

Article

Themed Issue: Radiation Effects and Events

Reporting Exposure: The Midwives of Nagasaki

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Abstract:

Between June 1950 and January 1954, the Atomic Bomb Casualty Commission (ABCC) piloted a novel program partnering with midwives' associations in Nagasaki and Hiroshima, branding the enterprise the "Genetics Registration Program." This short-lived collaboration aimed to surface firsthand reports of pre- or neonatal death and even physical corpses for autopsies, for which midwives were remunerated at a set scale by the American scientists in charge. So detailed were these largely financial records that reporting within "12 hrs. of death" was worth double the rate of reporting "later than 24 hrs. after death," according to memos contained within William "Jack" Schull Collection at the McGovern Historical Center in Houston, Texas. This article, "Reporting Exposure: The Midwives of Nagasaki," interrogates how the "Early Termination Program," a branch of the Genetics program defined "exposure" and how the "exposed" were determined to be "profitable objects for study," as one memo articulated. At stake in this project is more than historical analysis; these ABCC documents illustrate paradigmatic responses to the scalar and social logics of toxicity, particular with reference to the measurement of distance and time. These archival documents reveal invaluable insights about first-of-its-kind statistical collation and confirmation biases, to say nothing of how they animate conversations about life, death, and the sociopolitical tensions this arrangement undoubtedly complicated.

Keywords: toxicity, genetics, exposure, medical humanities, radiation

Each month, about ¥15,000.00 in fees are paid to the midwives (approximately 100) for reporting to ABCC births in Nagasaki, and distributed every other month to each midwife ... [but] we have a difficult problem on hand as to how best to make the distribution.

— Memorandum for Record No. N-125-51, May 15, 1951¹

For most members of the Atomic Bomb Casualty Commission (ABCC), 1952 would mark their fifth year of steady operations in Japan following the events of the Second World War. For Drs. William "Jack" Schull, D. J. "Duncan" McDonald, and James V. Neel—among others—1952 inaugurated the third year of the so-called "Genetics Registration Program."² This relatively short-lived collaboration with the midwives' associations in Nagasaki and Hiroshima aimed to surface firsthand reports of pre- or neonatal death as well as physical corpses for study, for which the midwives involved

were remunerated at a negotiable scale set by the American scientists in charge. As 1952 dawned, these scientists found themselves in a debate around the nature of scale, especially regarding the operative definition of “exposure” with respect to the distance from the impact site, or “hypocenter.” These questions about distance and measurement are, in my estimation, paradigmatic of a larger set of concerns about the spatial and social logics of toxicity, bearing important stakes for the shaping the many epidemiological studies to follow in the ABCC’s footsteps. In fact, much of the way modern science frames the parameters of toxic events is built on the back of groundbreaking—though not altogether definitive—studies like the “Genetic Registration Program.” When juxtaposed against twenty-first century assumptions about toxicity, the personal and professional writings of these ABCC scientists reveal counterintuitive, at times even paradoxical, articulations of exposure.

Put plainly, the emerging story of the broad-scoped “Genetics Registration Program,” specifically its flagship “Early Termination Program,” indicate an ever-refining sense of the scalar implications for studies of radioactive and toxic exposure, in terms of both time and distance. This attention to scale is enlightening for what it tells us about not only the developing methods of the day, but also the kinds of ethical and humanitarian questions raised by such methods. If bioethics and what we now more generatively call “medical humanities” are designed, as Tristram Engelhardt argues, to “frame the significance of the human world and guide human practices,” then the reshaping of the “human world” and the innovative “human practices” engendered by the atomic bomb are of high priority to directing the research agendas of the future.³ The following work is grounded primarily in ABCC communications contained within the “Papers of William Jack Schull” at the McGovern Historical Center in Houston, Texas. These multiform and often disparate documents, when seen through the lens of the ABCC’s decade of work on the subject of exposure, narrate a story along the boundaries of what one scholar, Lawrence Buell, calls “toxic discourse”—that is, the language and rhetorical strategies we deploy to talk about toxicity and risk.⁴ With respect to time, distance, and, even what McDonald labeled, “exposure categories,” questions of scale again and again rise to the surface of their work. Their debates concerning how to file, collate, limit, and expand the parameters of their study provide illustrative case studies for how scholars within the field of medical humanities continue to organize information about radioactivity, exposure, and risk.

First and foremost, many of the correspondences and interoffice memos related to these programs appear, at least to one less familiar with these kinds of studies, to describe little more than “administrative” matters. So detailed were the ABCC’s financial records, for example, that one can see how reporting abnormal terminations within “12 hrs. of death” was worth double the rate of reporting “later than 24 hrs. after death” (Box 26, MS

067/26.2). However, this regard for payment scales is in and of itself a reflection of a growing emphasis placed upon—natural though it may seem—procuring information and materials as close to the “termination” as possible. In other words, the financial records reflect the ABCC scientists’ sense of temporality and urgency. On the one hand, it is easy to understand why the delivery of a terminated fetus, or other medical materials, is considered a time-sensitive matter. On the other hand, the doctors are even concerned for the turnaround time on reporting testimonies apart from evidence. In this way, the ABCC understands that while less empirical, the relay of reporting at such a crucial juncture in medical history was still a worthwhile expense. Their perceptions echo what many medical humanities scholars now advocate—namely, the value of patient reporting and how one’s experience of sickness should be regarded as vital medical data.

The uncertain scope and impact of radiation exposure is a kind of “sickness” that opens upon new relations of study and encounter. For medical humanities scholars, in fact, “sickness” is becoming an increasingly important term of analysis, distinguished from labels like “disease” or “illness,” which reflect more defined conditions. Given the ambiguity of generic terms like “health” and “wellness,” acknowledging the relational and negotiable world of “sickness” is an important area of study for the medical humanities. As Heather Houser writes in her book *Ecosickness in Contemporary U.S. Fiction: Environment and Affect*, “If disease is synonymous with diagnosis and illness with personalized experience, sickness is a relation.”⁵ Whether investigating the impacts of radiation sickness or the less clear impact of radiation upon natal development, the ABCC’s papers suggest a provident investment in the “relation” between patient, midwife, doctor, and scientist. In fact, their pay scales are at least partly structured around supporting education within the midwives’ associations in Nagasaki and Hiroshima: “Payment will be made directly to the midwives as at present except in the case of infants obtained for autopsy. of the ¥100 paid for each case, ¥50 will be paid directly to the midwife responsible for obtaining the body, and ¥50 will be paid into the teaching fund of the Midwives’ Association as at present” (Box 26, MS 067/26.2). Far more than a method of currying favor with their Japanese counterparts, the willingness to fund continuing education among their interlocutors underscores the ABCC’s recognition of the value found in fostering relationships of learning even beyond their own institution.

Elsewhere, debates surfaced about how to notate distance from high-concentration exposure regions. The “Genetics Registration Program” foregrounds many of the statistical biases that emerge when trying to measure the effects and distances of radiation exposure, especially when viewed alongside long-term, epidemiological impact. In September and October of 1951, McDonald begins to raise concerns about how they are understanding the very word “exposure” in the subjects of the study (those subjects being primarily parents who may have genetically transferred radiated tissue or other vectors

of medical import). Naturally, one would privilege data sets presented by those surviving parties closest to the hypocenter; and yet, not only were the statistics failing to conform to such an assumption in a correlative fashion, but also the distance categories they employed were proving problematic. In McDonald's words, "A shocking thing has come out from [the IBM Master File] already: all distances are coded to the nearest 100 meters, and in practice I find this means that our distance categories are 0-940; 950- 1440; 1450-1940, etc., instead of 0-999; 1000-1499, etc." (Box 25, MS 067/25.1).⁶ McDonald goes on to ask if it is too late to change their measurements and address potential biases—biases that, as Schull will soon write, "underestimate the exposure of the individual" (Box 25, MS 067/25.1). While normal obstacles in formulating the limits and affordances of a given study, these questions of geography and infrastructure—"shielding" by walls or other infrastructure will become an increasing concern in measuring exposure—invite a larger set of questions regarding how to limit the biases introduced by assumptions of scaled impact (Box 25, MS 067/25.1).

Beyond its obvious political and social import, understanding the effects of the atomic bomb is complicated by the seeming paradox of its emergence: while its impact is dramatic and immediate, its exposures are subtle and often slow in taking shape. Radiation exposure is most certainly an example of what Rob Nixon has termed "Slow Violence," even if the initial moment of exposure is sometimes anything but "slow."⁷ In her study on environment risk and toxicity, Ursula K. Heise addresses the importance of geography and perception when talking about the effects of a catastrophic environmental—or, we might add, medical—event:

The geographical scope of a potential hazard also affects perceptions of its magnitude, with local ones appearing less risky than regional or global ones, as do the benefits that are thought to accrue from incurring a particular risk scenario. At times, these kinds of variables in risk perception do not operate in isolation but correlate with each other in individual's perceptions through an underlying evaluative perspective that statisticians uncover by means of the technique called "principal component analysis."⁸

Time and space intersect in public perception of a hazardous event. The atomic bomb is both a geographic and geological event and a temporal anxiety, since the effects of radiation can have generational consequences far beyond the "event" in question. The reason writers like Heise and the sociologist Ulrich Beck have come to identify modernity as "Risk Society" is, at least partially, an extension of these kinds of complicated, scalar events. "In the risk society," writes Beck, "the unknown and unintended consequences come to be a dominant force in history and society."⁹ The function of the ABCC was to

discover what could be known about those consequences that have henceforth dominated our anxious, often toxic times.

In response to McDonald's concerns and annotations, Schull and Neel spend the last months of 1951 determining the best course of action through which to address the potential bias produced by the IBM Master File. On January 15, 1952, Schull seems to rule on the matter through a letter that contains a reprinted ABCC memorandum to the same effect. Per Schull:

Your plans to attempt to estimate the direct radiation sound fascinating, and as you point out, certainly long overdue ... It has always been my belief that there are individuals in the 1000-1500 meter zone, say, that are potentially more important than survivors within a thousand meters. It seems fairly well established that the LD50, in the absence of shielding, occurs in the 1000-1200 meter zone. Assuming this to be true, then many of the survivors in the thousand meter zone survived, obviously, because they were effectively shielded, and hence are not necessarily the most profitable objects for study (Box 25, MS 067/25.1).

"LD50" is a dose of radiation which, over the course of thirty days, would cause death in 50% of an exposed population. His observation is based upon the counterintuitive insight that given the densely populated hypocenter (with its infrastructural "advantages" for shielding or otherwise), they may be unnecessarily privileging proximity to the site of detonation. While Schull is writing only from a standpoint of his "belief," his collected papers hold a clue to how that opinion formed. Firsthand reports and newspaper clippings help confirm this insight, particularly stories in which survivors describe finding themselves partially protected by walls or other debris. His papers contain the report of one Dr. Shirabe regarding the "Survivors of the Nagasaki Medical College. In Shirabe's own words, "They say in Hiroshima more people were killed by the ceilings falling on them than by the radiation disease" (Box 26, MS 067/22.6). That said, this same doctor adds shortly thereafter: "Here more people died from burns and radiation effects than from external injuries" (Box 26, MS 067/22.6). There was, in short, room for considerable debate about the correlation between proximity and exposure.

Schull thus shares McDonald's urgency to understand how best to code the exposures they were studying. "The matter of distance," writes McDonald in November 1951, "requires an immediate decision, regardless of what we do about age, because other material is about to be put on IBM cards, and the various programs should be comparable" (Box 25, MS 067/25.1). Within this folder—and within all the consulted "Papers of William Jack Schull"—McDonald's reference to "age" is the only indication

that yet another statistical problem was afoot: how to round or collate age ranges represented in the study. Interestingly, as in any study, the forms and facets of selected media dictate the way in which data is collected (in this case, the IBM cards). In the last days of November 1951, Schull responds in an interoffice memo clearly meant to get those working within the “Genetics Registration Program” on the same page. He explains,

The present system of rounding distances as employed by the genetics program is as follows: When the coordinates for an individual’s position relative to the hypocenter are obtained, the Census Section rounds the distance off to the nearest tens of meters. They round off by a rule wherein the distance is rounded to the nearest 10-meter mark ... It is possible, for example, that for an individual whose distance from the hypocenter was 946 meters, to be recorded as 1000 meters from the hypocenter in the genetics system of coding. It will be noted that the bias which may be introduced by this system of coding distances is *a bias which will underestimate the exposure of the individual*. This seems to be, biologically speaking, a worthwhile precaution. This is particularly true in view of the fact that three successive interviews will very frequently yield three estimates of distance varying as much as thousands of meters (Box 25, MS 067/25.1, emphasis added).

The problems facing the Genetics program—including the unreliability of externally-reported data, the limitations of a given media for the purposes of research, and the counterintuitive findings that proximity is not *always* the best indicator of exposure—are relevant insights for any epidemiological or risk-assessment studies involving radiation and nuclear security.

What is most noteworthy in Schull’s summary is the last sentence, where he observes that “three successive interviews will very frequently yield three estimates of distance varying as much as thousands of meters.” When relying so heavily on second-hand reportage of both distance and symptoms, the ABCC were often at a loss to know how to effectively validate their findings. If the IBM punch cards present a problem of medial limitation, reliance upon personal histories presented a problem of discursive limitation—a limitation intensified by the fact that most information was being relayed through third parties like the midwives or other local doctors. In this sentence is perhaps a crystallized suggestion concerning the value of the medical humanities—the need for rhetorical and linguistic experts who can account for language’s operations as well as the ever-present problem of confirmation bias within the hard sciences. The ABCC scientists were discovering that the information relayed was not only unreliable at the source, but also suggestive of unsettling patterns within the third-party relay of information set up

by the study itself. This issue reached its fever pitch in August of 1952, when the “Early Termination Program” analyzed data in two pools that they referred to as “Kitamura” and “Post- Kitamura” data sets. The Kitamura in question was a Dr. Kitamura, whose findings varied greatly from those collected following his departure from the program’s network. Given the heterogeneity of findings between the two moments, another doctor is called in, Dr. Renwick, who was tasked with “investigat[ing] the differences in methods of collection of radiation data in the various programs.” Renwick’s research exposes the disparities and discrepancies that lead McDonald to recommend a dramatic change of course.

In fact, on August 26, 1952, McDonald writes to the research committee of the “Early Termination Program” under the subject “Exposure Categories.” The technical document requesting input from the committee is notable for at least two reasons. First, here we sense the severity of statistical problems facing the doctors and scientists, leading to McDonald’s recommendation—at the end of his writing—that the ABCC terminate the “Early Termination Program,” citing “serious discrepancies ... in the methods of obtaining histories of radiation symptoms” (Box 26 MS067/26.1). More importantly, McDonald offers a summative assessment of how the study sought to understand what he calls “Exposure Categories.” He adds, “The two easily-worked-with criteria of exposure are distance and medical symptoms. Obviously, if an exposed population is divided into two groups, one over and one under a certain distance from the hypocentre [sic.], the nearer group has the higher average radiation, regardless of such factors as shielding or symptoms” (Box 26 MS067/26.1). Key to McDonald’s memo here is the underlined word “average,” most certainly a reference to the months of concern that visited the Genetics program a year earlier. By the end of the memo, he returns again to the unreliability of personal histories, stating:

The Genetics program has the *special problem of second-hand histories*, both as to exposure and symptoms. As Dr. Renwick has pointed out, most information on husbands comes from the wives, whereas wives give their own information. For this reason, we should suspect comparisons of husbands’ exposure with that of wives’, especially in the case of husbands only exposed (Box 26 MS067/26.1, emphasis added).

Another project might investigate the assumptions implicit in such an analysis, or even how accounting for distinctives between those reporting based on gender alone might play out in medical reporting more broadly. (Of course, this work has already been put forth by many in the fields of the medical humanities and science and technology studies, or STS.)

In the end, however, the IBM punch cards were not the primary means of statistical bias, despite the anxiety they caused in the program's early days. Quite pointedly, the problems of distance that clouded the Genetics program for months on end were problems in *reporting exposure*. Even at the very end, the ABCC doctors feel there is hope in validating distance through better means of collecting data. McDonald adds, "Mr. Wright is able, by comparing descriptions of buildings and streets with appropriate maps, to judge the reliability of an individual's statement as to his location" (Box 26 MS067/26.1). A penciled annotation is added here, presumably from Schull's own hand: an inverted caret making the correction, "Mr. Wright and Mr. Noble were able." To Schull's credit, accuracy remained paramount not only throughout his studies, but also even in his attributing correct recognition and reporting authority.

It may strike us as antiquated to gather radiation data using personal interviews in which the interviewer references a literal atlas or map—and then enters such findings into IBM punch cards fed through early computing technologies. Still, the ABCC discloses that the unreliability of those who have experienced a trauma like these atomic events raises, for those of us invested in topics of nuclear security, a pressing concern. The situation clearly called for a more holistic set of questions and census-gathering techniques. The midwives program, the genetics program, the early termination program—they all confront and pose related questions. First, *what is "exposure," medically or should we say "categorically"?* How do we determine what it means to be "exposed" to radiation or radioactive materials? Why should "LD50," to take one example, be regarded as a standard measurement? Secondly, *how do we report exposure?* What fail-safes or systems must be built up around second- or even third-hand histories in order to collect reliable data sets for long-term epidemiological studies of radioactive events? On the one hand, even a casual reader should be altogether struck by how the ABCC enlisted the services of the midwives' associations in Hiroshima and Nagasaki—clearly an acknowledgement that they needed help to surface and even validate personal histories. On the other hand, these strategies were ostensibly not enough to account for the kinds of biases that continue to plague research and policymaking around the risks of a nuclear age.

The ABCC's "Genetics Registration Program" is a reminder of the statistical risks inherent within reporting exposure, as well as the invaluable resources provided by those who record and transmit testimonies. The ABCC's "Early Termination Program" calls to mind the claims made by environmentalists who once advocated that reform must begin with local knowledge and local action. The global problems of health, disease, and exposure are too sweeping—and, being tied to the local geographies and infrastructures of their environment, too nuanced—to address in a holistic fashion. Rather, the medical humanities might adopt a "bioregionalist" framing made popular by ecologists and

sociologists in the 1960s and 70s. As the scholar Timothy Clark reminds us, “Peter Berg and Raymond Dasmann’s pioneering definition of bioregionalism in the 1970s referred ‘both to geographical terrain and a terrain of consciousness—to a place and the ideas that have developed about how to live in that place.’”¹⁰ Bioregionalism’s attention to both geography and consciousness—human environment and experience—is an important reminder for all those conducting or learning from long-term epidemiological studies.

While neither this term nor the wide discourse of environmental thinking was available to the doctors conducting the ABCC studies, their methods were nevertheless innovative inasmuch as they anticipated a need to comprehend both the exterior and interior worlds of those exposed. Writing in the pages of *Medical Humanities*, Ray Pahl argues that those within medicine and the humanities should refine their terms and more explicitly acknowledge the function of human relationships in relaying and documenting medical knowledge. He advises that “the term ‘personal community,’ being the actual set of social relationships that is significant for an individual at a particular point in time, is in fact relatively easy to define very precisely, and, most importantly, can be explored qualitatively to reveal meanings and significances.”¹¹ No matter what we call it, the imbricated relations of human actors working within complex and evolving environments underscore the need for more substantial dialogue between the humanities scholar and medical or scientific professional. As much as the ABCC scientists should be lauded for their frequently thoughtful engagement with the cultural and environmental factors that impacted the scale of their findings, one cannot help but wonder how such a study might now be mounted with the assistance of anthropologists, sociologists, and humanities scholars.

Still, when it came to reporting exposure, the ABCC doctors and scientists rightly leaned on the modes of communication and knowledge-formation that held to the cultural standards of their new environment. They appreciated complexities of information transmission, accounted for disparities and biases within their data sets, and did their best to formulate a reasoned finding with reference to the impact of radiation on natal development. Bearing all these intricacies in mind, how did the ABCC’s Genetics program, after all of the anxious memos, arrive at the point of publishing the article—and then book-length study—bearing the capacious title, *The Effect of Exposure to the Atomic Bombs on Pregnancy Termination in Hiroshima and Nagasaki*? While still inconclusive in areas, the study argued that the statistical variances, when accounted for, did not compromise the ultimate finding that radiation bears little correlation to adverse genetic developments. When the book arrived in 1956, reviewers called the study groundbreaking, or, as Sarah B. Pipkin said in the pages of *The Quarterly Review of Biology*, “the most ambitious survey of its kind ever undertaken.”¹² Pipkin summarizes the findings as follows:

No conspicuous genetic effects of the atomic bombings were demonstrated by this thorough investigation. None of the 5 indicators [sex ratio of infants, malformations, viability at birth, birth-weight, or death during the first 6 days] gave a consistently positive suggestion of genetic damage. The authors feel that some mutations were undoubtedly caused by the atomic irradiation, but these were not revealed by the methods of the survey or by the indicators used.¹³

While full comprehension of the impacts and effects of radiation still eludes us, the goal of these exhaustive studies is not simply to acquire more knowledge or data. Rather, these studies help scholars and scientists to refine methodologies, to reconsider the reliability of certain data sets, and to repeatedly ask what it means to “report exposure.”

Even the contemporaneous assessments of the “Genetics Registration Program,” like Pipkin’s review of its longform study, suggest ways in which to chart a path forward: toward new “methods” and “indicators” that might together establish stronger connections between exposure and risk. To do so, however, will require yet deeper investigation of the scales through which we measure what it means to be “exposed” — in terms of both time and distance. Although it may sound like a trivial matter, even the ABCC’s careful documentation of protocol for the retrieval of and payment for early termination reports is instructive. In one interoffice memorandum, McDonald clarifies what is to be done in the case that a doctor and midwife simultaneously report an early termination. “On occasion,” he writes, “both a doctor and a midwife may report the same case, one by phone, the other by Registration Form, or both by phone. In any case where the person has not been informed, at the time of reporting, that a case has already been reported, both informers are to be paid” (Box 26, MS 067/26.3). It is this generosity of spirit, particularly in the aftermath of the Second World War and the US deployment of atomic weaponry on Japan, that might indeed pay relational dividends—that is, more reliable or conscientious reporting, or goodwill toward the program itself. Such memos, while seemingly administrative in nature, reveal the extent to which these ABCC scientists operated as more than doctors and researchers; they were geopolitical emissaries, cultural interlocutors, and informational receptors who sought to not only facilitate a repair of US-Japan relations, but also preserve vital information for the future of scientific discovery.

Notes

¹ “Papers of William Jack Schull,” Box 26, MS 067/26.2, ABCC Collections, McGovern Historical Center, Texas Medical Center Library, Houston, TX. Unless otherwise noted, subsequent citations from the “Papers of William Jack Schull” will be cited parenthetically, indicating Box and MS numbers.

² I had the privilege of serving as a Schull Fellow in the summer of 2019, working in the archives of the McGovern Historical Center, which is part of the Texas Medical Center Library in Houston, Texas. Working through these documents once preserved by Jack Schull himself, I was drawn to the Genetics program, particularly those documents related to the so-called “Early Termination Program.”

³ H. Tristram Engelhardt Jr., *The Foundations of Bioethics* (Oxford: Oxford University Press, 1986), 11.

⁴ See Lawrence Buell, *Writing for an Endangered Word: Literature, Culture, and Environment in the U.S. and Beyond* (Cambridge, MA: Belknap Press, 2001), 31. For his part, Buell describes toxic discourse as “expressed anxiety arising from perceived threat of environmental hazard due to chemical modification by human agency” (31).

⁵ Heather Houser, *Ecosickness in Contemporary U.S. Fiction: Environment and Affect*, Literature Now (New York: Columbia University Press, 2014), 11.

⁶ A considerable portion of this article’s citations will be drawn from this archival box (25) and file number (25.1). This file contains “Correspondence re: ABCC Matters,” including, in total, six detailed correspondences between Drs. McDonald, Schull, and Neel, as well as one letter (25.1/4) addressed to Drs. Taylor, Brandt, and Reynolds in addition.

⁷ See Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard University Press, 2011), 2–3.

⁸ Ursula K. Heise, *Sense of Place and Sense of Planet: The Environmental Imagination of the Global* (Oxford: Oxford University Press, 2008), 125.

⁹ Ulrich Beck, *Risk Society: Towards a New Modernity*, trans. Mark Ritter (London: Sage Publications, 1992), 22.

¹⁰ Timothy Clark, *The Cambridge Introduction to Literature and the Environment* (Cambridge: Cambridge University Press, 2011), 131; and Peter Berg, *Reinhabiting a Separate Country:*

A Bioregional Anthology of Northern California (San Francisco: Planet Drum Foundation, 1978), 218.

¹¹ Ray Pahl, "Society, Community, Well-Being," in *Medical Humanities*, ed. Martyn Evans and Ilora G. Finlay (London: BMJ, 2001), 23–35, 28.

¹² Sarah B. Pipkin, review of *The Effect of Exposure to the Atomic Bombs on Pregnancy Termination in Hiroshima and Nagasaki* (1956), by J. V. Neel and W. J. Schull, *The Quarterly Review of Biology* 32, no. 4 (December 1957): 389.

¹³ Ibid.

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Conflicts of Interest Statement

While this article's research was funded by the Schull Institute, this article does not make direct claims about Dr. Schull's research but does refer to the Atomic Bomb Casualty Commission with which he was closely affiliated.

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