The Early Clinical X-Ray in the United States: Patient Experiences and Public Perceptions

MATTHEW LA VINE

Department of History, Mississippi State University, 214 Allen Hall, Mississippi State, Mississippi 39762. Email: mlavine@history.msstate.edu

ABSTRACT. The first x-ray machines were large, loud, sparking, smelly, and ostentatious devices, prone to mishap and injury even when fully under the control of the physicians who, in droves, invested money and prestige in them. Their bizarre and sometimes overwhelming presentation in the clinic reinforced the contemporary public understanding of x-rays as fantastically potent yet ambiguously helpful. As one of the icons of the new scientific medicine, x-rays bore much of the public’s expectations for a technological panacea, a belief that was reinforced by the spectacle of their generation and their undeniable effect on the body. A quarter century later, refinement of the technology had made irradiation safer and more effective, but also made the operation of the machines themselves almost undetectable. This “domestication” of x-ray machines underscored their failure as a modern-day heroic medicine, while reinforcing an emergent understanding of radiation as a subtle, cumulative, and insidious threat. KEYWORDS: x-rays, popularization, cancer, patients, nuclear culture, public understanding of science, scientific medicine, radium.

IN his breezy and popularizing memoir These Mysterious Rays, radiologist Alan Hart describes what a typical patient might experience during a visit to his modern x-ray therapy clinic. At the end of the treatment, the patient “has heard nothing, felt nothing. In fact, a good many of our patients cat nap during their
treatments. Most city bedrooms are noisier and far more uncomfortable than the treatment room. To a visitor expecting the horrendous it must all seem very drab and uninteresting. Of course,” Hart added, “older machines were not so quiet and convenient.”

The noise and inconvenience of the previous generation of x-ray machines had much to do with the reason a patient going in for radiotherapy in 1943 might “expect the horrendous,” but not simply because the patients of the 1940s had bad memories of the machines of the 1910s. In the early years of medical radiology, patients subjected to x-rays of any sort would have found it impossible to nap, and were far more likely than Hart’s patients to be burned, shocked, or misdiagnosed. Many entered the clinic expecting precisely those outcomes, yet it was in these first few decades of clinical radiology that they were most easily reconciled to the use of x-rays. The “horrors” that Hart knew his patients to be imagining were of a different sort: that radiation was inherently and irremediably dangerous, no matter how inconspicuous the machines that generated it. This understanding was possible only because of the more hopeful era that preceded it: the simultaneous terror and exuberance that early machines evoked in patients and doctors curdled into lingering fear and disappointment later on.

Historians have taken notice of the anxiety that x-rays initially provoked, even before any real evidence that they could cause physical harm arose. The chaotic mix of reactions to the news of their discovery has been explored in a number of works, but relatively few studies have attempted to reconcile the roentgenological zeitgeist with their use in the clinic. In the first few years after their introduction, when Americans were gripped by “radiomania” (to adopt Carolyn Thomas de la Peña’s useful term), thundering x-ray machines that worked on the edge of scientific understanding were trumpeted in newspapers and Chatauqua lectures as the source of miraculous cures. The excitement that attended the very existence of x-rays was fueled in no small measure by the fact that many physicians had similarly high expectations of the rays’ curative

potential—and a noticeable absence of trepidation that quickly resulted in both seemingly miraculous cures and gruesome injuries. This led Bettyann Kevles to make the intriguing observation that x-rays were “the first technology that taught us, collectively, to hold our breath, waiting for the next shoe to drop”—that the delayed harm that the rays could do was the model for anxiety about other novel environmental factors, like nuclear fallout or Nutrasweet. She also argues that x-rays were understood in large part according to their apparent capacity to denude and concludes that they were explicitly sexualized as a result, with consequences both for clinician and for their reciprocal impact on the visual culture of the post-Victorian period. This interpretation is shared by Joel Howell’s study of the social and political context of twentieth-century medical technology, including x-rays, which finds striking differences between the sexes in the ways that x-rays were applied, but also in the perceived reactions that men and women might have to the experience. Or, more accurately, Howell found that only women’s reactions were cause for comment in early medical radiology, an observation corroborated by the research undertaken for this article. Patients, in other words, are not invisible in the historiography of radiology, and these works take due cognizance of the role that the public discourse about x-rays influenced private medical care.

By contrast, the intellectual and technological histories of the first three decades of radiology, which saw the creation of a professional identity for radiologists and a full course of methodological and instrumental changes, have been thoroughly considered. Radiology was already forming a distinct professional identity by the end of the nineteenth century, and the internal communications of that first generation of radiologists focused on the adaptation of the x-ray apparatus into a useful and reliable clinical tool. As a result, historians of health physics have been able to exhaustively

detail every step in the evolutionary process. In order to make an exposure, three technological elements—a current source, a Crookes tube, and a photographic plate—had to work in concert. At first, all of these elements were, to some extent, unreliable. Static generators were finicky about humidity; tubes were fragile, poorly focused, and produced rays of varying wavelengths from one day to the next. Glass plates were breakable, bulky and required for their developing, skills and chemicals that few physicians possessed. The human elements, too, of clinician and patient were only just learning their roles.

This chaotic first age is sometimes referred to as the “gas tube era,” for the low-vacuum Crookes tubes that were used. Beginning in 1913, they were replaced by the hardier and more adaptable hot-cathode tubes, the first of a series of transformative changes to the overall experience of x-raying. Taken as a whole, these improvements effectively “domesticated” the x-ray machine, transforming it from an unreliable, smoking, sparking spectacle into one unobtrusive piece of clinical equipment among many. Older machines were not replaced instantaneously, of course, but by 1926, Henry Pancoast could declare that the “epoch” of the old gas tubes was nearly at an end: patients were by then far less likely to encounter bedside gasoline generators powering the tubes, uninsulated live

---


wires throwing off sparks and ozone, or the other especially vivid elements of gas tube era technology.\(^8\)

The transition from one kind of machine to the next completely changed what it meant to visit the x-ray doctor. Notwithstanding the works mentioned above, however, historians have said little about patients’ experiences in that regard. This is not, as I will argue, a trivial omission: not only did their reactions help shape the development of the machines used to generate rays, but the endpoint of that evolution—Hart’s somnolent apparatus—helped a new kind of anxiety about radiation to take hold. The contrast between these two technological epochs is therefore significant not only for our understanding of American medicine in the early twentieth century, but also for the study of early American nuclear culture. This article will characterize patients’ anxieties about x-rays in the first quarter century of their use and demonstrate that long before Americans perceived radiation as a subtle and insidious threat to health, they were earnestly convinced of the overt power of x-rays to both heal and harm. In fact, many patients believed from the start that this new icon of scientific medicine might bring them to physical harm in various ways, and their anxieties were no less strongly felt for lack of the preponderance of evidence that would inform later x-ray fears.

Rather, x-ray anxieties (and enthusiasms) in those first decades were sustained by the profoundly dramatic nature of the x-raying experience—so indelibly vivid as to be utterly incommensurable with the notion of a silent, sinister threat. The risks of over-irradiation remained in the 1930s and beyond, especially as therapeutic x-rays became more and more the standard of care for malignancies, but neither the machines nor the media climate of those later decades made it possible for patients to sustain expectations of miraculous cures. It was, instead, the manifest impotence of the latter-day x-ray, rather than its capacity for harm, that allowed those subtler concerns to take root.

---

8. Henry Pancoast to George Hoadley, 22 March 1926 (available at: http://www.fi.edu/learn/case-files/coolidge-2853/medium/respond-pancoastmerits.jpg; accessed 3 June 2011). Acknowledging that no clear boundary can be drawn, I will use the term “gas tube era” to refer to the three decades between 1896 and 1926.
Henry Pancoast admitted in 1904 that he had been lured into the practice of radiotherapy by the newspapers, which never missed a chance to report on “miracles” wrought by x-rays, but never mentioned the hundreds of cases they had failed to help. What misled Pancoast and his contemporaries can inform the historian: newspapers did not manufacture their readers’ excitement about x-rays, but they certainly helped to maintain it, and as I will show in the following section, in doing so they steered the narratives about x-rays into a few discrete channels. Readers might have been treated to stories in the gas tube era that were humorous (x-rays being used to discover small toys that children had swallowed), or frightening (obituaries for the first wave of radiological martyrs), or exciting (the always-pending cancer cure), or of local interest (the opening of a town’s first x-ray studio), but they never read stories of the routine. Successful x-ray treatments for minor diseases—acne, for example—escaped the attention of the press, and were not usually the subjects of fiction, or memoirs, or cartoons, or advertising copy, or of the other kinds of sources I have considered here. I do not wish to make too strong a claim: no matter how well tailored for spectacle the x-rays may have been, there were surely patients who were unimpressed or unmoved, who became numbed by repetition, or who were simply too concerned with the circumstances that brought them to be x-rayed in the first place to worry much about the means by which they were diagnosed or treated. If the patient voices that can most easily be heard are the ones shouting in fear or pain or delight, however, they are nevertheless capable of useful testimony.

**X-RAYS IN THE PRESS DURING THE GAS TUBE ERA**

In order to understand how the physical experience of being x-rayed might be perceived by patients in the gas tube era, we must first consider the informational landscape that they inhabited with respect to the rays. As with any consideration of the American public writ large, it is useless to speak blithely about what was “known,” since that might vary enormously from individual to individual. We can, however, mark the boundaries set by the x-rays’

---

coverage in the American press, which was at the time unprecedented in scope and intensity for a scientific discovery, and we can broadly characterize its tone and tropes. The era’s print reportage reveals expostulations of pure fin de siècle techno-optimism, as well as a wariness on several levels about the intrusiveness of rays, and a backlash against their sudden ubiquity on the pages of newspapers and the lips of casual conversationalists. Yet there is more to the first efflorescence of x-rays in the press than these broad brush strokes suggest. The unguarded and collectively incoherent statements in the public sphere about the medical applications of Roentgen rays during that initial furor show that whether potential patients reacted to the prospect of x-raying with curiosity, fear, optimism, or resentment, they nevertheless had every reason to expect something fantastic: a radical departure from the usual doctor’s visit that promised change of some sort, whether good or bad.

In newspapers and magazines, accounts of the rays’ miraculous healing powers were a commonplace for years. In April 1896, a Chicago Daily Tribune headline posed the rhetorical question, “Is the X Ray a Curative Agent?” and the nation’s papers spent two uninterrupted decades answering in the affirmative. Much Expected of X Rays read the subhead of another Tribune article the following year, and for the remainder of the gas tube era, x-rays were perennially on the brink of fulfilling those expectations, to gauge from the papers. Where there were no breathless articles, there were advertisements for x-ray studios. Borrowing against the same scientific modernity as the worthies of the American Roentgen Ray Society, their ads touted painless, surgery-free and above all immediate cures. If they failed to cure many patients, they nevertheless succeeded in raising expectations as to what “x-ray doctors” were supposed to be able to accomplish.

Because electricity, in the rather spectacular form of a static discharge, was used to generate the rays, and because those rays were immediately put to use illuminating dark, hidden places like the

interior of the body, they quickly became rhetorically linked to sunlight and electricity. This is significant because heliotherapy and electrotherapeutics were already well established as important tools for the new scientific medicine. X-radiation seemed to possess even more of its predecessors’ ability to subtly, fundamentally alter the living body. In fact, the association between the x-ray and the body was being discussed well before anyone had realized the significance of the red welts and watery eyes that attended x-ray research. The Independent’s treatment of “The New Photography” on 30 January 1896, for example, wondered whether “this new force which will give a picture of a living man’s skeleton . . . may not have some sensitive effect on the human body.”

When Thomas Edison invited reporters to witness a series of roentgenographical experiments in February 1896, they wrote with what now looks like an extraordinary understatement of a drowned mouse’s apparent revival by the x-rays: while being imaged under Edison’s experimental apparatus, the mouse “struggled to one side of the plate and then dragged itself back beneath the powerful ray as if it found warmth there.”

The adoption of x-rays was rapid and geographically thorough, and even very rural populations had access to them after a few years. Consequently, much of what was said in print about x-rays was born of local reporters’ direct observations. An x-ray machine

12. Anon., “Thomas A. Edison’s Experiments,” New York Times, 8 February 1896, 9. Several days later, the Times dutifully reported that a Columbia professor used four dead mice and a garter snake to try to recreate the revival, but failed. (Anon., “Tests with New Plates,” New York Times, 14 February 1896.) Science journalism at the time—to the extent that the concept existed for American newspapers—is justifiably accused of sensationalism and outright fabrication. However, the sudden insatiable appetite for news of x-rays among readers was matched by a sudden wealth of stories to report on. And very little of what appeared in print seems to have been fabricated or even “massaged.” The collective confusion over what x-rays were and what they signified, in this case, seems to flow directly from the fact that a very light editorial touch was used.
13. Suites of equipment that manufacturers marketed for office use could, of course, be shipped to rural clinics nearly as easily to city practices. Joel Howell notes that the presence of an x-ray machine in a nearby town did not necessarily help a patient with injuries too severe to permit travel; in this regard, urbanites probably had disproportionate access. See, Howell, Technology in the Hospital, 108. However, one of the specific concessions that manufacturers made to the country doctor were fully portable, battery-powered diagnostic machines. For specific examples of the models used, see Otto Juettner, Modern Physio-Therapy: A System of Drugless Therapeutic Methods, Including a Chapter on X-Ray Diagnosis (Cincinnati: Harvey, 1906), 502. I am indebted to David Pantalony and the staff of the Bakken Museum of Electricity and Life (Minneapolis, Minnesota) for letting me examine a similar portable unit in their collection.
appearing in a clinic was, at the very least, a significant commercial development for a town, and prompted commentary on radiation, health, medicine, and science from newspaper after newspaper in the waning years of the nineteenth century. Because x-ray machines were, for practical purposes, ubiquitous after their first decade, and because doctors had independently experimented with their use and generation, locally authored accounts of x-ray remediation of cancer were common. For example, Madison, Wisconsin, residents not only heard one of their own physicians proclaiming high-voltage x-irradiation as a promising cancer cure, but also saw him present eight local people who had been successfully treated by his protocols.  

These accounts had a sense of immediacy that was lacking in Science Service wire stories or Popular Science features: they conveyed not that benefits were imminent in the abstract, but that specific local doctors were at work with extant technology today.

Not all accounts were positive. By the first decade of the twentieth century, references to therapeutic x-rays “burning” and “withering” were ubiquitous in the public discourse. Even ostensibly positive articles about the development of supposedly “burnless” machines, or accounts of debates among doctors as to whether x-ray burns were any more serious than sunburns, served to reinforce the public’s awareness of those burns.  

Backhanded compliments like these were not confined to the articles: a depilatory patent medicine advertising in 1905 pointedly reminded readers that it was “better than the X-ray, because it does not burn, scar, or paralyze the tissues under the skin.”

The occupational hazards that x-irradiation presented provided an early and perennial stream of newspaper stories. In 1903, Thomas Edison announced that his own health had been negatively affected by exposure to the rays six years before, causing poor digestion, lumps in his stomach, and eyestrain. It was in this report that

---

the public learned of the illness of Clarence Dally, one of Edison’s glassblowers, who had undergone a series of surgeries and amputations that had taken his left arm and was threatening his right. The coverage included brusque language from Edison on his changed attitude towards x-irradiation: “Don’t talk to me about X-rays…. I am afraid of them. I stopped experimenting with them two years ago, when I came near to losing my eyesight and Dally, my assistant practically lost the use of both of his arms.”17 This was not an offhand remark: Edison swore off any further exposure to the rays, even very mild diagnostic irradiation much later in his life. Dally died the following year, and was promptly labeled a martyr in front-page obituaries that left little to the imagination as to the sort of agony he had experienced as a result of his exposure.18

His death was not quickly forgotten: his name remained a standby in a minor but recurring note in coverage of x-rays. When the Washington Post devoted a front-page column to medical martyrs in 1909, it paused to note the likely future martyrdom of Pierre Curie (trampled to death by horses before injuries from radium could worsen) before noting Dally’s case (“seven years a martyr to dermatitis,” and worse ailments that the Post omitted) and that of several more recent ray victims in medical practice.19 When radiological experimenter Mirhan Kassabian contracted skin cancer the following July, neither the Post nor the Trenton Evening Times waited for him to die before proclaiming him an x-ray martyr on their front pages—the latter paper noting that Kassabian had recently come to Trenton in order to testify as an expert witness in a lawsuit in defense of doctors accused of causing x-ray burns in another patient.20 Though the radiology profession collectively bore extraordinary losses with stoicism and black humor, the gruesome nature of their declines and deaths and the ostensibly self-abnegating cause of it all made them sympathetic figures, and

18. See, for example, Anon., “Protege of Edison Killed by X-Rays,” Post-Standard [Syracuse, New York], 4 October 1904, 1.
provided ample ammunition for readers predisposed to see the rays as more baneful than beneficent.

For all the general exuberance in the press toward the positive potential of x-rays, newspapers also made clear that the same rays could burn, maim, or kill. Of course, there were means other than reportage by which this particular understanding of the rays circulated in the public sphere. X-rays were a popular target for humor columns and blind editorial items, allowing newspapers to simultaneously cater to the interest that they aroused and sublimate some of the anxiety they created. “It is said,” wrote Arthur Waugh of The Critic, in one of the first items printed in the American press on the subject, “that this new light can penetrate human flesh. Mind-reading was bad enough, but here comes an instrument that can read the innermost secrets of the heart... The possibilities of this new invention are terrible.”21 This uneasy humor was characteristic of many subsequent such meditations on the rays: x-rays connoted not merely omniscience, but a subtly awful, penetrating sort. The New York Times deadpanned that some doctors’ early resistance to using the rays sprung from the fact that they would instantly reveal the physical cause of all physical and moral deficiencies, including “cussedness.” The same article repeated a little poem from the Indianapolis Journal surmising that “now the timid, doubting suitor / by Professor Roentgen’s art / May, before he speaks, discover / If she has a marble heart.”22 While this doggerel was not actually intended to advance the notion that the rays could be put to such a purpose, there can be no doubt that this was whistling past the graveyard. In a more serious tone, the Chicago Tribune reported:

Walter Besant, a popular author, is not enthusiastic over the new X ray and its results. He says the more he thinks about it the more uncomfortable he feels. He shudders at the thought that the prying eye of science, not content with laying bare our bones, will spy out our thoughts, dreams, ambitions, loves, jealousies, and other emotions, record them, and file them away for future reference.23

Other fears were less abstract, such as those depicted in the 1903 short story “Uncle Jimmie and the X-Ray Doctor.” Uncle Jimmie

is a stock hillbilly character who discovers a whitish patch on his skin that he is told may be leucoderma (or “lukerdammer” as rendered). Fearing it is contagious, he travels to Atlanta to see a doctor who has “some sort of lightenin’ machine fer takin’ off cancers, bonefelons, warts, and had even drawed a bug outen a little gal’s year with hit.” Jimmie is frightened at the prospect of being x-rayed: he believes he will be struck with a lightning bolt from the machine, and further, “the room was dark, an’ I felt creepy like I was bein’ conjured.” He steels himself and tells the doctor to proceed, only to find out that the x-ray examination and treatment have been underway for ten minutes already. The doctor cannot convince Jimmie that the dim light from the tube is enough to make his bones visible, and so steps in front of the fluoroscopy screen himself, casting a shadow of his skull. Jimmie is terrified and flees. A week later, his skin clears up, and he sends “the conjurer” a quarter in payment, but swears he’ll never dabble in such witchcraft again, as “the Bible’s ag’in sech doin’s.”

The Independent was a relatively highbrow journal, and the story was probably intended as little more than a broad lampoon of ignorant hicks, with the ostentatiously modern x-rays serving as a point of contrast against the illiterate and superstitious Jimmie. Nevertheless, these stories neatly capture the essence of many patients’ experience with going in for their first x-raying. It was, as I will discuss at greater length below, a potentially bewildering or terrifying experience during the gas tube era, in part because patients often entered the clinic with dramatic expectations for x-rays to live up or down to.

PHYSICIANS’ AND PATIENTS’ EXPECTATIONS

From the moment of their discovery, x-rays were trivially easy to generate with a current source and a Crookes tube, both of which were readily available. Detailed instructions to make a simple apparatus were available in books like Edward Trevert’s Something About


25. In fact, the same basic story and characterizations were repeated years later in the monologue, “Mandy Gets an X-Ray Photograph,” except with a caricature of a black housemaid standing in to represent ignorance and antimodernism through her naïveté about x-rays. Ruby Livingston Erwin, Mandy Gets an X-Ray Photograph (Chicago: Means & McClean, 1932).
the X-Rays for Everyone published in 1896. Homemade generators were occasionally pressed into regular service in the clinic, but before the end of 1896, manufacturers of laboratory equipment and electrotherapeutic devices were selling all the necessary elements and accoutrements of an x-ray machine, individually and in all-in-one kits. Brass and marble fixtures, see-through glass enclosures, and ornately carved wooden frames adorned the pricier apparatuses, and their esthetic appeal was stressed in the advertising copy: “All parts of the Acme X-Ray Unit are finely finished in black enamel and highly polished nickel,” read a typical catalog entry. Moreover, “the quality of the workmanship is the very best that money and experience can supply. Taken together with artistic design it makes a piece of apparatus that was intended to be and is an ornament in any doctor’s office.”

Such ornaments were expensive; prices at the turn of the century for even a bare-bones apparatus rarely fell below $500 when freight and the necessary accessories were factored in, to say nothing of the added cost of electrification or a generator, the construction of light-proof examining and developing rooms, and the consumable tubes, glass plates, and chemicals needed to produce an image. Small wonder, then, that many physicians were pleased to see in their patients an appropriate awe, or even fear, of the looming cabinet with its imposing array of switches and rheostats and accessories. It validated at a glance the doctor’s credentials as a purveyor of the new scientific medicine—at least, when everything worked as expected. For their part, physicians tended to regard the addition of an x-ray apparatus as a momentous occasion for their practice, both in terms of its impact on patient care and on the practice’s finances. Referring to a static generator and tubes that made him the first local doctor to use x-rays, Texas physician Charles H. McCollum was pleased that “when my newly purchased appliances had been added to the rather modern equipment I already had, my office became a sort of show place of the town.”

27. Charles H. McCollum, Pills and Proverbs (Boston: Meador, 1941), 103.
in such a way as to draw attention to themselves even when not in use.\textsuperscript{28}

Giving diagnostic or therapeutic x-rays was not by any means exclusive to the medical profession during these initial decades. Photographers, electrical hobbyists, and science teachers often set up shop in independent studios. For example, in 1897, Minnesota physics professor Edwin J. Freeman built a simple machine in his lab and used it, on a consulting basis, to create diagnostic images. He then showed those images in lectures at local high schools, where he made further images of the students for their amusement, and, evidently, his professional development.\textsuperscript{29} The physicist’s technique as a roentgenologist at first left something to be desired: his images were mostly of poor quality even by 1897 standards. Nevertheless, it appears to have provided him with a gratifying sideline, until he found a more direct professional application for his talents as a dean at the Northern Institute of Osteopathy in Minneapolis. Like many doctors, he had a photograph taken of his workroom there, showing to best advantage the enormous cabinet containing his static generator and tubes, which dominate a room strewn with various electrotherapeutic tools and carefully placed skiagraphs. X-raying may have appealed to Freeman as a technical challenge, or as a gateway into a new career, or simply as a second income, but the photograph conveys a certain sense of excited pride. Many radiologists’ reminiscences dwell on the romance of the young field: when making every image was a challenge, and every therapeutic exposure had the potential for extraordinary and novel results, and patients might still be awed by a glimpse beneath their own skin, there was certain glamour to the work.

Many others felt its allure, too. “With proper care and the necessary apparatus,” Trevert had noted, “even an amateur may meet with wonderful success,” and the electrical hobbyists and photographers who built or bought machines of their own in those first

\textsuperscript{28} Hospitals also quickly adopted x-ray technology, usually by clearing out space in the basement for an examining room and developing facilities. For the establishment of radiology departments in hospitals, see Phillip C. Goodman, “The X-Ray Enters the Hospital,” \textit{Am. J. Roentgenol.}, 1995, 165, 1046–50.

\textsuperscript{29} Edwin Freeman, Original X-Ray Photographs, Bakken Museum of Electricity and Life Artifact Collection (Minneapolis, Minnesota).
years bore out the truth of that assertion. Fearful that these entre-
preneurial laymen were at once reducing the medical x-ray to a
mere mechanical process, while simultaneously infringing on the
prerogative of doctors to practice medicine, the first radiological
societies spent much of the gas tube era attempting to drive out (or
at least co-opt) the lay providers. Ultimately, only widespread
adoption of x-rays by physicians and hospitals served to render non-
physician x-ray services superfluous, and that was itself brought
about by a deliberate campaign on the part of early adopters and
radiologists to portray doctors who eschewed the rays as not merely
old-fashioned but dangerously unscientific. “Let us be up-to-date
physicians—twentieth century physicians if need be,” one physician
urged his colleagues in 1898. He continued, “The time is not far
distant when our patients will not be content to believe our unpro-
ven statements. The public is becoming better educated. The days
of magic and mystery in medical practices are numbered. . . . Let us
welcome the dawn of public enlightenment (and our own) with an
x-ray illumination.”

For many physicians, their own enlightenment with respect to
the rays came on the job. Freeman, a physicist who gravitated
toward a quasi-medical second career, may have had some insight
into the nature of the rays he was generating, and certainly had a
practical understanding of electrical devices. By contrast, many
physicians who began offering x-ray services in the years immedi-
ately following their discovery were themselves complete novices
with respect to the equipment that produced them, and little if
any grasp of the physics involved. In this respect, the first generation
of “x-ray doctors” had—with notable exceptions—far more in
common with the sensibilities of their patients with respect to
Roentgen’s rays than they did with physicists of their day or the
professionalized radiologists who would ultimately supersede them.
An early textbook aimed at doctors who were adding x-rays to
their practice advertised itself this way: “This book is intended for
the general practitioner who, having purchased an electrical outfit
and desiring to make use of it, finds himself hopelessly at sea, not

30. Edward Trevert, Something about the X-Rays for Everyone (Lynn, Massachusetts:
only in applying his various rays and currents, but in the use and care of the machine itself.”

Those “better educated” patients, for their part, brought their own rich and varied understandings of x-rays to the experience of being x-rayed in the gas tube era. Their attitudes regarding the rays ran the gamut from horror to unseemly interest, and the effect of that unusually strong interest can be seen in the evolution of the machines themselves and the way they were used. Because nervous reactions could spoil both images and profits, doctors were especially inclined to note the reactions of nervous patients. In a 1902 textbook, Monell wrote of a fifteen-year-old girl with an injured shoulder who, when asked to stand for a fluoroscopic examination, “exhibited the greatest terror. . . . She declared that she ‘knew it would burn her up and hurt awfully’.” Even after seeing a nurse undergo the procedure she was still “so nervous and alarmed that she was almost in hysterics.” Monell blamed newspapers as the source of her fears, but word of mouth from burned patients played a role in spreading these ideas, too. So many were burned in the 1890s, one practitioner recalled, that patients often entered the clinic “gun shy,” and that “almost a decade passed before the average citizen failed to talk ‘burns’ when x-ray examination was suggested.”

At the other extreme were patients whose impressions of the healing potential of the “new electric light” were such that they insisted on its use regardless of their actual complaints, or lack thereof. “Through lurid stories in the daily press and in the pseudo-scientific sections of the Sunday supplements,” a memoirist physician named Ernest Smith wrote, “many people have been led to believe that the roentgen ray can reveal almost anything.” Some patients, he added, “walk into the office of a general practitioner and expect to receive a five-minute ‘tell-all’ report on his physical condition by means of the roentgen ray.” It was because of this class of patients that doctors like R. M. Burlingame of Hendricks,

Minnesota, felt obliged to add the boldfaced caveat “when necessary” to their advertisement of x-ray services.\textsuperscript{36} A physician wrote in 1898 of being inundated with blind would-be patients—“poor, unduly misled individuals who arrive at our office and demand treatment with the x-rays, feeling assured that they may be made to see at once.”\textsuperscript{37} He, too, blamed the newspapers for unduly raising the public’s expectations.

Enthusiastic patients sometimes mistook diagnostic x-rays for therapy. Eli Friedman wrote of a panicked mother whose infant son had been diagnosed via x-rays with an enlarged thymus by three other doctors before she came to him late one night, begging him for another “x-ray treatment.”\textsuperscript{38} So common was the expectation that x-irradiation could be a panacea that even patients who had steeled themselves against psychosomatic effects believed they saw improvement as a result of contact with the rays. One woman wrote to thank Dr. M. H. Richardson for the “splendid effect” of his diagnostic x-rays of her injured foot, adding that “My family think it is all imagination, but that is impossible, because all that I expected from the rays was what you might discern.” Richardson, in relating this to his local medical journal, acidly noted that patients also sometimes attributed cures to thermometry.\textsuperscript{39}

This diversity of patients’ initial reactions reflects the similar breadth of information available about the x-rays that had been available from the moment of their announcement. Even relatively neutral media reports, ostensibly on the same subject, carried widely divergent tones. When readers of the \textit{New York Times} in 1908 heard about a new kind of tube that “robs the X-Ray of its terrors” such that patients “need no longer fear the painful, disfiguring, and sometimes fatal burns which have hitherto accompanied its employment,” \textit{Los Angeles Times} readers instead saw an encomium to ten years of “marvelous results” in radiological

\textsuperscript{37} F.S. Kolle, “X or Roentgen Ray Results in Amaurosis,” \textit{Am. X-Ray J.} 1898, 2, 149. The idea that the blind could be made to see by both x-rays and radium was indeed one of the more commonly voiced speculations in the newspapers, probably because each was rhetorically associated with light.
\textsuperscript{38} Eli Friedman, \textit{Doctor Eli} (Cambridge, Massachusetts: Microglyphics, 1972), 52.
\textsuperscript{39} M.H. Richardson, \textit{BMSJ}, 1896, 137, 250–51; Cf. Brecher and Brecher, \textit{The Rays}, 66. X-rays can, in fact, have an analgesic effect to the extent that they kill nervous tissue.
experimentation marred only by a handful of “regrettable accidents.” Each patient’s expectations were the result of their idiosyncratic path through the forest of other people’s perceptions of the rays. Between the testimonials of friends and family who had been x-rayed, sensationalist articles in magazines and newspapers, lecture-demonstrators and wonder showmen, and all the other occult avenues through which information about the rays might be passed, a patient might have formed almost any impression.

THE EXPERIENCE OF THE CLINICAL X-RAY IN THE GAS TUBE ERA

Whatever notions patients might have brought into the examination room, the experience of coming physically into contact with the x-rays was dramatic in its own right. Direct testimony from patients about what transpired in the x-ray room is all but nonexistent. Entrepreneurial physicians who had invested perhaps a year’s profits in a suite of tubes and generators and accessories, however, paid particular attention to the impressions that their machines made, or failed to make, and discussed the matter at conferences, in journal articles, and in their memoirs.

“The psychology of roentgenology would make for an interesting study,” wrote Arthur Dunn in the *Journal of Roentgenology* in 1919. “The dim lights and strange glares in a black darkness, the whir of machinery, the assemblage of unusual objects, all tend to arouse the dormant sense of the supernatural.” Even a simple diagnostic x-ray, on a perfectly functioning machine, to confirm a straightforward diagnosis of a minor complaint required the use of an apparatus that assaulted the senses with unfamiliar and vivid sights, sounds, and smells. The mere presence of the machine itself, usually larger and evidently more expensive and complex than anything else in the examining suite, made impressions on patients whose previous visits to the same doctor might have involved no procedure more ostentatiously significant of a commitment to scientific medicine than the meticulous recording of body temperature. (Dunn accused

his professional brethren of being “likely to trade too much on this asset.”

The electric discharges given off by the machine were the most striking element for patients: “The psychic effect of a red-hot four-inch spark was rather torrid,” deadpanned one medical memoirist of his turn-of-the-century machine. He continued, “You had a convert right then and there; incidentally the convert had a blister, but blisters didn’t count.” Not all the converts were to the side of radiomania, though. Even when patients had been acculturated to electricity, they nevertheless tended to harbor a healthy fear of sparks. Given the rays’ early visual iconography, reified by a thousand newspaper cartoons in which a subject was often rendered literally transparent by stylized lightning bolts, it was possible for patients to suspect that the sparks were the rays. Nor were fears of coming in contact with the sparks entirely unfounded: patients and doctors alike were routinely shocked when the spark discharge went awry, or when they accidentally touched exposed high-tension wires or ungrounded parts of the machine. The shocks themselves were not usually dangerous (though fatalities were reported), but they were certainly unpleasant enough to make an impression on those who received one. They also presented a fire hazard, especially in the presence of ether.

42. F. S. O’Hara, “Looking Backward,” 6. The “blister” would have been a radiation-induced erythema (an x-ray burn, in other words) and would have appeared after the actual treatment.

43. This is amply demonstrated in period cartoons and light fiction, including Harris’ “Uncle Jimmie.” Lightning bolts striking objects was also a common theme in the iconography of x-ray manufacturers. The American College of Radiology Archives contain a collection of logos and trademarks for such companies, and electricity is the dominant theme in the prewar period, only yielding to “atomic” imagery in the postwar period. See “General Professional Files,” Box 534, ACR.

44. Harold Swanberg, “X-Ray Electrocution,” Radiol. Rev. Chicago Med. Rec., 1927, 49, 440. This article claims “a noticeable increase of electrical deaths due to X-ray apparatus—if we are to believe newspaper reports,” but gives no statistics. One example is reported in “X-Ray Shock Kills Patient Ready for Tooth Examination,” Pittsburgh Press, 12 November 1920, 28. One author called the relatively small number of serious electrical injuries “a matter of good fortune, as opportunities for contact with dangerous conductors have been extremely general.” J. S. Shearer, “Electrical Dangers in X-Ray Laboratories,” Am. J. Roentgenol., 1920, 7, 432. See also William F. Hemler, “High Tension Electric Shocks in Roentgenologic Practice,” Am. J. Roentgenol., 1920, 9, 365–70.

45. For example, Roland Hammond, “Fracture Work,” Am. Q. Roentgenol., 1911, 4, 12. In the transcribed discussion following this article, Dr. Arthur Holding refers to having witnessed “several instances where the spark has caused serious damage” by igniting an ether fire.
considered a radiologist until he had received at least one good shock,” one physician reminisced, although shocked patients were not necessarily so philosophical.\textsuperscript{46} Even if patients turned their eyes away from the spark, the noise of it remained. The manufacturer of a purportedly noiseless apparatus took care to remind doctors that such sounds were “very violent and irritating and absolutely fatal to the peace of mind of a nervously constituted patient.”\textsuperscript{47}

Some sense of the prevalence of these fears can be gathered from the frequency with which early x-ray adopters spoke of ways to assuage—or circumvent—these anxieties in patients. Kassabian, participating in a discussion at the 1909 meeting of the American Roentgen Ray Society, recommended administering anesthetics before an anxious patient even entered the room, and only then gradually acclimating the sedated patient to the spark of the machine, before finally beginning the examination.\textsuperscript{48} His colleague Percy Brown demurred, advocating for “more psychological method[s] of producing quiet,” on the grounds that anesthesia could produce involuntary spasms in a patient that were just as bad as nervous shaking.\textsuperscript{49} A third commenter preferred to fight fear with fear: faced with frightened children, George Johnston said, “I blow a very shrill whistle with considerable force. The noise petrifies the child long enough so that I can make a very good exposure.”\textsuperscript{50}

Once patients were before the machine itself, the part of the body to be exposed was brought within a few inches of the tube. Tubes were so fragile that any agitation might cause them to implode, as they frequently and spectacularly did. This was alarming enough when it happened during the warming-up phase, but when it happened during an actual exposure, the patient might be showered in shattered or even molten glass.\textsuperscript{51}

\textsuperscript{46} Leo G. Rigler, “A Half Century of Radiology: The Herbert Lecture,” March 1973, Radiology Professional Collection, General Professional Files, SF History Files, Manuscripts, Box 531, ACR.


\textsuperscript{49} Ibid., 131.

\textsuperscript{50} Ibid., 134–35.

little substance to the glass (so as not to absorb the rays generated within), the injuries this might cause were minor, as Henry Pancoast emphasized in reporting two of his own encounters with imploding tubes, but the noise and surprise of the experience were considerable.\textsuperscript{52}

The fragility of the tubes, and the fact that they were tethered to the sizable transformers or static generators that powered them, meant that the tubes were largely immobile in early apparatuses. Consequently, patients, no matter how injured, were forced to conform to them. Bodies might be slung headfirst over chairs, or strapped to boards and suspended by chains above the machine.\textsuperscript{53} In fluoroscopic examination, the doctor, too, had to adopt contorted poses. For fluoroscopy of the lungs, for instance, a doctor might sit in a chair beneath a specially tilted table, looking up through the patient’s chest toward the tube placed above them both.\textsuperscript{54} More often, though, specialized equipment was lacking and both doctor and patient made do as best they could. Even patients not in immediate physical distress found it difficult to remain still in the extraordinary poses necessary to get the proper angle, and for the length of time necessary to get the proper exposure (often as long as ten minutes, and occasionally up to an hour).\textsuperscript{55}

Techniques for immobilizing patients before the tube ranged from chloroform to sandbags to the elaborate apparatus devised by Percy Brown of Boston for x-rays of the head.\textsuperscript{56} Believing the pain that patients sometimes complained of during an x-raying probably

\textsuperscript{53} The improvisatory use of a chair, a footstool, and a fairly athletic patient cantilevered over them in order to achieve the proper angle and distance for a pelvic irradiation is illustrated in Guy Pallardy, Marie-José Pallardy, and Auguste Wackenheim, \textit{Histoire Illustree de la Radiologie} (Paris: Editions Roger Dacosta, 1989), 477.
\textsuperscript{54} See, for example, the illustration in Mould, \textit{A Century of X-Rays and Radioactivity in Medicine}, 34.
\textsuperscript{55} For reference to hour-long diagnostic exposure times, see Michael Pupin, \textit{From Immigrant to Inventor} (New York: Scribner’s Sons, 1923), 307.
\textsuperscript{56} J. M. Martin, \textit{Practical Electro-therapeutics and X-Ray Therapy with Chapters on Phototherapy, X-Ray in Eye Surgery, X-Ray in Dentistry, and Medico-legal Aspect of the X-ray} (St. Louis: C.V. Mosby, 1912), 216. Martin took a belt-and-suspenders approach to controlling patient anxiety: “When the patient is unfamiliar with the working of the machine, he should be made to understand that there will be some noise, but that the flashes can in no way hurt him in the least. Small children, if nervous and easily frightened, should be chloroformed…. With nervous patients it is often necessary, when skiagraphing a limb, to strap it to the table with sand bags.”
came from the muscular stress of having to hold a position for lengthy exposures, Brown built an adjustable wheeled chair with head restraints, which was intended to accommodate an x-ray source and photographic plates. In relieving the subject of the responsibility for holding himself still, “he, therefore, resigns himself to the mental comfort of this assurance” and was spared both pain and a blurry exposure.\(^{57}\) Some parts of the body simply defied imaging or therapeutic irradiation except with the addition of special accoutrements. The Sweet eye localizer, for example, consisted of metal prongs attached to a band strapped around the head, which were inserted under the eyelid and pressed, by a screw mechanism, against the surface of the eye itself. The purpose was to aid in exposure of ocular x-rays and to serve as a point of reference; the effect on the patient can be imagined. One of the first dental x-rays required packing the mouth with so much gutta percha and film that an anesthetic cocaine spray was needed to prevent the subject from gagging.\(^{58}\)

When the patient was arranged and the apparatus was ready, the patient of the early gas tube era beheld an eerie tableau of light and shadow. Because fluoroscopy required doctors’ eyes to be sensitive to very faintly glowing images, examination rooms were almost always windowless so that the procedure could take place in near-darkness. Some procedures required the patient to hold up a fluoroscopic screen against their chests, which allowed the dim phosphorescent glow to fill the room. The electrified evacuated tube also glowed, and these visible light rays were occasionally mistaken for the x-rays themselves by patients.

The weirdness of these new sensations extended to patients’ sense of smell. The sparks flying across the terminals of static generators created a great deal of ozone, which was not only unfamiliar to many people in the days before widespread electrification, but also irritated their eyes and lungs. When struck by x-rays, wires in the machine itself would also emit ozone and nitrous oxide, and “fluorese [sic] like a cat’s tail,” in the words of a North Dakota


physician, suggesting yet another unexpected phenomenon to command the patient’s attention.\textsuperscript{59} Gasoline generators added to the odors in the windowless examination rooms. If induction coils were used rather than static generators, the smell of ozone was supplemented with that of hot oil from the insulating bath that those coils required. The miasma that built up in x-ray rooms was not merely unpleasant; a 1919 textbook deemed an exhaust fan “absolutely essential” because “[t]he ozone which is liberated in the room during the use of the high-tension currents which are necessary in deep therapy becomes poisonous to the patients and makes them very sick.”\textsuperscript{60}

Even the sense of taste could be a part of the immersive and affective experience of the early x-ray. Fluoroscopy of the gastrointestinal tract required the consumption of food or liquids that had been impregnated with a radio-opaque substance like barium or bismuth. Perhaps the only dramatic sensory element of the radiological experience that has never been muted in some way by technological or methodological refinement, barium drinks were prominent among the unlooked-for indignities that patients suffered in order to undergo diagnosis by the icon of scientific medicine. The ominously restrained advertising slogan of the Buck Barium Meal, “It Does Not Nauseate the Patient,” gives some sense of the best that doctors could hope for.\textsuperscript{61} The worst-case scenario, even for this ancillary procedure, was grim: druggists sometimes supplied barium sulfide, a poison, when doctors requested the barium sulfate used to make opaque meals.\textsuperscript{62} Even the correct compound could occasionally react with food in such a way as to create toxic salts.\textsuperscript{63} Bismuth, too, was toxic; iron oxides were tried, but they discolored food so badly that patients were disgusted by the resulting meal even before it was ingested. “Finicky” patients might swallow the “thoroughly unob-

\textsuperscript{59} Leo J. Hennie to H. M. Berg, 19 June 1964, Radiology Professional Collection, General Professional Files, SF; History Files, Manuscripts, Box 531, ACR.
\textsuperscript{60} Albert Franklin Tyler, \textit{Roentgenotherapy} (St. Louis: Mosby, 1918), 40.
\textsuperscript{61} Buck X-Ograph Company, Catalog, 1937, Manufacturing Catalogs, Box 658, ACR.
\textsuperscript{63} A. Howard Pirie, “Preparation of Barium Sulphate for the Opaque Meal,” \textit{Am. J. Roentgenol.}, 1914, 1, 220.
jectionable” zirconium oxide, a roentgenologist suggested in 1910, but it was not widely adopted.\textsuperscript{64}

The sum effect of just a few of these dramatic manifestations of the x-raying process was sometimes enough to overwhelm patients. Henry Pleasants, a general practitioner, gave a fairly vivid sense of the impression that even a simple fluoroscopy could make:

It was a frightfully hot day, and the x-ray laboratory was like the inside of a furnace. All cracks had been closed so that no light could possibly enter. . . The patient was stood upright before the “fluoroscopic screen” and told to drink the nauseous mess [a barium drink]. . . Just as things began happening, I felt something wet and cold strike the top of my head in the dark. At the same instant, the patient’s knees buckled forward and he collapsed in a dead faint on my shoulder, pouring the rest of the meal down my back.\textsuperscript{65}

Nothing about the procedure Pleasants describes was unusual, nor is this kind of reminiscence atypical for x-ray-employing physicians of the early decades.

Dealing with this sort of anxious patient was a source of constant concern to physicians and radiologists, who discussed various tactics for defusing those worries at conferences and in their disciplinary journals. The problem was worsened by a gradual change in technique brought about by their recognition of the cumulative effect of chronic irradiation, and the harm it was doing to physicians. Forced to balance the suddenly urgent need to protect themselves from exposure with the need to reassure patients that the process was safe, doctors began wearing protective garments. The first such suit was a thick rubberized leather smock, with elbow-length gloves and a bucket-shaped helmet with two smoked-glass inserts for eyeholes.\textsuperscript{66}

Monstrous in appearance, it had the benefit of thoroughness, but clearly would not put at ease the sort of patient who had heard of x-ray burns and had to be cajoled into the process in the first place.

Notwithstanding the rhetoric of voyeurism and violation that occasionally attended early public discourse about the rays, some

\textsuperscript{64} Henry Hulst, “Zirconium Oxide, A New Substitute for Bismuth Compounds in Roentgenology,” \textit{Am. Q. Roentgenol.}, 1910, 2, 199.

\textsuperscript{65} Henry Pleasants, \textit{A Doctor in the House} (Philadelphia: Lippincott, 1947), 186.

patients entered the examination room hopeful that the new technology would preserve their modesty by sparing them the need to fully undress in front of a doctor. This was not an entirely vain hope: in March 1896, Dr. Edward Parker Davis reported with surprise that a pregnant patient of his was not only untroubled by the imposing electrical apparatus that he proposed to use in an examination of the fetus, but that she much preferred the use of a machine which “requires no exposure of the patient, no vaginal manipulation, and puts her to no essential discomfort.” Similarly, patients frequently sought out x-ray treatment in the hope that it would render surgery unnecessary. First-generation radiologist Albert Soiland cited breast cancer sufferers’ willingness to submit to any degree of irradiation—from any source, no matter how disreputable—rather than face the “mutilation” of a mastectomy. This was in keeping with the generally credulous and miracle-themed coverage of the rays’ medical applications in their first two decades.

In therapeutic radiology, however, where specificity of dosage and precision of application was an important consideration, and any bodily orifice might be exploited to help localize the irradiation, patients might have wondered whether x-rays were really any less invasive than surgery. By 1907, a Toledo physician had developed a procedure for the treatment of uterine cancer that involved a standard gas tube being partially inserted into the vagina while the patient, under local anesthesia to ensure muscular relaxation, knelt on a couch. Though an unusually graphic inversion of patients’ hopes that x-ray treatment would be less immodest or invasive than traditional methods, it was hardly the only one: special tubes for insertion into the vagina, throat, and rectum were subsequently manufactured. Even relatively simple diagnostic imaging of the urinary system required the subject to undergo a day’s fasting and an enema or purgative.

Therapeutic radiology also brought with it the possibility—and, early on, the certainty—of a burn, which manifested several days after the treatment. Many physicians, of course, knew what x-ray erythema felt like, even if only from a single acute overexposure during fluoroscopy. At the annual meeting of the American Roentgen Ray Society in 1904, John Pitkin put it this way:

For a description of the pain and suffering [of an x-ray burn], hyperaesthesia paresthesia, no language, sacred or profane, is adequate. The sting of the honey-bees or the passage of a renal calculus is painful enough, but they are comparative pleasures, because being paroxysmal they have a time limitation. Extreme tenderness to the slightest touch. Hot and cold waves and flashes, warmth, tingling, pricking, throbbing, stinging, crawling, boring and burning sensations, as if the parts were on fire and contained bugs, and other living things... All forms of radiant energy, light, heat, magnetism, ultra-violet rays, etc., increase the suffering.71

But because the burn so often accompanied an apparent cure of the patient’s complaint, it was treated as a benchmark of adequate exposure in therapeutic radiology: “I make it a point in every case to produce a ‘burn,’” averred Dr. H. W. Wright of Ottawa, Kansas—not in a medical journal, but as a selling point in an advertisement for the company whose apparatus made it so easy to do so.72 The pressing question for doctors was not whether to burn, but how to manage patients’ fears. “I make it a point of telling everybody who is exposed to the x-ray, whether for purposes of making an x-ray picture, a fluoroscopic examination or radio-therapeutic treatment, that I may produce a burn or dermatitis,” Emil Grubbe told the ARRS in 1902. “If you do that you will save yourself much trouble and it will do you no harm.”73 His colleague Wilbur Hamilton went one step further: furious that sensationalist coverage in the papers had put the fear of burns into the heads of “nine out of ten patients,” he found that he could

72. Anderson, Norden & Co, photocopied pamphlet, 1907, Manufacturing Catalogs, Box 655, ACR.
only “set their minds at ease by assuring them that we will not be satisfied until we have produced just that result.”

This grim assurance carried weight with patients precisely because there was no substitute for the x-ray’s apparently miraculous ability to reduce tumors, blanch scar tissue or keloid lesions, treat acne and warts, or otherwise make comparatively normal bodies that had been disfigured by growths of some sort. When irradiation causes a tumor or lesion to undergo a change in size or external presentation, it does not necessarily improve the overall prognosis. Nevertheless, the stark difference in appearance that x-irradiation could effect in such cases, combined with the fact that radiation therapy provided an alternative to surgery, made such an impression on patients, that doctors complained that they occasionally failed to complete the course of treatment. Others demanded more: dentist Weston Price wrote in 1904 of his amazement at the lengths an elderly patient would go to in order to obtain more of the treatments he was giving her for a periodontal disease. Physicians, too, were amazed at the relief that the rays could offer otherwise irremediable disorders, especially lupus, and lesions or tumors on the face. Radiology journals and textbooks were rife with before and after photos, and it was a mark of professional pride for pioneer radiologists that they could offer some hope to patients while surgeons could not.

In fact, the many dubious (and some genuine) “miracles” of early radiotherapy that patients were astonished by and newspapers trumpeted were not limited to the effects that their physicians expected. Virtually every symptom imaginable (or its cure) was at some point attributed to irradiation, with varying degrees of physical justification. X-rays frequently removed hair but sometimes spurred hypertrichosis; they could have an analgesic effect even as their destructive effect ensured a painful burn would arise. Within a decade they were understood to induce sterility that was at least


75. Weston A. Price, “The Treatment of Pyorrhea Alveolaris with the X-Rays,” Arch. Electro. Radiol., 1904, 4, 78–79. “It is very significant that, though the lady traveled a long distance and was not able to get on and off the cars without considerable difficulty and danger, she would telephone between appointments for permission to come, giving as her reason that her gums felt so much better for a day or two after treatments.”
temporary, provoking editorializing on the “sociological problems” that this raised: whether eugenic sterilization was now a moral obligation, and whether the prospect of easy sterilization would be abused by unscrupulous physicians and “misguided” women. And as de la Peña has demonstrated, even rumored effects never really observed, like the wholesale whitening of black skin, were treated as credible by the general public and physicians alike. All of this served to reinforce the idea that x-rays had some occult connection to human vitality.

For all these reasons, the experience of being x-rayed in the gas tube era was inherently arresting and potentially transformative, particularly if it brought about a physical transformation like an erythema or a sudden change in the presentation of a malignancy. As easily as they burned away unwanted hair or acne, x-rays burned away the sensational and fantastic elements of the rhetoric surrounding the phenomenon, and replaced them with a tangible sense of the Roentgen rays’ power to affect the body. Physicians could look on their machines—often bulky, sometimes dangerous—and see both potency and still more unrealized potential, and so could many of their patients. A visit to the “x-ray doctor” was by no means a sure cure for radiophobia, but it did serve to sharpen the questions that an x-ray skeptic might ask: not whether the x-rays might have some effect, but whether those effects could be rendered entirely beneficial.

Whether x-irradiation was, on balance, a positive thing was occasionally a matter for the courts. The turn of the twentieth century saw a sharp rise in medical malpractice cases, and some of the earliest textbooks in radiology contain chapters dealing with the “medico-legal” implications of their use. Tellingly, the threat that doctors perceived was not that a patient would sue for the pain arising from a burn, but for mistreatment arising from misinterpretation of a diagnostic image, thereby turning the physician’s own

omniscient machine against him. Daniel Goldberg has noted that doctors in the gas tube era were well aware of the emotive power that an x-ray image had, and believed that patients could easily be convinced to sue doctors if a sufficiently striking image could be presented to them (regardless of its actual medical significance). This was one of the reasons why most radiologists refused to give patients custody of the images, or even to see them, although patients’ curiosity meant that they were constantly asked to do so.

Suits over damages from irradiation, however, do not seem to have been common during the gas tube era, and for all that doctors were well aware (often from personal experience) of how painful and long-lasting x-ray erythema could be, radiology textbooks and journals did not treat it as a serious legal problem. Mihran Kassabian’s 1907 textbook went further than most by spending six pages summarizing a dozen lawsuits for damages from x-irradiation. One case in particular neatly captured the situation that a patient in the gas tube era might encounter: a man was sent by his physician to an independent x-ray studio for a course of ten or eleven therapeutic treatments for locomotor ataxia. The patient was placed too close to the tube by the pharmacist who owned the machine, and left unattended during the treatment. “The machine emitted great sparks,” Kassabian summarized, “and once or twice gave the patient a shock, but being quite ignorant he made no complaint to his physician. His feet began to blister, for weeks he suffered greatly, and his screams were such that lodgers left the house.”

Most of the cited lawsuits were resolved in favor of the defendants, and Kassabian concluded that, setting aside reckless negligence, courts were inclined to see the essentially “perfidous nature” of these claims: that x-rays were already commonly understood to be an inherently dangerous “heroic therapy,” and that responsibility for the consequences of x-irradiation therefore lay with the patients. In other words, barely a decade after the discovery of x-rays, and while expectations still ran high for the discovery of an x-ray panacea, the

79. Ibid.
80. Mihran Krikor Kassabian, Röntgen Rays and Electro-Therapeutics, with Chapters on Radium and Phototherapy (Philadelphia: J.B. Lippincott, 1907), 387.
potential dangers were so well known that a physician might legally insulate himself simply by “mention[ing] the possibility of a burn” at the beginning of treatment.\footnote{Ibid., 383, 387.}

DOMESTICATION OF X-RAY MACHINES AND THE SOURING OF PUBLIC OPINION

Kassabian also prophesied that the rapid pace of technological and methodological refinement would shortly make burns a less inevitable consequence of therapeutic irradiation.\footnote{Ibid., 387.} This reflects not only the prevalent belief of physicians and patients alike in the always-imminent breakthrough in radiotherapy, but also a certain weary frustration with the machine as it was in the instant. “You modern chaps who have never ‘baked’ a tube and who have never juggled lightning with the tube in a wooden clamp, spraying the room like a broadcasting station, cannot realize what those martyrs of yesteryear have saved you,” retiring radiologist F. S. O’Hara chided his younger colleagues in 1932. “Trouble? Why the handling of an x-ray apparatus of those days was nothing else. Like the early automobiles, if one thing was right the others were wrong.”\footnote{F. S. O’Hara, “Looking Backward,” 5. “Baking” a tube meant heating it in an oven to release gas back into a tube that had been “hardened” by use (that is, the tube’s vacuum had become too high from the action of the cathode rays on the gases and tube walls). It was a delicate process, necessary because of the expense of replacing tubes outright, but it added one more layer of complexity for doctors and one more variable to the performance of the tubes: a tube performed very differently before and after being “baked.”} His tongue-in-cheek scorn for the “modern chaps” whose machines worked as advertised, without heroic measures, underscores how thoroughly the apparatuses had changed in the decade or so that preceded his essay. During the gas tube era, doctors’ optimism that their sparking, smoking machines might be the technological antecedents of a simple radiation-based cancer cure did not mean that they found those machines’ current incarnation any less frustrating. The physicians who formed the core of the emerging discipline of radiology saw themselves as virtuosos of a difficult instrument, artists whose intuition about tubes and exposure times was honed by constant practice. They were not, however, in the majority.

For all that physicians who invested in the first generation of x-ray generators may have hoped to enhance their standing in the
eyes of their patients, the unreliable nature of the machines and doctors’ own unfamiliarity with the principles on which they worked often undercut the desired image. Samuel Monell, who had as much experience with the Roentgen apparatus as it was possible to have in 1898, fumed that it was “unsatisfactory to do x-ray work when the operator is obliged to fuss and putter with his tubes, sometimes for half an hour, before an examination can be made.”

Two decades later, Norman Prince found it necessary to write a textbook entirely on the process by which x-ray exposures were made—omitting therapeutic irradiation or interpretation of images—for the benefit of doctors whose experimentation with the process had never gone beyond what the sales agent had demonstrated. Their concern was for the reputation of the practice of roentgenography itself, and with doctors and the laity alike rushing to purchase machines, it was well founded. Alan Hart frankly admitted learning to operate his machines and wield his fluoroscopy screen “literally... with book in hand.” Many other physicians received their first lesson from the agents who had sold them the machine. F. L. Pengelly, who represented the Victor X-Ray Corporation in the western states in 1914, recalled that “every installation meant staying on the job until the customer could make fairly satisfactory x-ray exposures and could process the plates reasonably well. You can appreciate that the difficulties encountered with beginners were sometimes discouraging.” This was a diplomatic way of putting it: doctors burned out tubes prematurely, allowed their developing materials to become contaminated, and summoned technicians from hundreds of miles away to make minor electrical adjustments. Pengelly serviced the machines of rural doctors who had impressive cabinets but no heat or running water. At times the ad hoc nature of doctors’ strategies for dealing with their temperamental machines bordered on the absurd: faced with a static machine that balked in humid weather, one doctor left gingersnaps inside the case of his static generator as a makeshift hygrometer. He fared better than the Pittsburgh doctor who tried using calcium

carbide as a desiccant, which caused an explosion when a stray electrical discharge touched it.\textsuperscript{88}

Incidents like these embarrassed doctors, even when the effect was not really detrimental to the patient’s care, and through the power of the purse and constant commentary in their journals, they pressured equipment makers to make machines that were more reliable, less temperamental, and above all less dramatic. By the late 1920s, the effect of that pressure could be seen not only in the products themselves, but also in the language that appeared in catalogs comparing the newer, more domesticated machines with those of the previous generation. Announcing an improved transformer in 1926, Acme International guaranteed that this model would suffer none of the problems of the previous model, which included “extremely noisy” operation, “nauseating” gases, “long straggling sparks . . . always present, resulting in a flaming arc,” and an “ever-present fire menace.”\textsuperscript{89} Two decades earlier, by contrast, the makers of the Aristo 1907 model had pointedly boasted of its “flame discharge of 3 inches [which] proves the volume or amperage to be immense.”\textsuperscript{90} That kind of language was neither anomalous nor ill-considered: for all the anxiety it might produce in a patient, a robust electrical discharge was a point of pride for doctors, who were not only able to make better images with the more intense rays that accompanied it, but gained the satisfaction of having forced a notoriously temperamental machine into temporary submission.

The second generation of x-ray technologies was created with the aim of preserving and enhancing the dignity and authority that early-adopting physicians had sought from their first machines. This much can be read directly from their advertisements. If patients were frightened by the buzzes and sparks of an older machine, Acme was eager to assure doctors of its new unit that “being positively noiseless, it is pleasing to the patient in that all cause for

\textsuperscript{88} John F. McCullough, “Early History of Radiology in Pittsburgh,” interview with Lewis Etter, 29 May 1960, 2, Radiology Professional Collection, General Professional Files, SF, History Files, Manuscripts, Box 531, ACR.

\textsuperscript{89} Acme-International X-Ray Co., “Acme-International 120 K.V. Roentgen Generator,” 15 September 1926, advertising pamphlet, Box 653, ACR.

\textsuperscript{90} Anderson, Norden & Co., photocopied pamphlet, 1907, Manufacturing Catalogs, Box 655, ACR.
fear is removed.” If children were afraid of x-rays, then the portable machine model of 1928 was called for because “[e]very Roentgenologist knows that occasionally a suffering child is terrorized at the sight of the equipment in the X-Ray laboratory. To be able to conduct a fluoroscopic examination, or to make a radiograph, with the child in his bed is often a great advantage.” If the heat generated by machines was uncomfortable, and the electric fans used on older machines ineffective and dangerous, then a built-in cooling system new for 1928 was what was called for.

Every element of the x-ray apparatus underwent at least one major improvement in the 1910s and 1920s. Gas tubes gradually yielded to the more rugged and adjustable hot-cathode tubes. Glass photographic plates were replaced by film of steadily improving responsiveness and longevity. Near-universal electrification rendered the static generator obsolete, and with alternating current entering the clinic, Ruhmkorff and Tesla coil apparatuses were succeeded by the “interrupterless” transformer which permitted much higher voltages and thus worked best with the newer, hardier tubes. The Potter–Bucky diaphragm, a grid of lead wires that blocked stray radiation and sharpened images (thereby shortening exposure times), was invented in 1920. In medical terms, the sum effect of these improvements was to permit shorter exposure times, clearer images, a lower overall radiation dose, more localized therapeutic irradiation, and a wider range of frequencies. Between those advancements and refinements in radiological technique—deliberately burning patients was no longer best practice in the 1920s—patients in the latter era saw far fewer things go wrong.

By the late 1920s, x-ray anxiety was well enough established that alternative healers were doing a booming business in devices or therapies that claimed to remediate burns and other damage caused by x-rays. The entrepreneurial Dinshah Ghadiali, whose “Spectro-Chrome” devices were leased to followers nationwide, devoted an entire chapter of his textbooks (and a specific setting on

91. Acme-International X-Ray Co., “Acme-International 120 K.V. Roentgen Generator,” 15 September 1926, advertising pamphlet, Box 653, ACR.
92. Acme-International X-Ray Co., “Precision Mobile X-Ray Apparatus,” April 1928, advertising pamphlet, Box 653, ACR.
his phototherapy devices) to soothing x-ray burns specifically. By appealing to the many cancer patients that radiotherapy had not cured, whole hospitals were filled. The Baker Hospital of Iowa was preaching to the converted in its thirty-page, full-color brochures, when it recited a litany of charges against allopathic doctors and their infernal machines: “If you have a small cancer the size of a match head, they start with X-ray, electric needle or the knife and scatter it worse.... Then they repeat, start cutting again, more X-ray and more radium until your cancer has spread throughout your system and to the glands.”

Radiophobic alternative practitioners had an unwanted but powerful ally in the AMA and the various radiological societies, who had engaged in public relations campaigns of their own that stressed the dangers of “x-ray quacks,” beauty parlor depilation treatments, and other forms of nonmedical irradiation. Because of the influence that the AMA had cultivated with the nascent profession of science journalism, the same newspapers that had treated x-rays’ infancy with breathless astonishment, and their adolescence with constant boosterism, now registered the new mood of cautious pessimism that attended their middle age. Just as not all the initial reports of x-rays had been positive, not all of the articles in the post-gas-tube era were negative: newspapers devoted considerable coverage to the development of experimental ultrahigh-voltage x-ray generators in the late 1920s and 1930s. In these articles, the generators were once again suffused with the language of potency: Caltech’s million-volt “giant cancer tube” produced the “most powerful rays” which were “equivalent to [the] entire world’s radium supply.” Accounts of extraordinarily powerful radiation curing a few desperately ill people of a particular disease at a few select sites did create not an optimistic zeitgeist, however,
and the differences between Robert Millikan’s apparatus and the family doctor’s would have been impossible for patients to miss. These million-volt “siege guns of science” might represent a “new and dramatic chapter” in the story of x-rays, but they also closed the book on what most patients could hope to gain from irradiation.97

Meanwhile, a steady stream of news items about martyrs and missed opportunities kept up the work of eroding the mountain of x-ray optimism that had been thrust up at the turn of the century. The tenor of these pieces was not much more negative than before; even gruesomely detailed obituaries of long-suffering radiologists usually observed that more good was done by irradiation than harm in most cases. Indeed, more coverage was given to x-ray burns in the 1900s than in the 1910s, and in the 1910s than in the 1920s.98 The overall sentiment, however, was no longer buoyed by the optimism born of novelty, and the hazards were being quietly reinforced at every turn.99 A Popular Mechanics article from 1925 captured the tone neatly: topped by a picture of a “modern” therapeutic apparatus, encased in lead for the safety of the patient and operator, it announced in its headline that the “invisible but deadly rays” had been “made safe by elaborate precautions.” Twenty-nine years after the first clinical exposures, many readers would have been x-rayed, but almost none by a machine enclosed in a lead box to prevent the “burns, cancer, or some other serious infection” that


98. This assertion is based on a keyword search of the Google News Archive. In the three successive decades, the term burn appears in 4.0, 2.0, and 1.7 percent of articles that mention x (or Roentgen) rays (470/11,700, 247/12,200, and 475/27,400, respectively). This method yields many false positives and spurious correlations of the two terms, but examination of the relevant articles bears out the general trend: early on, burns are being reported as they occur, or in survey articles dealing with contemporary radiological practices, while later accounts tend to invoke burns as a problem that medical science has moved (or is moving) past. Search performed 9 June 2011.

99. Because radium and x-rays were rhetorically linked, it is significant that radium was undergoing its own downturn in public opinion. Three high-profile events in the late 1920s and early 1930s—the death of steel magnate Eben Byers from overconsumption of a radium-laced patent medicine, the death of Marie Curie, and the perennial attention given to the plight of sick and dying workers who had been occupationally exposed to radium-luminescent paint—surely also contributed to the general climate of anxiety regarding the long-term effects of irradiation.
overexposure could produce. Similarly, even an article that was thoroughly optimistic about an agricultural application of x-rays was obliged to note that the benefits derived were “left entirely to chance...the X-ray, used apparently in the same way and under identical conditions, may stimulate the course of life, deform it, destroy it slowly, or blast it to death.” By 1927, the editorial page of the Radiological Review was glumly noting that the formerly positive vitalist connotations, which had once caused patients to demand irradiation where none was needed, had soured into suspicion: “Every roentgenologist knows from experience that there is an ever-present tendency to ascribe every symptom or complication that arises during irradiation to the treatment itself,” including damage to patients’ teeth or even their jewelry.

CONCLUSION

In 1917, it seemed to Albert Soiland that something was changing. “The patient himself now frequently seeks the x-ray, irrespective of medical counsel, and it is quite refreshing to note how intelligent co-operation from an awakened public is gradually replacing old time ignorance and prejudice,” he reported. By then, the taming of x-ray technology was well underway, particularly for the patients under the care of well provisioned radiologists like Soiland. To be sure, four years later, Soiland was still dealing with the occasional “highly nervous case,” for whom “the superiority of the innocent-looking radium pellet over the large and complicated x-ray” determined the course of treatment. Nevertheless, managing patients and equipment was steadily becoming less adventurous and less improvisatory with every passing year.

103. Albert Soiland, “Comments on Roentgenotherapy,” Am. J. Roentgenol., 1917, 4, 613. No specific information was available about the particular collection of machines available to Soiland at his Los Angeles cancer clinic in 1917, but he was an aggressive advocate for experimental radiology. A laudatory editorial in the journal Radiology characterized him as an early-adopter with respect to new machines, see “Albert Soiland, M.D.: An Appreciation,” Radiology, May 1933, 22, 399.
In 1924, G. E. Pfahler expressed alarm in the journal *Radiology* over an 888 percent rise in malpractice premiums for radiologists, which “shows that the laity are regarding the practice of radiology as a dangerous procedure.” Pfahler laid some of the blame on his colleagues for unconsciously mirroring their patients’ fears: “Much will be accomplished if we eliminate the incorrect words ‘X-ray burn’ or ‘radium burn’ from our vocabulary.” But he was more concerned with what he perceived as the courts’ willingness to award damages to any patient who suffered some kind of negative reaction to x-raying, even if the practitioner had not been negligent.  

Juries and patients alike were rapidly losing patience with a technology whose actual drawbacks they were no longer willing to overlook in favor of hoped-for benefits. Pfahler’s professional colleagues shared his concern: in the decades that followed the gas tube era, radiology textbooks continued to include medico-legal chapters, but the focus shifted from the physician’s role as interpreter of diagnostic images to the physician’s liability as a defendant, and particularly in cases of overexposure.  

*The Roentgenologist in Court* (1937) took the matter up at great length, and drew on fifty-five other extant books and journal articles to do so.  

In 1967, John McClenehan was nearing the end of his career as a radiologist, which had begun in 1940, far too late for him or most of his patients to have much direct experience with lightning bolts arcing around the room or epilating doses of radiation from a diagnostic exposure. Rather, his career had been spent in something much like Alan Hart’s serene clinic, with modest machines generating x-rays in quantities that were homeopathic by comparison. “Surgeons cure some cancers. Drugs cure others. X-rays,” he admitted, “cure a few;” something he put, in terms of its likelihood, on a rhetorical par with “miraculous cures.” Radiotherapists, he knew, had learned the hard way the value of circumspection and candor. Yet he marveled at the state of mind with which his patients, often suffering from terminal cancers, approached the

---

prospect of therapeutic x-rays. “It helps at the beginning for us to ask a patient to do one thing: to believe nothing that anyone else tells him about x-ray therapy. Especially neighbors and relatives,” he wrote, shocked by “how often sadism masquerades as good council.” Having come to him as a desperate measure, McClenahan’s patients were wary, cynical, and difficult to reassure, no matter how carefully he explained about quantities of radiation and the possibilities of “skin reaction (you mean the burn, don’t you, doctor?).”

These three vignettes represent the harvest of the seeds that were sown in the gas tube era. Physicians were witnessing not only a change in the technology, but a change in patients’ ability to perceive the technology. Stripped of its immediate danger and its (literally) shocking nature, and brought fully into the mainstream of medical care, the machine was also stripped of the cultural context that had attended it in the era when it seemed capable of reviving drowned mice and holding a mirror up to the soul. Three decades of diagnostic and therapeutic radiology eventually succeeded in preferentially burning away the less vigorous elements of the x-ray mythology, leaving a somewhat more prosaic set of ideas in the public mind. The newer machines raised fewer burns, made shorter exposures, and conformed themselves to the patient (rather than the other way around). Their operation was subtle to the point of being undetectable, and the physicians who operated them were more often specialist radiologists trained in the nuances of a mature technology rather than inspired amateurs wrestling stubborn machines into compliance. X-ray machines were, at last, the refined tools of modern scientific medicine, and accordingly as baneful or beneficial as one chose to regard such things.

The early public discourse on x-rays had suggested an almost magical omniscience, and frequently a sinister omnipotence. To the often-limited extent that physicians had a more nuanced understanding of the risks and rewards of irradiation, they were loath to undermine the awe and respect that their expensive apparatuses commanded. Latter-day radiologists, by contrast, knew precisely what their equipment could and could not do, and this skepticism

109. Ibid., 21.
was shared by their prospective patients, who were well aware of the extent to which the rays’ blessing was a mixed one. Having lost the spectacular nature of their presentation and the rhetoric of potency and infallibility that had once attended them, x-ray machines faded into the background of the clinical experience, both literally and as symbols of the potential of scientific medicine.

**FUNDING**

This work was supported by the Department of History of Mississippi State University, the National Science Foundation (award number 0646688), and the Department of the History of Science of the University of Wisconsin–Madison.