

recommended in the United States, though Germany seems to have been unique in specifying a tolerance dose ten times stricter (0.025 roentgen per day) "when there is a possibility of (germ-line) genetic damage."⁶⁶ In 1942, special regulations were established to govern nonmedical uses of X-ray technologies—as, for example, in the construction industry, where the rays were used to locate flaws in metal castings and other materials.⁶⁷ German regulations may have been more strictly followed than those promulgated elsewhere, judging from the massive outpouring of compliance literature produced in the wake of the law, detailing optimal levels of lead shielding, control of beam coherence, and so forth.⁶⁸ Anyone wishing to install or operate an X-ray machine had to demonstrate compliance with these regulations.⁶⁹

Efforts also continued to document radiogenic cancer. In 1937, the journal *Strahlentherapie* (X-ray therapy) published a report of a woman who developed cancer in her larynx twenty years after receiving X-ray treatments for a thyroid disease. In 1938, the *Klinische Wochenschrift* described the course of a leukemia contracted by an X-ray laboratory assistant exposed for many years to the rays. In 1944, the *Zeitschrift für Krebsforschung* published the case of a thirty-year-old man with thyroid cancer who, at the age of six, had been X-rayed as part of a treatment for scrofula.⁷⁰

Of course, concerns about health effects were never distributed equally. Radiologists who suffered harms were elevated to the status of "martyrs to science," as in April of 1936, when Hamburg radiologists unveiled a monument to commemorate the physicians who had perished from work with radium and X-rays (the monument still stands outside the St. Georg Hospital). One year later, the journal *Strahlentherapie* published an "honor roll" of 169 "roentgenologists and radiologists of all nations" who had given their lives or limbs to the cause.⁷¹ American radiologists published similar lists (e.g., Percy Brown's of 1936)⁷²—though martyrdom by this time was beginning to shift to embarrassment, as evidenced by American characterizations of the 1937 Congress of Radiology as a "congress of cripples."⁷³ In neither Germany nor America were monuments ever erected to commemorate the much larger number of patients and technicians who must have suffered.

Let me end this section by pointing out that therapy, diagnostics, and sterilization were not the only uses for X-rays under the Nazis. During the Second World War, as plans were underway to create a "radiologic bomb"—using conventional explosives to scatter hazardous radioisotopes—discussions were also begun concerning the construction of an X-ray weapon for use in aerial combat, the idea being that a sudden burst of X-rays might be enough to kill or injure the crew of an enemy's aircraft. A 1944 report submitted to the Luftwaffe Research Institute at Gross Ostheim outlined plans for such a weapon, though it is not yet clear whether the idea ever got past the drawing board. Wartime urgencies were straining budgets for many such schemes, though air force chief Hermann Göring as late as January 1945 was still instructing his engineers to take seriously the idea of "nuclear methods of defense against enemy bombers."⁷⁴

RADIUM AND URANIUM

"Radioactivity," a term coined by the Polish-born Marie Curie and her French husband, Pierre, was discovered at the end of the nineteenth century—less than a year after X-rays—in the course of efforts to explain the fluorescence of uranium ores. The discovery is a classic one in the annals of serendipity: Henri Becquerel in Paris had been exposing uranium salts to sunlight to explore the phenomenon of luminescence, when by chance he noted that uranium even when unexposed had the power to darken photographic plates. Within a couple of years, Madame Curie and her associates had isolated two new elements, polonium and radium, both of which exhibited *radioactivity* (a term she coined) with emissions thousands of times more powerful than those of uranium.

Hoping to have discovered a medical tool equal in significance to X-rays, physicians developed various forms of "radium therapy" that soon joined X-rays in the roster of fashionable medical treatments. Radium therapy was as popular in Germany as it was in the United States; a 1935 list of medical uses for "radium emanation" (radon gas) or radium salts included: radium baths, radio-