

## MEDICINE AND SOCIETY

Debra Malina, Ph.D., *Editor***Race Correction and the X-Ray Machine — The Controversy over Increased Radiation Doses for Black Americans in 1968**

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On May 23, 1968, Howard Goldman, director of the New York Bureau of X-Ray Technology, acknowledged that x-ray technicians routinely exposed Black patients to doses of radiation that were higher than those White patients received.<sup>1</sup> This practice, which adhered to guidelines from x-ray machine manufacturers, may have been widespread in the 1960s. Senate hearings held that month, as political unrest rocked the country, prompted public outcry and led to calls from state and federal officials to end the practice. Yet in the 21st century, despite growing interest in the problems of race and racism in medicine, race adjustment of x-rays has received little attention.<sup>2-6</sup> It's important to understand the origins of this practice, its rationales, its possible harms, and related controversies. The history shows how assumptions about biologic differences between Black and White people affected the theory and practice of medicine in the United States in ways that may have harmed patients. These insights can inform ongoing debates about the uses of race in medicine.<sup>7-10</sup>

Beliefs about bodily differences have long shaped medical research, diagnosis, and therapeutics.<sup>11-14</sup> Racist theories motivated unethical experiments on Black Americans.<sup>3,15,16</sup> Physicians have used race-specific standards to interpret pulmonary function tests.<sup>10,17</sup> Psychologists used race-specific norms to interpret neuropsychological tests of retired football players who had had concussions.<sup>18</sup> They have exhibited bias in the assessment and management of pain.<sup>19</sup> Some widely used technologies underperform in Black and Brown people: pulse oximeters, for instance, can overestimate blood oxygen levels in patients with darker complexions and delay identification of patients in need of treatment.<sup>20</sup> There is now growing consensus that race is not a mean-

ingful biologic concept.<sup>21</sup> Despite this consensus, and despite recent attempts to mitigate the harmful effects of racial biases in medicine, race-based beliefs and practices, especially the use of racial categories, remain widespread.<sup>8</sup> The history of race adjustment for x-ray dosing reveals how mistaken assumptions can be admitted into medical practices — and how those practices can be ended.

## RACIALIZATION OF THE X-RAY

The discovery of x-rays in 1895 revolutionized medicine. It allowed doctors to diagnose and treat many medical problems more easily.<sup>22</sup> The ability to image teeth also transformed dental care. However, as x-ray technology developed in the early 20th century, false beliefs about biologic differences between Black and White people affected how doctors used this technology.

Ideas about racial differences in bone and skin thickness appeared in the 19th century and remained widespread throughout the 20th.<sup>5</sup> Theodor Waitz's 1863 *Introduction to Anthropology* asserted, for instance, that "The skeleton of the Negro is heavier, the bones thicker."<sup>23</sup> Such claims reflected both beliefs about behaviors attributed to Black people (e.g., violence)<sup>23,24</sup> and the interests of White scientists and slave owners who justified slavery.<sup>16,19</sup>

The ideas persisted even as contexts changed. Nearly a century later, in 1959, *An Atlas of Normal Radiographic Anatomy* described the skull bones of Black people as "thicker and denser" than those of White people.<sup>25</sup> Researchers continued to report race differences in bone density throughout the 20th century.<sup>26</sup> However, when the U.S. Public Health Service's National Center for Radiological Health (NCRH) reviewed this question in

TABLE I. PATIENT CLASSIFICATION		
<i>Easy to Penetrate</i>	<i>Normal</i>	<i>Hard to Penetrate</i>
Very young Old Under-developed	Average white adult 20 to 55 years.	Excessive musculature Additive pathology
Destructive pathology	Normal musculature and bone development	Black or brown color
<i>Modification in Technique</i>		
4 kv.p. less than for normal or K-4	Normal K values	4 kv.p. more than for normal or K+4

**Figure 1. Patient Classification, 1957.**  
Reprinted with permission from the American Society of Radiologic Technologists.<sup>32</sup>

mental causes (e.g., nutrition, exercise), and emphasized that large variations exist within so-called races.<sup>27,28</sup>

The belief that Black people have denser bones, more muscle, or thicker skin led radiologists and technicians to use higher radiation exposure during x-ray procedures. A physician in 1896 asserted that “black being perfectly opaque,” black skin would “offer some resistance to cathode rays.”<sup>25</sup> A 1905 review explained how “the skin of the negro offers more resistance to the X-rays than non-pigmented cuticle.” This resistance made it difficult “to get a good skiagraph of a negro’s spine”: “The large surface exposed (abdomen and back) contains so much pigment that a good deal of X-ray energy is lost.”<sup>24</sup> The *New York Evening World* described a celebrated Black boxer with a skull that was “almost impregnable”: it took “the utmost skill of Joseph Klobner, the celebrated electrician and Roentgen ray operator, to get a picture of the interior workings.”<sup>25,29</sup>

Formal teaching about race adjustment for x-rays appears to have begun later. Clifton Dummett, a prominent Black American dentist, described being taught in the 1940s to increase x-ray exposure times for the teeth and jaws of Black patients because their oral tissues were more resistant to x-rays.<sup>30</sup>

In the 1950s and 1960s, x-ray technologists were told to use higher radiation doses to penetrate Black bodies. *Roentgen Signs in Clinical Diagnosis*, published in 1956, described the radiographic examination of a Black person’s skull as a “technical problem” that required a modified technique. The author suggested increasing exposure by 10 kilovolts (an increase of 12.5 to 21%).<sup>31</sup> A 1957 article in *The X-Ray Technician* classified “whites” as “normal.” For “Black or brown” patients, adjustment was recommended to get a better radiograph (e.g., use a dose 4 kilovoltage peak higher than normal — an increase of 9.5 to 25%) (Fig. 1).<sup>32</sup> Race adjustments appeared in several other textbooks as well.<sup>33</sup> The second (1960) edition of Jacobi and Hagen’s *X-Ray Technology* added the unexplained recommendation that Black patients be given an exposure 40 to 60% higher than that given to White patients. This guidance remained in the third (1964) edition (Fig. 2).<sup>34,35</sup>

The General Electric Company (GE), then the largest manufacturer of diagnostic x-ray equip-

**General body considerations**

Consistent production of high quality radiographs requires development of an easily followed technique that is satisfactory in most instances. It is useful to develop a technique chart that shows the maximum permissible deviations from the norm. *The best total results can be obtained only when the time-temperature method of film processing is employed.*

Anatomic and physiologic variations in the patients present an element that precludes written presentation. Listed below are some of the variations requiring consideration. The exposure percentage changes are approximate and are to be varied within set limitations according to the requirements of the patient.

<i>Physical condition</i>	<i>Exposure change</i>
Extremely obese	Increase exposure 5 to 15 times
Muscular	Increase exposure 30 to 40% or to as much as 2 to 5 times
Very thin	Reduce exposure 20%
Child	Reduce exposure 20 to 50%
Elderly person	Reduce exposure 50%
Negroid	Increase exposure 40 to 60%
In wet cast	Increase exposure 3 to 4 times
In dry cast	Increase exposure 2 times
<i>Pathologic condition</i>	<i>Exposure change</i>
Sclerosis	Increase exposure 50%
Osteomyelitis	Increase exposure slightly
Osteoporosis	Reduce exposure 30 to 50%
Paget’s disease	Increase exposure 50%

**Figure 2. General Body Considerations, 1964.**  
Reprinted from Jacobi and Paris.<sup>35</sup>

1968, it raised doubts about the claims (e.g., “unsubstantiated,” “doubtful validity”), noted that reported differences might have environ-

ment, made its own race-based recommendations. In the 1961 and 1963 editions of its pamphlet “How to Prepare an X-ray Technic Chart,” it advised that Black patients needed increased radiation exposure.<sup>28</sup> In 1968, GE spokesperson Robert Molitor explained that the recommendation had reflected “current medical thinking” among radiologists.<sup>27</sup>

Black people were not alone in receiving more radiation. The guidelines and textbooks also recommended higher doses for people who were “extremely obese” or “muscular”; in patients with sclerosis, osteomyelitis, or Paget’s disease; and in patients wearing a cast. Meanwhile, thin patients, children, elderly patients, and those with osteoporosis were given lower doses (Fig. 2).<sup>35</sup> It is not clear which adjustments were based on intuitions or anecdotal experiences and which, if any, were based on careful study.

Several estimates offer a sense of the prevalence of race-based dose adjustment. Surveys of x-ray technicians in the San Francisco Bay Area in 1968 found that 75 of 90 technicians “habitually increased X-ray doses of Negroes.”<sup>36</sup> They said they did so because “[Black people’s] bones are harder and denser,’ ‘Their skin is darker,’ and ‘Their flesh is harder.’”<sup>27</sup> A sample of chief x-ray technicians in New York also found that Black patients received increased radiation doses. As Goldman explained, “a ‘significant proportion’ of the State’s X-ray technicians apparently have routinely exposed Negroes to higher radiation dosages than whites.”<sup>31</sup>

We do not know what percentage of x-rays taken of Black Americans used increased exposures. We also do not know how many people were potentially harmed. The radiation received during a chest x-ray is comparable to 10 days’ worth of natural exposure.<sup>37</sup> An increase of 40 to 60% in radiation from a single x-ray would have little effect on a person’s lifetime risk (and the increase used for Black people was less than that used for muscular or obese people). However, the cumulative effect could have been substantial for people who received multiple exposures. This question of the harm of low-risk radiation exposures was examined by the Advisory Committee on Human Radiation Experiments.<sup>38</sup> Even though most of those Cold War experiments probably did little physiological harm, the research subjects experienced other harms (e.g., being used for research without consent). The

situation has parallels with race-adjusted x-rays: many people were exposed to an increased risk (even if small), presumably without their knowledge, because of unsubstantiated beliefs grounded in racist science.

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DEBATE AND DENIAL IN THE SENATE

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The practice of giving larger x-ray doses to Black patients was brought to national attention in May 1968, when the U.S. Senate held hearings about the Radiation Control for Health and Safety Act of 1968.<sup>27</sup> The legislation was prompted by growing concern about the safety of radiation equipment and the laxity of existing regulations.<sup>6</sup> The act sought to protect public health by supporting research about the effects of radiation emissions and establishing a radiation-control program for electronic products. The reforms gained a prominent advocate: consumer safety activist Ralph Nader. Nader published a dramatic exposé that month in the *Ladies’ Home Journal*, “Wake Up America: Unsafe X-Rays.” Nader may have been recruited by his sister, Claire Nader, a political scientist who had studied the effects of radiation at Oak Ridge National Laboratory in the 1960s.<sup>6</sup>

At the hearings on May 15, Ralph Nader mentioned that technicians exposed Black patients to higher x-ray doses: “A practice widespread around the country is that by technologists and their supervisors giving Negroes one-fourth to one-half larger X-ray dosages than white patients because of a generalized intuition or folklore.”<sup>27</sup> This claim led to debate among Nader, senators, and health officials about whether there were biologic differences between Black and White people and about the possible harms of dose adjustment.

Nader’s remarks about race-adjusted x-rays triggered substantial attention in the national press.<sup>1,36,39-41</sup> Media interest was not surprising: the hearings came soon after the assassination of Martin Luther King, Jr., and the ensuing protests.

The discussions prompted objections and denials from the American College of Radiology (ACR) and the American Dental Association (ADA).<sup>39,41</sup> William C. Stronach, executive director of the ACR, protested in a May 29 letter to the Senate that Nader’s “allegation that there is a widespread pattern of giving Negroes ‘one-

fourth to one-half larger x-ray dosages than white patients' is a combination of misunderstanding and half-truths which needs untangling."<sup>27</sup> On June 11, Nader struck back. He called out the ACR and ADA for "errors, distortions, and avoidance of discomfiting, published data." He reviewed the evidence — the textbooks, GE's pamphlets, the surveys, and new testimony — that the practice was indeed real.<sup>27</sup> For instance, Robert England, a physician in the radiation safety office of the California health department, told the *San Francisco Chronicle* that many x-ray workers "do, indeed, still follow the principle of heavier doses for Negroes."<sup>36</sup>

Nader's testimony prompted the Senate to request more information from the Department of Health, Education, and Welfare. On June 13, P.R. Lee, assistant secretary for health and scientific affairs, summarized the results of the initial investigation by the NCRH, which was critical of the practice. Lee concluded that there was no scientific basis for increasing exposure in Black patients and that "every effort should be made to see that it is eliminated."<sup>27</sup> On June 18, the NCRH issued a formal statement advising against using race to adjust x-ray exposure for diagnostic imaging: "The process of obtaining a diagnostic radiograph is more than a routine mechanical function and should be individualized for each patient. Radiographic technique is a skill which, to be mastered, requires extensive training and experience. Hence, the technique should vary with the individual patient and with the requirements for a particular examination and not on the basis of race."<sup>28</sup>

Lee explained that the NCRH had urged state health agencies to review their procedures and take corrective actions if necessary. At least one did. New York's health department advised that radiation should be given on an individual, not racial, basis. It instructed the state's 60 x-ray technology schools to warn their students about the problem.<sup>1</sup>

While these reforms were being made in response to the hearings, other changes were playing out in parallel, presumably reflecting the criticisms that had triggered the hearings.<sup>6</sup> The NCRH, for instance, learned that Jacobi and Paris had already decided to remove the race recommendation from the 4th edition of their textbook in 1968.<sup>28</sup>

Race classifications have traditionally been based on skin pigmentation and other superficial physical traits. One might have expected x-ray technologies, which see through the skin to deeper structures beneath, to be spared racialization. They were not. During the 20th century, radiologists and device manufacturers embedded racial assumptions in the basic practices of radiology. Nader, a consumer advocate working on radiation safety, exposed the practices of race adjustment to public scrutiny, triggering investigation and rapid action by federal and state officials and by physicians and device manufacturers. However, radiologists and technicians retained the ability to determine x-ray exposures. We do not know how long the practice of race adjustment actually endured.

Several lessons can be learned from this history. First, the racialization of the use of the x-ray machine shows how social and medical beliefs (e.g., about the density of skin and bones) become embedded in medical practices and institutions. X-ray technicians exposed Black patients to increased radiation because they were trained to do so. This seemingly widespread practice did not generate substantial concern until an outsider brought it to national attention. There is nothing unique about x-rays in this respect: U.S. health professionals have frequently accepted racial logics.<sup>7,8,11-17</sup>

Second, it demonstrates the problem of focusing on supposed differences between socially defined races and ignoring heterogeneity within them.<sup>8,42</sup> Recommendations that all Black patients receive increased radiation ignored the range of pigmentation among people who would identify (or be identified) as Black. Nader cited one anthropologist who asked, "How black does one have to be?" to receive increased dosage."<sup>27</sup> This question remains relevant today: race adjustment is still used uncritically with Black patients in many areas of U.S. medicine.<sup>8,43</sup>

Third, the easy racialization of x-rays highlights the peril of widespread use of race categories. When many existing medical practices treat White as "normal" and adjust for Black people, it seems natural to recommend additional race adjustments. The adjustments for x-rays were introduced even though no compelling evidence

had been published to justify them. Similar changes in medical practice have been made repeatedly, often without adequate justification.<sup>8,13,17</sup> We need to reset the defaults in medicine.<sup>43</sup> Instead of assuming that differences between socially defined races are significant and widespread, we should subject race-based practices to strict scrutiny, both scientific and ethical. Even when a specific use of racial categories and race adjustment might benefit patients, we should consider the lessons of history and proceed with caution, interrogating the evidence, the possible biases that influence decisions about diagnosis and treatment, and the possible harmful effects.

Fourth, the history shows how professional societies, in this case the ACR and ADA, have resisted pressure from outside groups to change their practices. Nader argued that the ACR sought to protect its autonomy to define professional standards.<sup>27</sup> That desire led it to deny a practice that radiologists could have acknowledged and reassessed. To its credit, the ACR was one of the first medical societies to address racial injustice after George Floyd's murder in May 2020.

It will take time and effort to heal the scars of racism in medicine and to eliminate the biases that persist. The history of radiology provides another example of how the institutionalization of race categories — the translation of beliefs about race into formal recommendations, policies, and practices — can perpetuate health inequities and harm marginalized groups. Analysis of how and why this particular institutionalization happened in the 1960s can provide insights applicable to the reckoning and reassessments occurring today. Fuller knowledge of the harms of simplistic race classifications can help prevent future mistakes with race adjustment. Such prevention is no small challenge. Racist biases are often implicit and unnoticed. By continuing to document the misuse of race in medicine, we can help protect patients from medical racism and work toward health justice.

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1. Mintz M. N.Y. state health dept. orders change in negro x-ray use. *Washington Post*. May 23, 1968:A3.
2. Duster T. Buried alive: the concept of race in science. In: Goodman AH, Heath D, Lindee MS, eds. *Genetic nature/culture: anthropology and science beyond the two-culture divide*. Berkeley: University of California Press, 2003:273.
3. Washington HA. *Medical apartheid: the dark history of medical experimentation on Black Americans from colonial times to the present*. New York: Doubleday, 2006.
4. Tirak LM. *Radiant exposure: the art and spectacle of the x-rayed body in American visual culture*. (Master dissertation. Williamsburg, VA: William & Mary, 2016).
5. Tirak LM. Black and blue: revelations in Harold Mahoney's x-rayed anatomical sections. *Rjksmus Bull* 2021;69:27-49.
6. Nader C. The dispute over safe uses of x-rays in medical practice. *Health Phys* 1975;29:181-206.
7. Eneanya ND, Yang W, Reese PP. Reconsidering the consequences of using race to estimate kidney function. *JAMA* 2019; 322:113-4.
8. Vyas DA, Eisenstein LG, Jones DS. Hidden in plain sight — reconsidering the use of race correction in clinical algorithms. *N Engl J Med* 2020;383:874-82.
9. American Academy of Clinical Neuropsychology. Position statement on use of race as a factor in neuropsychological test norming and performance prediction. 2021 (<https://theaacn.org/wp-content/uploads/2021/11/AACN-Position-Statement-on-Race-Norms.pdf>).
10. Bhakta NR, Kaminsky DA, Bime C, et al. Addressing race in pulmonary function testing by aligning intent and evidence with practice and perception. *Chest* 2022;161:288-97.
11. Hammonds EM, Herzig RM. *The nature of difference: sciences of race in the United States from Jefferson to genomics*. Cambridge, MA: MIT Press, 2009.
12. Roberts D. *Fatal invention: how science, politics, and big business re-create race in the twenty-first century*. New York: New Press, 2011.
13. Kahn J. *Race in a bottle: the story of BiDiL and racialized medicine in a post-genomic age*. New York: Columbia University Press, 2012.
14. Benjamin R. *Race after technology: abolitionist tools for the New Jim Code*. Cambridge, England: Polity Press, 2019.
15. Reverby SM. *Examining Tuskegee: the infamous syphilis study and its legacy*. Chapel Hill: University of North Carolina Press, 2009.
16. Owens DC. *Medical bondage: race, gender, and the origins of American gynecology*. Athens: University of Georgia Press, 2017.
17. Braun L. *Breathing race into the machine: the surprising career of the spirometer from plantation to genetics*. Minneapolis: University of Minnesota Press, 2014.
18. Madden P. Neuropsychologists call for elimination of race-norming in clinical tests following NFL concussion controversy. *ABC News*. December 2, 2021 (<https://abcnews.go.com/US/neuropsychologists-call-elimination-race-norming-clinical-tests-nfl/story?id=81493363>).
19. Hoffman KM, Trawalter S, Axt JR, Oliver MN. Racial bias in pain assessment and treatment recommendations, and false beliefs about biological differences between blacks and whites. *Proc Natl Acad Sci U S A* 2016;113:4296-301.
20. Fawzy A, Wu TD, Wang K, et al. Racial and ethnic discrepancy in pulse oximetry and delayed identification of treatment eligibility among patients with COVID-19. *JAMA Intern Med* 2022;182:730-8.
21. Graves JL Jr, Goodman AH. *Racism, not race: answers to frequently asked questions*. New York: Columbia University Press, 2022.

22. Howell JD. *Technology in the hospital: transforming patient care in the early twentieth century*. Baltimore: Johns Hopkins University Press, 1995.
23. Waitz T. *Introduction to anthropology*. London: Green, Longman and Roberts, 1863.
24. Goodman AH, Hammonds E. Reconciling race and human adaptability: Carleton Coon and the persistence of race in scientific discourse. *Kroeber Anthropol Soc Pap* 2000;84:28-44.
25. Meschan I. *An atlas of normal radiographic anatomy*. 2nd ed. Philadelphia: W.B. Saunders, 1959.
26. Ettinger B, Sidney S, Cummings SR, et al. Racial differences in bone density between young adult black and white subjects persist after adjustment for anthropometric, lifestyle, and biochemical differences. *J Clin Endocrinol Metab* 1997;82:429-34.
27. Radiation Control for Health and Safety Act of 1967: hearings before the Committee on Commerce, United States Senate, pt 2. (Wash. D.C., 1968).
28. National Center for Radiological Health. Patient characteristics in the determination of radiographic exposure factors. *J Natl Med Assoc* 1969;61:282-3.
29. X-ray shows Jack Johnson to be almost bullet proof. *The Evening World*. March 22, 1911:14.
30. Dummett CO. A folk belief: Negro x-rays — heavier doses given here. *J Am Dent Assoc* 1968;77:507.
31. Meschan I. *Roentgen signs in clinical diagnosis*. Philadelphia: W.B. Saunders, 1956.
32. Gyss EE. A medical radiographic technique chart based on constants. *Xray Tech* 1957;29:76-80.
33. Shapiro R, Janzen AH. *The normal skull: a roentgen study*. New York: Paul B. Hoeber, 1960.
34. Jacobi CA, Hagen DE. *X-ray technology*. 2nd ed. St. Louis: C.V. Mosby, 1960.
35. Jacobi CA, Paris DQ. *X-ray technology*. 3rd ed. St. Louis: C.V. Mosby, 1964.
36. Perlman D. Negro x-rays — heavier doses given here. *San Francisco Chronicle*. May 25, 1968:2.
37. American College of Radiology. Radiation dose to adults from common imaging examinations (<https://www.acr.org/-/media/ACR/Files/Radiology-Safety/Radiation-Safety/Dose-Reference-Card.pdf>).
38. *Final report of the Advisory Committee on Human Radiation Experiments*. New York: Oxford University Press, 1996.
39. Lardner GJ. Stronger x-rays for Negroes assailed. *Washington Post*. May 16, 1968:A6.
40. U.S. aide says text on x-rays suggests higher Negro dose. *New York Times*. May 18, 1968.
41. X-ray technicians accused by Nader on Negro patients. *New York Times*. May 16, 1968:26.
42. Maglo KN, Mersha TB, Martin LJ. Population genomics and the statistical values of race: an interdisciplinary perspective on the biological classification of human populations and implications for clinical genetic epidemiological research. *Front Genet* 2016;7:22.
43. Jones DS. Moving beyond race-based medicine. *Ann Intern Med* 2021;174:1745-6.

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