such as strontium-90 and iodine-131 were contaminating the food supply and endangering the health of Americans. When confronted by politicians and scientists on these issues the AEC often denied the alleged risks, which only reinforced suspicion that the government's commitment to developing atomic energy was not driven by public interest.

The predominance of negative images of radioactivity in popular culture since the 1950s has led to a cultural forgetting of the vision of atomic transfiguration that went before. Not that the dreams were fulfilled; in particular, radioisotopes did not vanquish cancer. Yet the U.S. government's efforts to promote the utilization of radioisotopes did, in fact, produce significant advances in biology and medicine. Experiments in biochemistry and molecular biology of the 1960s through the 1980s, from the mapping of metabolic pathways to the sequencing of genes, relied on the routine use of radiolabels. In the field sciences radioisotopes advanced understanding of bioconcentration and the cycling of materials through ecosystems. Radioisotopes and the development of a new generation of detection devices put nuclear medicine at the technological vanguard of diagnostics. As the era of relying on radioisotopes enters its twilight, these accomplishments and their political origins should be remembered as part of the complex legacy of the atom bomb.

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Further reading

1. Rentetzi, Maria. *Trafficking Materials and Gendered Experimental Practices: Radium Research in Early Twentieth-Century Vienna*. Columbia University Press in conjunction with [gutenberg<e>; New York: 2007](http://www.gutenberg-e.org/rentetzi/index.html). at <http://www.gutenberg-e.org/rentetzi/index.html>
2. Heilbron, J.L.; Seidel, Robert W. *Lawrence and His Laboratory: A History of the Lawrence Berkeley Laboratory*. University of California Press; Berkeley, CA: 1989.
3. Welsome, Eileen. *The Plutonium Files: America's Secret Medical Experiments in the Cold War*. Random House; New York: 1999.
4. Walker, J. Samuel *Permissible Dose: A History of Radiation Protection in the Twentieth Century*. University of California Press; Berkeley, CA: 2000.
5. Creager, Angela N. H. Nuclear Energy in the Service of Biomedicine: The U.S. Atomic Energy Commission's Radioisotope Program, 1946-1950. *Journal of the History of Biology* 2006;39:649–684. [PubMed: 17575955]

Illustration.

“Medical Dividends” in May 3, 1947, issue of *Collier's*.