

The Politics of Science and Undone Protection in the “Samsung Leukemia” Case

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Abstract A labor health dispute between a multinational corporation and patient-workers in Korea received enormous attention from 2007 to 2018, when it was finally and successfully resolved. Sick workers of Samsung Semiconductor claimed they were contaminated by toxic chemicals at their workplace that resulted in their sickness, a contested illness known as “Samsung leukemia.” In this dispute, the Korean government and Samsung used epistemological studies to deny the workers’ claims. The patient-workers politicized the industrial disease, forming a labor health movement that advocated for workers’ rights and welfare. In this long disputed process, they developed their own bottom-up science that collected evidence from their factories and connected this evidence with the claims of counter-experts. They made done “undone science,” which investigated the relationship between the unknown disease and the semiconductor industry. But the undone science has been constructed in the context of “undone protection” stemming not only from chemical exposure in factories that weigh profit over safety but also from institutional failures to protect and compensate the loss of workers’ lives and health. The successful resolution of the “Samsung leukemia” case depended on a health movement that worked toward getting undone science and undone protection done simultaneously.

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On a cold day in December 2013, we went to watch the screening of *Another Promise* at the Peace Hall of Kyung Hee University in Seoul, where that commercial film was to be revealed to the public for the first time. Reporters flocked to cover this controversial movie, which was sponsored collectively by around eight thousand ordinary Korean citizens. Based on a true story, the movie shows how an ordinary taxi driver is transformed into an ardent activist who disseminates the truth surrounding his daughter’s tragic death. To support her family, Yumi Hwang, a young woman in her twenties, goes to work for Samsung Semiconductor, a major component of Samsung Electronics. She eventually dies from leukemia (in real life, her death occurred in 2007). Finding similar cases at the same factory, Sangki Hwang, Yumi’s father, suspects that his daughter’s death might have been caused by chemical exposure at her workplace. But the government and Samsung think otherwise, and they cite epidemiological studies as support for their position. Hwang promises his late daughter that he will never give up his pursuit of the truth, and he fights for many years. Activists form an advocacy group with patient-workers and oppositional experts to collect evidence and to wage Hwang’s David and Goliath battle. Eventually, the case goes to court, where Hwang struggles to persuade the judges with his disparate evidence. Toward the end of the film, the father shouts in court while pointing to patients: “We have evidence! Here . . . here . . . here . . . and there! Bodies of the patients sitting next to you, dead members of our families are our evidence! Is there more conclusive evidence than that? Yes? Yes? . . . Yes?”

For eleven years, from 2007 to 2018, a labor health dispute between a Korean multinational corporation and patient-workers gained enormous attention in Korea and beyond. Dubbed “Samsung leukemia” by the critical media, this illness first became an issue in 2007 (Lim 2015).¹ Thereafter, various conflicts and contentions surrounding the cause of the illness arose among the experts, the government, the patients, and Samsung. Science and medical knowledge were involved in a broad-based politicization of the workers’ illnesses, which ultimately evolved into a global labor health movement. The patient-workers and their families asserted that the cause of their illness was the harmful chemical substances at the semiconductor factory, while the government and Samsung contended that there was no causal relationship between the environment at the semiconductor factory and the illness. The patient-workers filed workers’ compensation claims with the Korea Workers’ Compensation and Welfare Service (KWCWS), but KWCWS dismissed their claims, based on an epidemiological study conducted by the Occupational Safety and Health Research Institute (OSHRI) of the Ministry of Employment and Labor (MOEL). The patient-

¹ The term *Samsung leukemia* is used in this article because the term is used widely by the media and the public in Korea; it also is relatively concise and conveys the meaning well. This movement, spearheaded by the Supporters for the Health and Rights of People in the Semiconductor Industry (SHARPS), was triggered when workers at Samsung semiconductor factories made an issue out of suffering from leukemia, but it came to include other cancers and rare illnesses as the number of patient-workers grew. Depending on the context, this term may be used interchangeably with *semiconductor industry disease* or *electronics industry disease*. However, the phrase *Samsung leukemia* is put in quotation marks because this illness is contested.

workers, not accepting these dismissals, filed administrative suits, resulting in court proceedings between the government/Samsung and the patients. Various oppositional experts, which included doctors, scientists, lawyers, and labor consultants, formed an organization with patient-workers called SHARPS (Supporters for the Health and Rights of People in the Semiconductor Industry) and tried to show that the cause of illness lay in the semiconductor factory, based on workers' experiences in the field and their stories (Kong 2012b). Through this knowledge construction process, the counter-experts gained a comprehensive understanding of the work environment of the patient-workers. They connected this understanding to their authoritative scientific knowledge and refuted the data from the epidemiological study of the semiconductor factory conducted by government scientists and those hired by Samsung.

However, in a context of "undone science" as well as manufactured uncertainty and ignorance of Samsung and the Korean government, SHARPS' bottom-up science was not enough to allow the workers' side to prevail. In this case, we highlight an overlooked but important aspect of the health movement: "undone protection"—that is, those multiple institutional failures to protect workers' health. SHARPS' citizen science in "Samsung leukemia" is necessary but not sufficient to fight against the unequal political economy of labor health. Consequently, SHARPS attempted to shift the focal point of legal and political debate away from the issue of causal link, which is essentially undecidable in individual cases, in favor of undone protection (or prevention), which is more easily decidable according to legal, historical, and scientific norms. Consequently, the SHARPS movement has requested institutional reforms to create more protective working environments, fair compensation for the loss of workers' health, and a more egalitarian legal system for industrial diseases. The counter-experts organized themselves, studied various illnesses in the electronics industry, and demanded an institutional reform of workers' compensation insurance (Park and SHARPS 2010). The successful resolution of the "Samsung leukemia" case depended on how much the health movement worked toward getting undone science and undone protection done simultaneously. We will examine in detail the contentious process between the government/Samsung and the patient-workers/counter-experts.

1 Science for Workers and Undone Protection: Science and Political Economy of Labor Health

Industrial pollution, along with its toxic consequences to people's health, has a long history of conflict among affected peoples, industries, and governments (Boudia and Jas 2014; Markowitz and Rosner 2002; Michaels 2008). People's mistrust of experts and government, widespread environmental pollution, and the rise of social movements have combined to create a new dynamic in these types of conflicts (Breyman et al. 2017; Ottinger, Barandiaran, and Kimura 2017). The field of STS has, in particular, shed new light on the role of science in the contested causality of how uncertain toxic chemicals influence citizens or workers. The rise of citizen science has transformed technocratic expertise and governance and has led to what has been called a *participatory turn* or *democratic turn* (Fischer 2009; Jasanoff 2017; Nieto-Galan 2016). Health movements fortified by citizen science have become a pivotal force in challenging mainstream science and technocratic governance (Brown 2007). But

uncertain toxic chemicals and contested illnesses do not themselves lead to a single coherent conclusion, but rather generate different results, not only because different types of science reveal contested interpretations but also because diverse sets of power and interest groups intervene in heated processes that do not clearly move toward a single conclusion.

“Samsung leukemia” is the name given to a new industrial disease claimed to be caused by uncertain toxic chemicals. The phrase arose from a form of “popular epidemiology” through which ordinary workers collect scientific data and information and collaborate with oppositional experts in an effort to understand the cause of an illness (Brown 1992, 2007). Science plays pivotal roles in determining the causes of industrial or environmental diseases. For instance, scientists and doctors, along with Radio Corporation of America (RCA) workers who suffered from various types of cancer caused by chemicals in their factory, conducted occupational epidemiological studies that led to legal victories against the multinational company after two decades of struggle in Taiwan (Jobin and Tseng 2014; Lin 2017). Scientists at Italy’s National Research Council (CNR) conducted epidemiological studies concerning the causes of cancer in the “triangle of death,” a waste dump site in South Italy, attacking the Italian government’s mismanagement of waste disposal (Cantoni 2016). With regard to the famous Minamata disease, Japanese scientists attempted to find “hybrid causation” of mercury poisoning from sea water, plankton, fish, and oysters (Walker 2010). But such industrial or environmental diseases often receive no attention from the scientific community or regulatory agencies. Prior to 2007, the Korean people and experts alike had never heard of semiconductor industrial disease, though this type of illness was first reported in the 1980s from Silicon Valley in northern California. “Samsung leukemia” is a form of undone science, that is to say, “areas of research that are left unfunded, incomplete, or generally ignored but that social movements or civil society organizations often identify as worthy of more research” (Frickel et al. 2010: 444). But like the “Samsung leukemia” case, undone science can be conducted by different approaches and actors, for example, a government’s regulatory science, Samsung’s hired science, or SHARPS’ science for workers. In other words, the way the science is conducted and constructed occurs within an unequal political economy of labor health.

Science for workers as a form of bottom-up science or citizen science usually starts from the workplace experience of workers, which gives them direct information about factory environments. Yi-Ping Lin (2017) emphasizes *hyunjang* (Korean; xianchang 現場 in Chinese) or *genba* (Japanese) in the making of science for Taiwanese RCA workers exposed to carcinogens. It can be roughly translated as a “field” where place (here), time (now), and flesh (body) are intermixed. The vividness and concreteness of *hyunjang* or *genba* stands in contrast to the neutral and objective stance of mainstream science. In this sense, workers are the “real experts,” who know their factories and working materials in detail. For instance, Barbara Allen (2014) shows how a chemical worker from Venice, Italy, transformed himself into an expert who collected data from his factory and workers. He even published nine articles and eventually brought companies that caused industrial diseases to justice. Science for workers is a field-centered approach, rather than the laboratory-centered or statistics-centered approach that is usually taken by regulatory or hired sciences.

A worker-based, bottom-up approach becomes more powerful and persuasive when oppositional experts combine it with authorities and public trust. A subsequent

implosion within the expert community results from various factors, such as discontent with a government's science and technology policies, the rise of environmental movements, the commercialization of science, and the intrusion of neoliberalism in universities and research (Boudia and Jas 2014; Moore et al. 2011). Consequently, oppositional scientists have formed diverse organizations and have influenced social movements and public policies after World War II and onward (Breyman et al. 2017). In the "Samsung leukemia" case, scientists and doctors from left-wing groups joined SHARPS, forming the Electronics Industry Workers Health Research Group, and conducted epidemiological and industrial occupational studies. The history of citizen science matters because the success of the SHARPS movement came from well-organized oppositional experts with several decades of health-movement experience and their class-centered approach (Korea Institute of Labor, Safety, and Health 2017). Although science for workers starts from a factory or field, the SHARPS movement evolved to a global labor health movement because it has also mobilized foreign scientists and experts.

However, science or counter-science, no matter how sound, are never enough to support a successful movement (Boudia and Jas 2013; Davis 2014). For instance, Fredrick Davis (2014) eloquently analyzes the tragic irony that, although US environmental politics and legal systems successfully terminated DDT use in the aftermath of Rachel Carson's influential book, DDT was replaced by even more poisonous organophosphate insecticides. Power and interests, and political economy, need to be taken into account to fully understand industrial or environmental health disputes.

Consequently, our approach adopts a political economy perspective in STS that analyzes four-party conflicts and negotiations among government, industry, social movements, and science (Frickel and Moore 2006; Hess et al. 2017). The arguments concerning "Samsung leukemia" take place within the political economy of labor health, i.e. the simultaneous unequal political, economic, legal, and scientific systems that deal with labor health. In other words, corporate interests, government executive power, and the scientific and legal systems organized for capitalistic logic affect how science concerning labor health is conducted (Wooding and Levenstein 1999; Levenstein 2009; Moore et al. 2011). In this regard, making undone science done is not enough to protect people's health and environment. What we call "undone protection" is equally problematic because science alone cannot dispel the uncertainties surrounding the use of toxic chemicals. The phrase *undone protection* refers to multiple institutional failures to protect people's health and environment due to political and economic reasons on the one hand, and the uncertainty of toxic chemicals on the other. Almost all industrial health disputes including the "Samsung leukemia" case and the RCA case problematize government and industry's undone protection, which has been poorly conceptualized in STS and other related fields.

In our case study, pro-business and anti-union policies from the governmental and industrial sectors helped sustain undone protection. In addition to pro-business policies for several decades, neoliberal regimes and policies mainly caused by the 1997 Asian financial crisis exacerbated Korean workers' conditions for the next two decades (Y. Kim 2017). Given Samsung's position as the most influential company in Korea, "Samsung tyranny" penetrated all economic, political, and social realms to protect Samsung's interests and strengthen the Lee family's ownership (Lee 2017). The Samsung ideology—that if Samsung collapses so does South Korea (or, Samsung is Korea)—has been pervasive and, in fact, strengthened because the current global boom in the

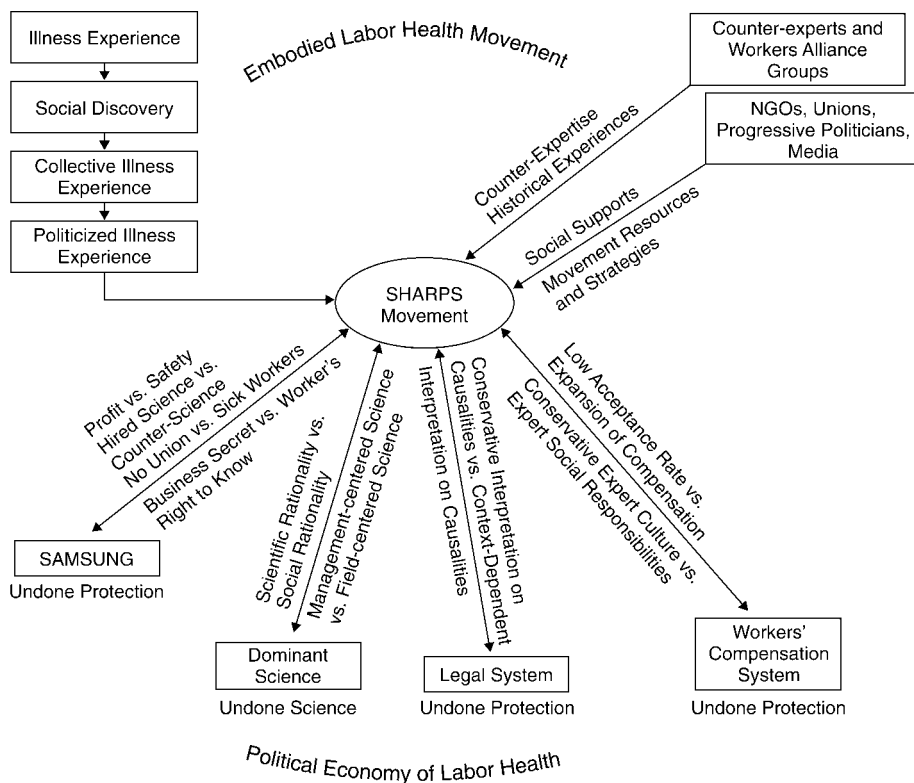


Figure 1 Analytical framework of the SHARPS movement.²

semiconductor industry has made Samsung's profits surpass even those of companies as large as Apple. As a result, the back-scratching alliance between Korean conglomerates (chaebol) and the Korean government has never been seriously challenged. On the other hand, Samsung's no-union policy and its secret operations to break unions have been notorious for several decades in Korea (Lee 2017). In these contexts, the Korean government has been reluctant to conduct rigorous scientific studies. Sellers' (2013) fascinating historical comparison between the occupational medicine models of the Soviet Union and the United States resonates with our case study: Soviet scientists undertook highly sensitive experiments and a cautious approach to determine the maximum allowable concentration levels for toxins in the workplace, while US scientists generally took a more hasty and statistics-oriented approach in the postwar era. Consequently, a particular threshold paradigm was set up, and low-dose exposures were ignored for a long time in the United States and beyond (Boudia and Jas 2014; Henry 2013).

In the "Samsung leukemia" case, undone protection can be found at several levels (Fig. 1). In semiconductor factories, managers tend to turn off safety devices to enable

² The framework in Figure 1 is partially indebted to Philip Brown's (2007: 25) framework of the public paradigm in health movements. It shows the importance of getting undone science and undone protection done in labor health disputes.

the speedy production of chips. Competition between assembly lines emphasizes profit over safety and can lead to managers violating safety rules, because profit is more certain and consequential, whereas toxic exposure is more uncertain and ambiguous. Also, the Korean compensation system for labor loss has fewer protections than European systems, and the acceptance and coverage rates are far below and more limited than those of developed countries ([Korea Institute of Labor, Safety, and Health 2017](#)). In legal struggles, workers bear the burden of proof, and the court has a tendency to take a conservative stance. It is rather rare for workers to win legal battles without concrete and sufficient evidence. Undone protections stem, therefore, from structural inequalities through which industry and government organize and regulate labor forces to promote profit and production. “Samsung leukemia” is a perfect example of how a labor health movement politicizes an industrial disease to make undone science and undone protection simultaneously done.

2 Methodology

Our research team is composed of two academically trained STSers and one activist-lawyer. For this case study, the two STSers conducted fieldwork for thirty-six months from September 2011 to August 2014. The activist-lawyer worked for SHARPS until the end of the dispute, November of 2018. As a member of SHARPS, he gave legal advice to SHARPS and also battled against the Korean government and Samsung in court. As a result, this study is a collaborative outcome of STSers and an activist-lawyer who crossed the boundaries of science, social movement, and politics, leading to in-depth knowledge of the “Samsung leukemia” case.

We collected diverse sets of data to reach a comprehensive understanding of the semiconductor illness movement. From the constructionist point of view, informed by science and technology studies, this research intends to analyze not only the social and contextual elements but also the material and scientific ([Law 2017](#)). The fieldwork consisted mainly of participatory observations, interviews, and various data-collection efforts.

During the fieldwork, diverse sets of official and unofficial data were collected. We read and analyzed the Korean government’s various epidemiological studies on the disease as well as controversial scientific studies revealed in court documents or in documents made available to the public. We also looked at the patients’ disease reports submitted with the workers’ compensation claim to the Department of Employment and Labor. This report, written by oppositional experts, was a detailed account of how the illness developed in the patient-workers. To understand the legal arguments involved, we also collected legal materials from both sides of the dispute. In addition, we collected and analyzed scientific articles and reports, because the scientific aspect of the semiconductor illness movement was also deemed important.

We conducted interviews with a total of thirty-two experts, activists, patients or their families, and related people. An expert for Samsung (an occupational and environmental medicine specialist) was also interviewed. To understand the global formation of the health movement, we visited California in the summer of 2013 to interview eight US experts and activists who helped SHARPS. The interviews lasted one or two hours on average, and the expert for Samsung was interviewed for four hours. All interviews

were recorded with prior consent and were transcribed for analysis. After our intensive fieldwork, we conducted follow-up studies until the “Samsung leukemia” dispute was fully resolved in 2018. We have continuously updated our account of this labor health dispute and ensuing changes and transformations.

3 From a Father’s Fight to a Global Labor Health Movement

The “Samsung leukemia” struggle began when Sangki Hwang, father of the late Yumi Hwang—who worked at the Samsung Semiconductor factory in Giheung, Korea, and who died from leukemia—made an issue of his daughter’s death. After graduating from Sokcho Commercial High School, Yumi entered Samsung Semiconductor in 2003 with about ten other graduates of the same school. She worked on diffusion and wet etching processes in line 3, now known to be one of the more decrepit of the nine wafer-processing lines at the Giheung factory, founded in 1984. Yumi started showing symptoms of nausea, fatigue, and dizziness around May 2005 and was diagnosed with acute myelocytic leukemia around June 10 of the same year. She underwent bone-marrow transplant surgery in December of that year. However, after the leukemia recurred around November 2006, she died on March 6, 2007, while undergoing outpatient treatment. While caring for his daughter, Sangki Hwang learned that there were five other people who had developed leukemia while they were working at the Samsung Semiconductor factory. In particular, when Sookyoung Lee, who worked in the same group as Yumi, died while receiving care at Ajou University Hospital, Sangki came to suspect that this leukemia was an industrial disease. In October 2006, Samsung staff visited Yumi’s home. Sangki demanded that the matter be processed as an industrial accident, but Samsung rejected this demand saying it was simply an illness that had arisen in Yumi. After that, Sangki tried to make an issue of his daughter’s illness by visiting major broadcasting companies and the ruling party, but his initial efforts did not go well.

After it became known that several other workers in addition to Yumi had died from leukemia, Sangki and nineteen civil organizations came together and had several rounds of meetings. With the goal of attaining compensation for, and the recognition of the rights of the patients suffering from semiconductor electronics industrial illnesses, the patients (and their families), activists, experts, human rights organizations, and movement organizations joined forces to form SHARPS. The early activities of SHARPS prompted the politicization of collective disease to begin in earnest. The issue became especially widespread with the efforts of such progressive media in Korea as the *Hankyoreh Daily*, *Kyunghyang Daily*, *Pressian*, and *OhMyNews*.

The activities of SHARPS can be grouped largely into six tasks. First, the patient-workers suffering from illnesses were confirmed, and organized into filing workers’ compensation claims with the Korea Workers’ Compensation and Welfare Service (KWCWS). Oppositional experts such as doctors, scientists, and lawyers were mobilized in this process to bring to light the association between the cause of illness and the factory environment. Second, various street demonstrations publicized the issue and put pressure on the institutions involved (Fig. 2). Third, bringing the illnesses to the media’s attention transformed this issue into a major social issue and mobilized more patient-workers and interested people. Fourth, alliances with political parties and labor unions promoted the rights and interests of the workers, put pressure on

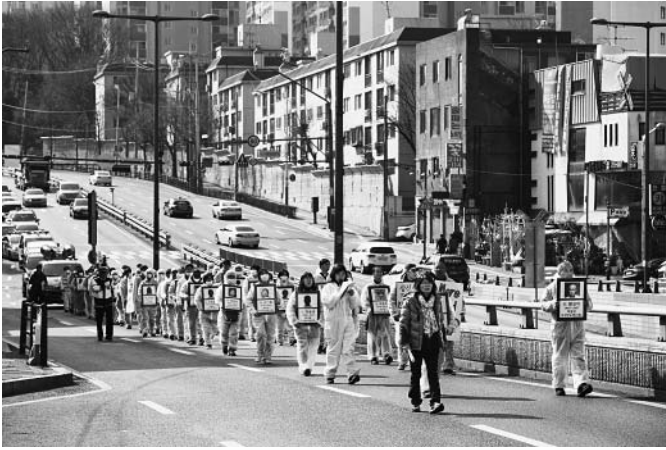


Figure 2 Dustproof dress march for the tenth anniversary of Yumi Hwang's death (photograph by Takyong Jung; courtesy of SHARPS).

the corporations, and urged resolution of the problem. Fifth, experts and witnesses were mobilized for the administrative suit to have the workers' compensation claims of the patients approved in court. Sixth, a global alliance publicized the "Samsung leukemia" issue abroad, and extracted knowledge and strategies for the movement from similar cases in the United States, Taiwan, Japan, and the United Kingdom.

SHARPS prioritized receiving information from workers who had developed leukemia or cancer while working in semiconductor factories. The number of victims known in November 2007 stood at only 6. After media coverage, however, the number of patient-workers grew to 21 by March 2009, to 45 by May 2010, to 155 as of June 2012, and to 362 as of September 2015 (S. Kim 2012: 148; Kim and Kim 2016: 127). The workplaces of these patient-workers were diverse, with workers from not only the semiconductor branch of Samsung Electronics but also from its LCD and mobile phone production sites. In addition to workers from Samsung, workers from Hynix, Amkor Technology Korea, and third-party subcontractors of electronics parts also came forward with information. With this, the informing of illnesses that was initially focused on the Samsung Semiconductor factory was extended to other parts of the electronics industry. In the meantime, the illnesses being reported also extended beyond leukemia to include brain tumors, breast cancer, skin cancer, uterine cancer, thyroid cancer, aplastic anemia, and other illnesses with very low incidence. Of 362 cases, there had been 131 deaths as of September 2015.

In the end, the struggle over "Samsung leukemia" evolved into a global labor health movement. In particular, meetings with Ted Smith of the United States (who founded the Silicon Valley Toxics Coalition), with the International Campaign for Responsible Technology, and also with Amanda Hawes (who founded the Santa Clara Center for Occupational Health and Safety) had a large impact on the activities of the international alliance of SHARPS. Both Smith and Hawes are lawyer-activists who organized and led the struggle over occupational illnesses (leukemia, cancer, etc.) suffered by workers at IBM's semiconductor factory in the 1980s, and both of them have played an important role in the global occupational health movement even to this day.

As the “Samsung leukemia” case evolved into a global health movement, it became a significant case study in understanding how science, law, justice, and toxic politics are interconnected in industrializing East Asia, especially within the seemingly clean high-tech industry. For instance, Samsung Semiconductor lauds itself as a clean industry, emphasizing that chips are made in “dustless rooms” (S. Kim 2012: 140). Samsung and the Korean government denied the existence of toxic chemicals in the making of chips, but SHARPS attempted to reveal that the “dust-free” rooms were in fact contaminated with carcinogens. For a long time, the semiconductor industry has been regarded as the savior of the Korean economy, with semiconductors being its number one export product, generating enormous profits. But the toxic politics initiated by SHARPS challenged the clean image of the semiconductor industry, raising questions on toxic chemicals’ impact on workers’ health and safety, which led to a renaming of the industry from *savior* to *killer*.

4 Contested Causalities

The core of the “Samsung leukemia” struggle was to find out whether a causal relationship existed between the illness suffered by the patient and toxic chemicals in the factory in which the patient has worked. In Korean law, *proximate causal relation* (상당인과관계 相當因果關係) is the applied criterion. It does not mean objective causality, but instead contextual, conditional, and circumstantial causality due to the post-hoc nature of occupational illness. This means that the patient is not obligated to *explicitly* prove his or her illness scientifically; rather, a proximate causal relationship needs to be established between the work environment and the illness or the resulting death. Usually this is done by taking into consideration circumstances such as the health of the worker at the time of employment, the presence of substances at the workplace that might cause the illness, the onset of the illness, the period of time during which the worker worked at the workplace, and so on. Although the term *proximate* is unclear and uncertain, which consequently led legal scholars to debate its meaning at length (Lee 2013), it can be assumed that the more medical and scientific evidence there is, and the more persuasive and authoritative this evidence, the easier it is to argue for a particular proximate cause.

Korean law also makes it clear that the establishment of a causal relation between an occupational illness and the work environment depends on three factors: (1) existence of a harmful substance and the exposure to that substance, (2) sufficiency of the exposure, and (3) medical acknowledgment,³ all of which would come to be contested in the “Samsung leukemia” case. The contest between the patients/SHARPS and the government/Samsung regarding the illness originated from the differences in the ways

³ Article 34, clause 1, of the Enforcement Decree of the Industrial Accident Compensation Insurance Act determines the criteria for acknowledging an occupational illness as follows: (1) the worker has an experience of handling or being exposed to a harmful or dangerous factor in the process of carrying out job tasks; (2) it is acknowledged that it is possible to cause the illness suffered by the worker based on the period of time of handling or being exposed to the harmful or dangerous factor, the length of time working in the position, work environment, and so on; and (3) it is medically acknowledged that the illness was caused by the worker being exposed to or handling the harmful or dangerous factor.

each side has constructed, judged, and interpreted causalities. While the former has mobilized inductive evidence based on the “field experiences” of the workers “as much as possible” (from which counter-experts then extract scientific and medical connections), the latter has constructed information in a statistical way (Kim and Kim 2013: 292).

First, it was contested whether or not there existed harmful substances at the semiconductor factory, and whether there have been any workers who have been exposed to them. The number of chemical substances used in a semiconductor factory, counting only those ones known, exceeds several hundreds, and only a small proportion of those chemicals are monitored under Korea’s occupational health and safety acts (J. Kim 2017: 115). Problematic among the chemical substances used in the semiconductor manufacturing process are known carcinogens such as benzene, ethylene oxide, trichloroethylene, arsine, arsenicals, and formaldehyde (J. Kim 2017: 117). These substances have been reported to cause leukemia and various types of cancer (Hankyoreh 21 2010). In addition, because radiation is a major cause of cancer, determining whether there has been an exposure to ionizing radiation emitted from the radiation-emitting apparatus used in the semiconductor manufacturing process became a point of contention between SHARPS and Samsung.

However, patients face the following difficulties in becoming aware of the existence of specific harmful substances. First, it is difficult to obtain information on the past work environment, because the time taken for exposure, illness development, and illness detection is considerably long, usually many years, as it was in the “Samsung leukemia” case. Second, factory environments change very fast in a cutting-edge industry like electronics that employs the latest technology. Third, Samsung does not proactively disclose information on its past work environments, citing this as commercially sensitive information. Fourth, because any investigation by the government into harmful factors is post hoc, the result of such investigation will lack concrete information. Fifth, the complex interactions between chemical substances occurring during work processes cannot be measured.

The second condition for the acknowledgment of occupational illness is the level or degree of exposure, that is, whether the exposure was *sufficient*. Even when there is an exposure to substances that cause leukemia or other types of cancer, it is not easy to prove that the exposure was sufficient for an illness to develop. For example, when OSHRI evaluated the compensation claims of three female workers with acute leukemia, it dismissed all three, saying that “the exposure levels to factors causing leukemia (benzene, ionizing radiation, formaldehyde, 1,3-butadiene, and ethylene oxide) are as low as that of natural exposure, and it is also hard to conclude from the epidemiological study results that there was an occupational exposure” (Kong 2012a). Problematic yet again is the absence or shortage of past environmental assessment data gathered by Samsung. The substances subject to the work environment assessment were very limited: of about 400 chemical substances used at the semiconductor factory, only about ten percent were measured. In addition, for a large number of harmful substances, there does not yet exist any standard for assessing exposure. Even where there is a regulatory standard for exposure, there still remains the question of whether it is reasonable to use it as a standard for decisions regarding compensability.

Scientific acknowledgment, the third requirement for an illness to be classified as an occupational illness, is also contested. Diseases develop via complex processes, and

the scientific community rarely comes to a complete consensus with regard to diseases like electronics industry illnesses that are induced by invisible and complex factors (Smith, Sonnenfeld, and Pellow 2006). Even when there is a considerable amount of research done on causal relations between a certain chemical substance and illness, often different conclusions are reached and *scientific approval* becomes an object of interpretation and debate once again. The strategy taken by OSHRI and Samsung has been to constantly point out the *uncertainty* and *incompleteness* of the evidence for a cause of illness. In contrast, the standpoint of SHARPS and the patients has been that it is not fair to delay or refuse compensation just because the level of proof does not satisfy a scientific certainty which is inappropriate to a workers' compensation scheme. SHARPS has also tried to show that there is sufficient evidence for decisions on compensation based on scientific studies themselves.

SHARPS' counter-experts have countered those of OSHRI by using two strategies to obtain *scientific acknowledgment* of illness. One has been to cite cases from an institution which enjoys the public's confidence regarding the specific harmfulness assessment, and the other has been to find well-known and authoritative studies on illnesses occurring in the semiconductor industry. The counter-experts have occasionally borrowed from the experiences and authorities of institutions in developed countries where regulations and measures concerning chemical substances were created early on, especially from regulatory agencies or professional organizations in the United States. For example, whereas the permissible level in Korea for benzene, a carcinogen, was reduced from 10ppm to 1ppm only in 2003, already in the 1990s the American Conference of Governmental Industrial Hygienists recommended reducing the permissible level for benzene to 0.1ppm. Looking at this criterion, one can surmise that Koreans who worked at semiconductor factories before 2003 worked in an environment with relatively high permissible levels of benzene, and thus with a relatively high possibility of ensuing cancer. Even if many current Korean standards for managing chemical substances are stricter than or the same as those in the United States, they still trail those of the United States in terms of time.

Another strategy of the counter-experts for obtaining "medical acknowledgment" has been to collect and analyze scientific articles on diseases at semiconductor factories in other similar countries. At the time, there were no research articles from Korea in this field; but the issue of illnesses at semiconductor factories arose in other countries in which an advanced semiconductor industry had developed early on, and many of the early studies are from the United States, the United Kingdom, and Taiwan (Smith, Sonnenfeld, and Pellow 2006). The counter-experts analyzed relevant studies from other countries. Not all foreign studies supported the opinions of the patients (or their families); many argued on behalf of the companies (J. Kim 2017: 124). In spite of this, the analysis of foreign studies helped build a foundation of knowledge essential for establishing the medical and scientific basis for the correlation between illnesses and environmental factors in semiconductor factories, and that analysis played an important role in the formation of standards of logic.

From the start to the end of 2017, SHARPS helped ninety-four patient-workers in total file compensation claims with the Korea Workers' Compensation and Welfare Services (KWCWS). The patients were able to file a lawsuit against KWCWS if it rejected patients' compensation requests. Initially, KWCWS rejected almost all patient-workers claims, and just eighteen cases had gone to court by the end of

2017. Because “Samsung leukemia” had become a well-known case to the public, the legal disputes received enormous attention and both sides mobilized as much evidence as they could. In this process, SHARPS problematized the concept of proximate causality, because industrial diseases face a Godot situation, borrowed from Samuel Beckett’s famous play “Waiting for Godot” (J. Kim, 2017: 151). SHARPS argued that, whatever obvious or proximate causality exists, you would have to wait eternally for the final determinant of industrial disease, just as one waits endlessly for Godot. SHARPS emphasized the role of a “social rationality” that the court should seriously take into account in the case of “Samsung leukemia,” instead of waiting for Godot, which is *scientific certainty*. It took several years for the Supreme Court of Korea as well as lower courts to acknowledge the importance of *social rationality*, admitting the limitations of science. Consequently, twelve cases had won and six had lost by the end of 2017, but those six cases were later compensated by either KWCWS or by the responsible companies.

In fact, legal judgements on industrial diseases are based on *socio-scientific* causality. Both scientific causality and social causality matter, though initially just the former has been heatedly debated in court. Accounts of causal relations between an illness and the factory environment, along with the resulting contentions of both sides, are under the influence of factors such as the uncertainty of science, the limited nature of information due to commercial confidentiality, and the inability to reproduce past situations (Boudia and Jas 2014; Shapiro 2015). In other words, the science of “Samsung leukemia” has operated and performed within the political economy of labor health. Government control, Samsung’s corporate interests, and the legal system have all opposed patient-workers’ claims. In the next sections, we examine how those sciences are constructed within unequal political, economic, and scientific systems dealing with labor health.

5 Government’s Official Science and Samsung’s Hired Science

Because causalities of semiconductor industrial diseases were contested, the Korean government, Samsung, and SHARPS each attempted to mobilize science in their favor, and each of them used it differently (Kim and Kim 2013). When the “Samsung leukemia” issue first became a social problem, the Korean government commissioned OSHRI to do a leukemia-risk-group epidemiological study of semiconductor factory workers. This study was conducted from March to December of 2008, and was released on December 29 of that year (OSHRI 2008). This report has been cited as a major reference in judgments of individual epidemiological studies and litigation processes, and thus warrants a closer look.

The group epidemiological study was conducted across nine semiconductor workplaces of six companies (including Samsung Electronics) and thirty-seven subcontractors, with the goal of determining whether the risk of leukemia-related illnesses was high or low among workers at semiconductor factories. The risk assessment dealt with measures of the standardized cancer mortality rate, the standardized cancer incidence rate, and the standardized medical care use rate. Standardization was used to eliminate the impacts of demographic differences such as gender and age when comparing the mortality rate or the incidence rate across the standard population and the observed group.

The results of the group epidemiological study can be summarized as follows (OSHRI 2008: 33–34). Analysis of the mortality risk level in men for semiconductor industry workers, using National Health Insurance data, shows that it was lower than that of the general population group, and this finding was statistically significant. In the leukemia risk analysis, death from leukemia in men was lower than that of the general population, and the incidence was at a similar level. For women, both mortality and cancer incidence in semiconductor workers were higher than the general population; the standardized mortality ratio and standardized cancer incidence ratio were 1.48 (95% confidence interval 0.54–3.22) and 1.31 (95% confidence interval 0.57–2.59) respectively, but neither was statistically significant. To put the results of the study simply, no result that would have favored the claims of SHARPS was determined to be statistically significant.

On December 30, 2008, the very next day after the release of the group epidemiological study, SHARPS immediately rebutted the results of the investigation, basing their rebuttal on the following three points (Park and SHARPS 2010: 73–77). First, high-risk groups were lumped together to mitigate the incidence risk. For example, Lines 1, 2, and 3 at Samsung Semiconductor's Giheung factory were older production lines, and among people working on those lines, there were five incidences of leukemia. Among workers on all lines together at Samsung Semiconductor, there were nineteen incidences of leukemia. If the workers at a factory with frequent incidences and those with infrequent incidences are all included in the denominator, the result will not be statistically significant. Second, this investigation did not take into consideration the so-called healthy worker effect. The study showed that workers in the semiconductor industry are generally much healthier than the general population. Simplified comparison of incidence or mortality of workers with those of the general population without considering the healthy worker effect can hide the real risks among workers. Even a slight increase in risk among workers should not be ignored in this context. Third, the epidemiological study by OSHRI interpreted illnesses of the same mechanism differently. High rates of lymphoma in women that had not yet developed into cancer were detected in the study. SHARPS interpreted those high rates as a sign of the risk of lymphatic and hematopoietic cancers, even as the government downplayed any such risk. For women, the risk of leukemia was found on investigation to be high, but was deemphasized for not being statistically significant.

Taking things a step further, the counter-experts noted that the phrase *statistical significance* might be interpreted conservatively in a group epidemiological study. When a causal relation is not clear for a certain illness, an expert group will tend to choose the type two error (false negative) in concluding that there is no causal relation when there is one, over the type one error (false positive) in concluding that there is a causal relation when there isn't (Brown 1992: 274). From the point of view of an expert culture that seeks "certainty," it may be risky to conclude that there is a relationship between a certain harmful substance and an illness when the cause has not been ascertained.

As the public mood soured, Samsung felt the need to *directly* mobilize science in addition to the government's OSHRI study. How the investigation should be conducted was discussed within Samsung Electronics, and it was concluded that, because national opinion on the "Samsung leukemia" controversy was extremely divided, the investigation and its results would not be trusted no matter who conducted it. It was

considered, then, that the investigation would gain at least some authority and credibility if a globally authoritative institute were commissioned to carry it out. But it had to be pro-business science, and Samsung selected ENVIRON, a well-known hired science firm in the United States (source: our interview with an expert from Samsung).

On July 13, 2011, at the Samsung Electronics establishment in Giheung, the results of a study conducted by ENVIRON International Corporation during a one-year period beginning in 2010 were presented. ENVIRON (2011a, 2011b) conducted two studies; one was an evaluation of past risks based on the semiconductor factory environment at present, the other an assessment of the risks for the six workers who had filed workers' compensation claims. For the first study, ENVIRON presented findings that the level of exposure to harmful substances at the Samsung Semiconductor factory was much lower than international standards, and that these substances were managed well. For the second study, with regard to the cases of the six individual workers, ENVIRON asserted that four of them had not been exposed to carcinogens, and two had been exposed but not to a degree sufficient for an illness to develop.

SHARPS' oppositional experts immediately took to rebutting ENVIRON's research. All data used by ENVIRON was provided by Samsung. They pointed out that ENVIRON's assessment of past risks was based on the factory environment at "present," and the evaluation of the past environment was based on documents superficially collected by Samsung. The second study was also flawed in relying on data provided by Samsung and investigative studies by OSHRI for adjudication of each compensation claim. Even an expert from Samsung admitted that ENVIRON's studies were inadequate (source: our interview): "They are inadequate. Actually they couldn't help being inadequate because when you look at the data, no other data will really just come along, you can't really search nooks and crannies for more. . . ." SHARPS criticized ENVIRON's studies, saying that the studies were "contracted science" purported to legitimize and condone Samsung and OSHRI.

6 SHARPS' Bottom-Up Science

Under these disadvantageous conditions, SHARPS constructed knowledge by merging the workers' field experiences and stories with the counter-experts' professional knowledge. Their method of causality construction can be termed a *field-centered approach*, in which workers' information from the field—the *hyunjang*—is translated into the scientific language of doctors and scientists. Their long experience of working in factories provided rich and detailed data for finding the cause of illness, and the professionals' expertise added authority and credibility. With such a method of knowledge construction, SHARPS was able to confront on an equal footing the knowledge construction and illness judgments of OSHRI and Samsung.

Above all, it was the stories and information from the patients who had worked at the site, their family members, and co-workers which laid the crucial foundation for exposing the existence of and exposure to harmful substances (Kong 2012b). For example, the late Yumi Hwang had worked on the diffusion and sensitization processes, repeatedly putting wafers into and pulling them out of a container filled with hydrogen peroxide (a harmful substance) and BOE ("buffered oxide etch"—a mixture of hydrogen fluoride, ammonium fluoride, and a surfactant), a process dubbed

splashing. Her coworkers said that Yumi Hwang was also exposed to radiation-emitting equipment to a considerable degree. Because the semiconductor manufacturing process and equipment were very complicated, patients and coworkers explained the process to the experts in great detail. For example, to Samsung's argument that workers couldn't inhale toxic gases during the splashing process because the exhaust system operated to make the air flow from top to bottom, a fellow engineer responded in their testimony that the air flowing downward was not that strong, and that the smell of the gases spread sideways. Also, many people testified that the *interlock*, a safety device for blocking radiation, was routinely turned off to increase the work speed. Jongran Lee, a labor consultant who was deeply involved with the construction and understanding of illness through integrating diverse expert information in the SHARPS movement, said that:

To tell you the truth, when you think about who the experts are in this field, workers are the experts. They know the field the best. For example, why there is a gas leak in what part of which plumbing because of what, only workers in the field know things like this. No matter how good of an industrial hygienist you have, that person cannot process all that with one look, and at any rate, the experts of that field are the workers in that field.

In addition to using patient-workers' detailed information from the field, SHARPS created its own research group, the Electronics Industry Worker Health Research Group (EIWHRG). EIWHRG met once a month, with ten to fifteen counter-experts participating, and conducted education of members and research relating to electronics industry illnesses. Counter-experts' activities consisted of field examinations, study of scientific papers on relevant illnesses, disaster reports, and the mobilization of medical knowledge in court. Usually, occupational and environmental medical professionals dealt with these tasks. They needed to study new materials to prepare disaster reports for patients, since the scientific research on electronic industry illnesses in Korea was meager. Difficulties faced while documenting the development of illness in patients, opinions on interpretations, and comparisons among similar cases were all discussed and professional experiences shared. The lively discussions that took place at these group meetings helped to better prepare the group's disaster reports.

In time, EIWHRG achieved better understanding of electronics industry illnesses through its own research. Research was considered an important strategy that would lead to electronics industry illnesses being acknowledged, through systematic analyses of data, as a *collective* illness. Writing review articles and re-analyzing the epidemiological data for the industrial park were done first. Subsequently, those research plans that require more resources have progressed relatively slowly. One of EIWHRG's significant accomplishments was to publish an article on "Samsung leukemia" in the *International Journal of Occupational and Environmental Health*, a reputable academic publication in the field. The article carried out a close analysis of seventeen leukemia and non-Hodgkin lymphoma cases from among fifty-eight cancer cases among Samsung Electronics workers, meticulously analyzing their demographic characteristics, job history, and medical history. It stated that carcinogens such as benzene, formaldehyde, arsenic, and ionizing radiation were detected, strongly implicating the factory environment in the workers' illnesses (Kim et al. 2012). The front cover of the journal issue featured a photograph of Yumi Hwang and her father Sangki, taken before her death.

Consequently, their efforts yielded visible successes. First, in 2012 a workers' compensation claim relating to leukemia in a semiconductor factory was approved for the first time. Second, in February of 2012, OSHRI's second official study announced that benzene, formaldehyde, ionizing radiation, and arsenic had been detected at several semiconductor factories. This led to the government's acknowledgment, for the first time, of the existence of carcinogens at semiconductor factories. This acknowledgment had an impact on SHARPS' activities, Samsung's disposition, and litigation from then on.

With regard to these significant changes, we interviewed a member of the Occupational Disease Decision Committee who took part in the workers' compensation claim evaluation at the time, and asked whether political thinking had influenced the illness judgment. He admitted that, in adjudicating a workers' compensation claim, the sense of social responsibility felt by an expert could exert some pressure on decision makers. But he denied that it was a political judgment, asserting that the main factor in approving a workers' compensation claim was the accumulation of scientific evidence. He said that, as illnesses in the semiconductor industry had become a social issue during the past few years, committee members had studied various scientific materials on the illnesses, through which they had started to recognize more risk factors. When semiconductor occupational illnesses first began to be investigated, the Occupational Disease Decision Committee members hardly had any in-depth knowledge of them. It was a kind of undone science that mainstream science has ignored and not conducted because of lack of funding, attention, and necessity, all of which are linked with the political economy of science (Frickel et al. 2010; Yoon 2012). Members had, therefore, to make decisions based on existing information, but there were hardly any cases of semiconductor occupational illness reported domestically at the time. Most of the scientific evidence presented in the previous few years, however, was either accumulated by counter-experts or uncovered thanks to pressure from them and the social movements supporting them. Ted Smith, who has played a prominent role in leading electronics industry illness conflicts in various parts of the world during the last three decades, has stated that the characteristic of the "Samsung leukemia" movement has been the close alliance between the social movement and counter-experts:

I mean at the forum I was at last year, the symposium [in Korea], we met many professionals: doctors, industrial hygienists, epidemiologists. It was a much more concentrated group of professionals than I ever saw in the US. So the fact that there is such a rich resource here in terms of the people who are involved, paying attention, studying it, and doing what they can to try to support the workers is, in my view, unique and very important.

Smith emphasizes that this is unique and significant when compared with other countries' cases, that there are more counter-experts who are involved in the "Samsung leukemia" movement, and that they are well organized. Despite the lack of resources and institutional support that stems from the unequal political economy of labor health, SHARPS successfully mobilized counter-experts with patient-workers' concrete information from the field, forming "collaborative expertise through which experts and lay people helped one another to form legitimate knowledge claims, using their own strengths and connecting their specialty and experiences" (J. Kim 2014: 235).

7 Undone Protection: Institutional Failures to Protect Workers

In the “Samsung leukemia” case, science is necessary but not sufficient for workers to gain institutional recognition and receive compensation. Consequently, in addition to the building up of oppositional sciences, experts and workers in SHARPS have blamed institutional failures for the lack of protection of workers and demanded institutional reforms on multiple levels: factory environments, compensation processes, and industrial health and safety laws. In other words, they insist that what we call *undone protection* should be made done, to prevent toxic exposure and industrial disease.

In the process of understanding toxic exposure in semiconductor factories, SHARPS interviewed many patient-workers who knew their factory layouts and working environments in detail. They informed SHARPS that safety regulations were ignored mainly because of the emphasis on speedy production. The approach that emphasized production over safety was reinforced as workers in different lines competed to make more products. Before he passed away from leukemia, one worker-patient described this situation as follows (Lim 2015: 58–59): “In the end, the problem happened because we had to work very fast. We should have had enough time to remove remaining gases but we did not have time to spare. For example, workers inhaled gases during etching because they had to do it very fast. Radiation came out and we had the measuring badge but we didn’t do it as the price of production.”

Workers in semiconductor factories are compared to one another in terms of productivity. If a worker shows relatively low productivity, they receive a warning from the company. At the same time, workers would sign a safety education document even though they had not received safety education. A government special examiner, one of our interviewees who checked toxic chemicals and safety, lamented the half-hearted supervision of toxic exposure in semiconductor factories by Samsung’s environmental engineers. Samsung’s mismanagement of toxic chemicals was publicized and received enormous criticism. The Korean government had to order a special examination of Samsung Semiconductor and discovered approximately two thousand violations of the Industrial Health and Safety Act (Ministry of Employment and Labor 2013). Samsung had to admit its failures to manage chemicals and to protect workers, and it reached an agreement with SHARPS in 2016 for enhanced safety measurement and workers’ health. As a result, Samsung set up a Health Protection Center staffed with fifty medical personnel, and an Ombudsman Committee that supervises toxic materials in semiconductor factories (J. Kim 2017: 102). Through this agreement, SHARPS made Samsung’s undone protection done.

SHARPS also challenged the way that workers’ compensation is decided. The Korea Workers’ Compensation and Welfare Service (KWCWS) is under the Ministry of Employment and Labor, which administers workers’ compensation claims. In that complicated process, the Occupational Disease Decision Committee plays a defining role in deciding whether the worker is eligible for compensation. Basically, experts on the committee vote for *rejection* or *acceptance*, and the decision is made by majority rule. If the worker’s claim is rejected, they may file a lawsuit, but this legal process is long and tedious. Winning the vote at this committee stage, therefore, matters a great deal.

Initially, six patient-workers who filed compensation claims had their claims rejected by the committee, the votes going mostly 10:2 or 9:3 against (J. Kim 2017: 92). The

members of SHARPS were outraged by such skewed results. Some of its doctors and experts had in-depth knowledge of the decision-making process in the committee. Professor Domyung Paek, one of our interviewees who had worked for the decision-making committee for more than twenty years, evaluated the process as being more likely than not to be conservative. Doctors on the committee tended to favor erring on the side of a false negative decision rather than a false positive, because experts demand more definitive evidence for a new industrial disease. Doctors for the committee were recommended from three parties: unions, industry, and the government's KWCWS. Though a committee member's affiliation and political sympathies do not always determine their voting, the composition of the committee strongly influences overall voting results. Unless a disease is a well-known occupational illness, doctors recommended by industry and government tend to be conservative, leading to rejections of workers' compensations demands.

Anonymous committee members who know the decision process very well told us that "Samsung leukemia" strongly influenced a change in "expert culture" rather than fomenting institutional changes: experts on the committee have become more lenient, despite a lack of obvious causality in semiconductor industry diseases. Conversely, as more scientific evidence has been accumulated, the committee has tended to favor patient-workers, resulting in some winning at the committee stage without proceeding to court. Multiple anonymous experts told us that experts are leaning more toward normative judgments than simply adopting scientific ones. The Occupational Disease Decision Committee is a *gray expert system*, where normative and scientific judgments are intermixed and there are no clear-cut criteria for decisions. Because "Samsung leukemia" became a lightning rod in the area of occupational disease for the last ten years, committee members have been influenced by social movements and the general public atmosphere. Moreover, after the [Supreme Court of Korea's decision in 2017](#), the KWCWS in 2018 set out inclusive guidelines for eight types of semiconductor industry disease ([Chung 2019](#)). Consequently, the decision committee has in general voted to uphold patient-workers' compensation claims.

SHARPS' legal challenges are, therefore, even more significant in that its activities led to some milestone decisions. After failing to get compensation, six patient-workers and their families filed lawsuits in the Seoul Administrative Court. The legal confrontation between the government/Samsung and SHARPS lasted for several years, and was focused mainly on the causality of the disease. Both parties mobilized their own science to persuade judges, but the burden of proof lay heavily on the patient-workers. But under enormous pressure from SHARPS' coalitions and continuous scientific studies, new government studies began through more elaborate research processes to acknowledge the existence of some carcinogens in semiconductor factories. Other scientific evidence was suggested by SHARPS' counter-experts in court. Consequently, Yumi Hwang and Sookyoung Lee, who worked in the same team and who passed away from leukemia, won their cases ([Fig. 3](#)). Three additional cases were lost, and one case was dropped by the plaintiff. These were partial victories for SHARPS, but also the first legal victories anywhere in the world on industrial diseases in the semiconductor industry. SHARPS continuously filed lawsuits on behalf of patient-workers whose claims had been rejected by KWCWS. Hwang and Lee's legal victories influenced SHARPS' subsequent lawsuits, and it won nineteen more cases by 2017. In



Figure 3 The SHARPS press conference outside the Seoul Administrative Court after a victory at Yumi Hwang and Sookyoung Lee's second trial (photograph courtesy of SHARPS).

addition, KWCWS started accepting the existence of industrial disease in a number of cases filed, basing the change on new legal conclusions, government studies, and counter-experts' studies.

SHARPS also demanded changes in industrial health and safety laws. In particular, they problematized the interpretation of *proximate causality* in the governmental and legal sectors. South Korea has been notorious for having one of the world's highest rates of industrial disasters, after several decades of the "developmental dictatorship," which formed its current pro-business and antilabor economic and legal systems (Kim et al. 2014: 26). It is worth noting that until the early 1990s for administrative purposes Korean labor health regulations accepted only "obvious cases" when it came to passing judgment in industrial disease and accidents, but this changed to proximate causal relation as a result of the first massive labor health movement in Korea, the Occupational Disease Victims' Struggle against Wonjin Rayon (Kang 2015: 12). Known as the Wonjin Incident, several hundred factory workers died as a result of carbon disulfide poisoning while making rayon. Government and industry denied the causal connection, leading to a decade-long campaign by workers.

Governmental and legal interpretations of the causality of occupational diseases have a long and complicated history in Korea (Myong et al. 2018). Though it goes beyond the scope of our current work, it is clear that the labor health movement contributed to the expansion of causality in occupational disease. In 1963, when the first Industrial Accident Compensation Insurance Act was introduced in Korea, industrial accidents needed two rigid criteria when it came to compensation: work performance and work attribution. Until the end of the 1980s, compensated cases of occupational disease were few and far between, since "occupational disease was a taboo to openly discuss in Korea" (Zoh, Park, and Paek 2019: 1). For example, only two percent of all occupational diseases were compensated by the Korean government (Zoh, Park, and Paek 2019: 2). Korea was formally democratized in 1987, and a massive labor movement that transformed the entire landscape of labor-industry relations occurred in the same year. After thirty years of dictatorship, the late 1980s and early 1990s became pivotal periods for labor. The concept of proximate causal relationship was introduced into administrative regulations in 1989, and, though this legal expression was formally written into the revised Industrial Accident Compensation Insurance Act in 2007, the Supreme Court of Korea was already using the concept in legal cases concerning contested occupational disease in the early 1990s. Consequently, the government's

acceptance rate of occupational diseases rose from two percent in 1987 to twelve percent in 2007 (Zoh, Park, and Paek 2019: 2). Of course, it is a little dangerous to generalize from the concept of the proximate causal relationship, as the judgment of occupational disease depends on several intermingled factors unless accepted by the expert community.⁴ Rather than pinpointing one defining moment, it is more suitable to acknowledge cumulative effects and several important moments, such as the Wonjin Incident, that contributed to broadening the idea of proximate causal relation. Though scientific evidence regarding a disease is necessary in judging causality, social and normative rationality also play significant roles. In this context, the labor health movement was definitely an influence in making the proximate causal relation more inclusive, to the benefit of patient-workers. “Samsung leukemia” became one of the most important moments in the broadening of the term.

With regard to that broadening of the proximate causal relation, a milestone legal victory for SHARPS came in August 2017 (Supreme Court of Korea 2017). The Supreme Court of Korea ruled that the Korean government should compensate Heejin Lee, a former Samsung worker who was suffering from multiple sclerosis. Ms. Lee’s claim, supported by SHARPS, was rejected three times—by KWCWS, at a first trial, and then again at a second—mainly because the causality of multiple sclerosis is unknown. But the Supreme Court of Korea finally ruled for Ms. Lee, explaining that *proximate causal relation* needed to be more inclusive, even though an industrial disease might have obscure causes and workers a burden of proof with limited information on toxic exposure (Do and Choe 2018). The court also emphasized the role of industrial accident compensation insurance as “public insurance” despite uncertain scientific evidence on the disease (Supreme Court of Korea 2017: 1). Furthermore, it specifically pointed out that it was the first Supreme Court decision that favored the worker in “Samsung Semiconductor or LCD industrial disease cases.” Though the Supreme Court did not reverse the burden of proof, it emphasized that the lower courts should not deny causality even though it is hard to prove, and it demanded more forward thinking on contested causalities (on RCA litigation in Taiwan, see Chen 2017).

More important, the Korean courts collectively have moved away from *scientific rationality*—including proximate causality—and toward *social rationality* in legal judgments on industrial diseases asserted by SHARPS. For instance, the Korean administrative court has handed victories to workers with leukemia and cancer, explicitly stating that Industrial Accident Compensation Insurance as a public insurance (공적 보험 *gongjeog boheom*) is designed to relieve the risks associated with workers’ health and safety and should compensate workers due to its “publicness” (공공성 *gong-gongseong*) without recourse to scientific causality (Lim 2018: 31–32). The Supreme Court of Korea confirmed this line of judgement, stating that the causal relationship between working environment and disease is not judged by medical and scientific perspectives but instead legal and normative (Supreme Court of Korea 2017: 3; Lim 2018: 39). The Supreme Court has emphasized the importance of social rationality in

⁴ The concept of proximate causal relation (*adäquanztheorie*, adequacy theory) was suggested by a German scholar, Johannes von Kries, in 1888. Proximate causal relation is not a unique concept in judging occupational disease but a general concept widely used in the legal sphere. This concept has been debated for a long time because of its ambiguous and multiple meanings (Lee 2003).



Figure 4 Occupational protest by SHARPS in front of Samsung headquarters, Seoul, Korea (photograph by Kihwa Lee; courtesy of SHARPS).

that Industrial Accident Compensation Insurance should cover workers suffering from leukemia and cancer because of its role of social protection of workers. It has emphasized the lack of safety regulation, the insufficiency of safety education, and lack of medical research on workers' health in a rapidly changing high-tech industry. Considering those aspects, the Supreme Court has stated that "the social function of Industrial Accident Compensation Insurance should be harmoniously reflected in the process of judging the causality relationship" (Lim 2018: 38). In the end, SHARPS' legal victory contributed to changing the patient/victim's disadvantageous position in court in that the court finally admitted the limit of scientific rationality and instead emphasized



Figure 5 SHARPS' key members at an Arbitration Committee meeting. From left: Jongran Lee, Jawoon Lim, Jeong-ok Kong, Sinyo Kim, and Sangki Hwang (photograph by Ungie Shin; courtesy of SHARPS).

social rationality. Consequently, seventeen cases had won and six lost by the end of 2018, but the six losing cases were also compensated by either KWCWS or the companies responsible. After the courts' collective acceptance of social rationality, patient-workers' compensation claims have been accepted with growing frequency, in contrast to the initial rejections by KWCWS. To bring about additional institutional change, lawyers and doctors affiliated to SHARPS have been working together with congresspersons to amend industrial health and safety laws. With the rise of concerns about workers' health that were sparked by the SHARPS movement, the much-publicized death in 2018 of one Yong-kyun Kim, who had worked for a thermal power plant, finally pushed the Korean Parliament to pass a new Industrial Health and Safety Act in December 2018.

Meanwhile, the SHARPS movement gained new momentum when in early 2014 a commercial movie, *Another Promise*, was released, attracting half a million Korean filmgoers and massive media attention. Samsung once again received tremendous criticism both domestically and internationally. Consequently, serious pressure from civil society and the Korean government led Samsung, SHARPS, and patient-workers to form the First Arbitration Committee in December of 2014. The committee discussed detailed solutions for industrial diseases for around seven months and reached an agreement in July of 2015. But then in September of the same year Samsung suddenly announced that the company could not accept the agreement despite its full participation in the negotiation process. SHARPS began a round-the-clock sit-in protest in front of the Samsung Headquarters in Seoul's Gangnam district, which lasted around three years (Fig. 4).

After this breakdown, all movement between Samsung and SHARPS came to a standstill, but as time went by the legal and political situations came to favor SHARPS. First, two major electronic companies influenced and damaged by the SHARPS movement made public apologies and promised to offer financial compensation to patient-workers. As explained, the industrial health dispute swallowed not only Samsung but also other major semiconductor and electronics companies in Korea. Patient-workers

Table 1 Timeline of the SHARPS Movement

May 2007	Sangki Hwang calls into question six deaths, including that of his daughter, Yumi Hwang, who had worked for Samsung Semiconductor.
November 2007	SHARPS is formed.
December 2008	OSHRI denies the causality between the Samsung factory and leukemia based on an epidemiological study.
March 2009	The number of patient-workers increases to twenty-one.
August 2009	SHARPS begins a global alliance with international labor health organizations.
January 2010	Six patient-workers and their families file lawsuits in the Seoul Administrative Court.
June 2010	The number of patient-workers increases to fifty-eight.
June 2011	Two cases, including Yumi Hwang's, win during the first trial; the number of patient-workers increases to 155.
February 2012	OSHRI acknowledges the existence of carcinogens and harmful toxins in factories based on a second epidemiological study.
April 2012	KWCWS accepts its first former Samsung Semiconductor patient-worker's claim.
February 2014	The movie <i>Another Promise</i> is officially released.
August 2014	Two cases, including Yumi Hwang's, win at a second trial; the government decides not to appeal to the Supreme Court.
December 2014	The first arbitration committee of SHARPS, Samsung, and patient-workers is formed.
July 2015	The committee reaches an agreement and makes a public announcement.
September 2015	Samsung breaks the agreement.
October 2015	SHARPS begins a 1,023-day sit-in in front of Samsung Headquarters.
November 2015	SK Hynix announces a compensation plan for patient-workers.
January 2017	Jae-yong Lee, Samsung heir and head, is arrested and imprisoned after involvement in the President Park corruption scandal.
May 2017	President Moon, human rights lawyer and leader of the progressive party, is elected.
August 2017	The Korean Supreme Court makes a historic verdict in favor of patient-workers and SHARPS.
July 2018	The second arbitration committee of SHARPS, Samsung, and patient-workers is formed.
November 2018	The committee reaches a final deal; the dispute ends.
May 2019	Patient-workers number 643; SHARPS continues to work on their behalf.

in those companies reported similar health problems, including leukemia and cancer. In November of 2015, SK Hynix, the internationally well-known second-largest semiconductor company in Korea, admitted their responsibilities on industrial diseases and proposed financial compensation for patient-workers. In July of 2017, LG Display, another global company based in Korea, started to compensate patient-workers despite ambiguous causation between industrial disease and factory environments. Second, after the Supreme Court's verdict in August of 2017 gave a major victory to SHARPS, the Korean government became more collaborative in the compensation process.

Finally, Jae-yong Lee, Samsung's heir and de facto head, was arrested and imprisoned in January of 2017 on account of his involvement in a former Korean president's corruption scandal and subsequent impeachment. Guen-hye Park, the former president and leader of Korea's Conservative Party, had strong connections with Korean conglomerates, especially Samsung. Guen-hye was a daughter of Chung-hee Park, the notorious dictator behind Korea's economic miracle. She and Jae-yong Lee had entered into illegal deals and mutual support during her presidency, and she was eventually impeached in March of 2017, mainly because of her involvement in a corruption scandal that embroiled her lifelong friend Soon-sil Choi. As a consequence,

a presidential election was held in May of 2017, which Jae-in Moon won. Moon is a human rights lawyer and leader of a progressive party, who has also in the past worked for trade unions. Moon's government has emphasized the role of labor in Korean society and taken on pro-union policies. In this changed political, legal, and business environment, in July of 2018 Samsung and SHARPS formed a Second Arbitration Committee and reached a final deal in November of that year (Fig. 5). Samsung finally made an official apology and agreed to the detailed compensation plan proposed by the committee (Samsung Electronics and SHARPS 2018).⁵ The eleven-year long dispute finally ended (Table 1), and SHARPS' victory became legendary in Korea and beyond.

8 Conclusion

The development of the "Samsung leukemia" movement from a father's fight into a global labor health movement is largely due to the simultaneous mobilization of science and social movements. Science played a pivotal role in understanding and determining the cause of the industrial disease. Because the causalities behind "Samsung leukemia" were contested, the Korean government, Samsung, and SHARPS each attempted to conduct science in their favor, and each of them used it differently. The government's official science took a more statistics-centered approach, denying patient-workers' claims, while Samsung's science mobilized a US-based scientific authority to nullify "Samsung leukemia" with limited sets of data. On the contrary, SHARPS' bottom-up science collected workers' illness experiences, embodied knowledge of the production process of chips, and used information about factory layouts and environments. Elsewhere, oppositional experts formed a research group and published significant scientific research that lent epistemic legitimacy and authority to its movement and also empowered it. Our research has shown how the political economy of labor health influences the way in which sciences are organized, conducted, and interpreted in highly contested situations.

But our research also reveals that science is necessary but not sufficient for patient-workers to obtain institutional recognition and receive compensation. In this regard, the SHARPS movement realized the importance of structural inequality and demanded the transformation of the political economy of labor health, that is, of the unequal political, economic, legal, and scientific systems. SHARPS blamed undone protection resulting not only from chemical exposure in factories that weighed profit over safety but also from institutional failures to protect and compensate workers for the loss of life and health. In the "Samsung leukemia" case, multidimensional inequalities were made manifest in the industry's control of and monopoly on labor and environmental

⁵ Total compensation amounts to ₩50bn (approximately US\$44m). Because the dispute included such diverse diseases as leukemia, cancers, stillbirths, and genetic disorders, the committee set guidelines on the amount of compensation, and both Samsung and SHARPS agreed to them. For example, the maximum compensation for leukemia is ₩150m (US\$130,000), and for cancer it is ₩100m (US\$88,000). If a child of a patient-worker develops a genetic disorder, Samsung has agreed to pay ₩5m (US\$4400) initially and up to ₩3m (\$2,600) every year thereafter until the disorder is cured. For detailed compensation guidelines, see Samsung and SHARPS (2018).

information, the Korean government's conservative management of workers' compensation, a rigid legal system and high burden of proof for determining the causality of disease, and an inflexible scientific system for studying the causes of disease. To make undone protection done, SHARPS pressured Samsung and reached an agreement to set up a Health Protection Center and an Ombudsman Committee. SHARPS also worked together with the two most influential labor organizations in Korea and succeeded in creating a more balanced Occupational Disease Decision Committee for workers' compensation. More importantly, its activities led to various legal victories, including the Supreme Court of Korea's decision on a more inclusive interpretation of the causality of industrial disease. Finally, the SHARPS movement, in alliance with unions, led to the changes in the Industrial Health and Safety Act, which demands that business take up more responsibilities and protect workers in harmful working environments.

SHARPS' struggle is an exemplar of how collaboration between powerless workers and oppositional experts works toward getting undone science and undone protection done simultaneously. "Samsung leukemia" revealed the structural inequality among labor, industry, government, and science, while the SHARPS movement contributed to building more democratic and participatory science and politics in the area of industrial health and safety. It is our hope that the "Samsung leukemia" case will shine a light on the road ahead for future studies of how labor health, science, and political economy are entwined within global capitalism and how they may be transformed for the achievement of a more democratic society.

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