

## The Hwang Scandal that “Shook the World of Science”

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Dr. Hwang Woo Suk, a South Korean animal-cloning expert and veterinary scientist, was a national hero in South Korea. In 2004, he and his collaborators published in *Science* a paper on the establishment of the first human embryonic stem cell with the somatic cell nuclear transfer method (Hwang et al. 2004). Hwang’s method, which had been used to create the world-first cloned mammal Dolly, consisted of denucleating a human egg and inserting in its place a nucleus from an ordinary somatic cell. The nucleus and the egg were fused into one by means of electricity, creating a cloned embryo, from which a stem cell line was developed. For this experiment, he announced that he had used 242 human eggs. The next year, in 2005, in a paper also published in *Science*, Hwang allegedly claimed that he had established 11 patient-specific stem cells with 185 human eggs (Hwang et al. 2005). As these stem-cells were patient-specific, there was no concern about immune reaction. Also, compared with his 2004 paper, the success rate rose enormously. For this marvelous achievement, he used a method dubbed the “squeezing method,” which he loved to call the “Korean metallic-chopstick method.” However, in November 2005, his achievements began to be considered suspicious and spurious. Eventually, it turned out that his 2005 paper, as well as his 2004 paper, was

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Lawrence K. Altman and William J. Broad, “More Science, More Fraud,” *New York Times* (20 December 2005). The article starts with the passage that “The South Korean scandal that shook the world of science last week is just one sign of a global explosion in research that is outstripping the mechanisms meant to guard against error and fraud.”

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fraudulent. These papers not only involved a serious violation of medical ethics in collecting human eggs but also fabrications and falsifications of scientific data. In early 2006, Hwang's allegedly world-first human embryonic stem cells turned out to be non-existent. This fraud "shook the world of science."

This introduction briefly reviews the rise and fall of Dr. Hwang Woo Suk, which has been called the "Hwang Scandal" or "Hwang Affair," and discusses some issues of it pertinent to science and technology studies (STS). From 1999, when he cloned a dairy cow (named "Yeongrong-i") for the first time in Korea, Hwang successfully built his fame and credibility as a star scientist. He was very adept in making networks with influential politicians, bureaucrats, and the media. For instance, his second cloned cow was given a name "Jin-i" by the then President of Korea after the famous Korean geisha "Hwang Jin-i." Around the same time, he announced his plan to clone the Siberian tiger that was on the verge of extinction in North Korea. This project eventually failed, but as this sensational project was widely advertised by the media, it made a deep impression in the mind of the Korean public. In 2002, he claimed that he succeeded in cloning a gene-modified pig for organ transplant. In December, 2003, he announced that he had cloned a BSE (mad cow disease)-resistant cow for the first time in the world. At that time, he invited the Korean president Roh Moo Hyun to his laboratory and demonstrated how he cured a severely injured dog with stem cell treatment. The president was so amazed that he acclaimed that "I feel like I got an electric shock" and "this is not a science; this is a magic." Until this time, however, Hwang had not published a single paper on these notable achievements. He only held a press-conference and provided striking demonstrations and multi-media presentations.<sup>1</sup>

There were some suspicions about Hwang's achievements, especially because he had not published peer-reviewed papers on his achievements. Hwang eliminated such suspicions in 2004 and 2005 when he and his team published two papers in *Science*. He also began to collaborate with the famous American scientist Dr. Gerald Schatten at the University of Pittsburgh. Soon after his 2005 *Science* paper, he introduced the first cloned dog Snuppy to the world with a subsequent paper on Snuppy published in *Nature* (Lee et al. 2005). The government support of Hwang's research increased from 2003, peaking in 2005. The total amount of money for Hwang's research was about 30 million dollars during the year of 2005. In 2005, he was selected as the first 'Supreme Scientist' of Korea. The World Stem Cells Hub, a stem cell research center, was established in the Seoul National University Hospital in October 2005, with Hwang as its first director. More than 3,000 disabled or ill people signed up for stem cell treatment just on the first day. At that time, Hwang was the most famous Korean scientist who ever lived, and certainly the national hero.

The fall of Hwang was unexpected and sudden. Ethical questions on the process of acquiring human eggs had been raised since May 2004, when *Nature* reported that two junior female researchers in his laboratory had donated their eggs; yet, *Nature's* report did not attract much attention from the public and scientists at that time.

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<sup>1</sup>For an excellent account of Hwang Woo Suk's life and works, see Kim (2007).

Suddenly, however, on November 12, 2005, Korean newspapers reported that Dr. Schatten ended his collaboration with Dr. Hwang due to the former’s recognition of the latter’s unethical acquisition of human eggs. On November 22, ‘PD Su-cheop’ (which means the producer’s memo-book) of the MBC broadcasting networks, one of the most popular Korean TV investigative journalism shows, aired a special program on Hwang’s unethical acquisition of human eggs. It showed some convincing evidence that the rumor about Hwang’s violation of biomedical ethics might certainly be true, since Hwang seemed to have purchased human eggs and forced his female researchers to donate their eggs. As Leem So Yeon and Park Jin Hee show in their joint paper in this issue, however, some women voluntarily provided their eggs for Hwang’s stem cell research for various reasons (Leem and Park 2008). PD Su-cheop also alluded that it would air a follow-up program soon, where some of Hwang’s scientific achievement would be reexamined critically. However, the first PD Su-cheop show infuriated the public, to such an extent that 12 sponsoring companies of PD Su-cheop cancelled their commercials within a few days due to intense public protest. This was an unprecedented event in the history of Korean television broadcasting.

On 24 November, Hwang held a press conference and apologized for letting his female researchers donate their eggs even though he was not informed about it at that time. He also said that he did not know that other donors of the eggs had received payment. Taking the responsibility for all these ethical problems, he resigned from his official positions. But most Korean people objected to his resignation, expressing their sympathy to Hwang and stating that unethical egg donation was not a serious problem for further research. For instance, Yahoo Korea’s online poll showed that 86% of 10,300 Koreans did not consider ethical issues in obtaining eggs to be a critical problem. Why the majority of the Korean public supported Hwang is an interesting social phenomenon that is worthy of analysis from the perspective of science and technology studies. Mr. Kim Tae-ho’s paper in this special issue tackles this problem, and discusses strong nationalistic elements in Hwang’s research, which were consonant with the ideology of nationalism of the Korean public (Kim 2008).

How did PD Su-cheop come to suspect Hwang’s scientific achievement? PD Su-cheop was approached by a former member of Hwang’s team in June 2005, who was one of the major authors of Hwang’s 2004 *Science* paper. This whistle-blower informed PD Su-cheop of Hwang’s use of a lot more than 200 eggs, and told the producers that Hwang’s 2005 *Science* paper must have included some kind of scientific fallacies, because too many patient-specific stem cells (11 stem cells) were created in a very short time. After having met him, PD Su-cheop secretly investigated this case for several months, and interviewed Hwang’s former junior researcher, Dr. Kim Sun Jong, at Pittsburgh University in October 2005. At that time, PD Su-cheop heard an important testimony from Kim that Hwang had ordered him to multiply the number of stem cells from 2 to 11 by manipulating data. Then, PD Su-cheop contacted Hwang and his collaborators, and asked for some samples of the 11 stem cells for DNA analysis. At the end of October, PD Su-cheop and Hwang agreed that if the result of the DNA analysis turn out to be the same with Hwang’s 2005 paper, then the PD Su-cheop would completely give up its show on Hwang’s stem cell research; if not, they agreed to have these samples tested again by different

DNA fingerprinting institutions. On 7 November, Prof. Kang Sung Keun at Seoul National University, Hwang's junior collaborator and his 'left-hand man', handed in the PD Su-cheop some DNA samples, which were then sent to the DNA test company IDGene and to the Forensic Lab of Seoul National University Hospital.<sup>2</sup>

The surprising result came out in a week or so. IDGene obtained a series of meaningful DNA marks only from one of the stem cells, but this single DNA data matched neither with that of the patient's somatic cell nor with that presented in Hwang's *Science* paper. The analysis of the Medical School of Seoul National University did not even produce one single meaningful DNA data. After reviewing this analysis, PD Su-cheop urged Hwang to do a retrial, but when he rejected the PD Su-cheop's proposal, it publicized the results of the DNA analysis at a press conference on 2 December. However, on 4 December, the Cable-TV networks YTN exposed a serious violation of ethics on the part of PD Su-cheop. Relying on Kim Sun Jong's testimony, YTN allegedly exposed that the producers of PD-Su-cheop had threatened Kim to testify against Hwang. In his interview with YTN, Kim changed his previous testimony completely, stating that Hwang never asked him to fabricate data and that all the data in 2005 *Science* paper was genuine. After YTN aired this special news, the public became infuriated and upset. They pointed their anger to PD-Su-cheop and MBC. MBC quickly made an apology, but the public's protest against MBC was so vehement that MBC suspended the two producers of the PD Su-cheop. MBC soon cancelled PD Su-cheop's follow-up show on Hwang's scientific data originally scheduled on 6 December.<sup>3</sup>

On 4 December, Hwang's team had a press conference and repudiated PD Su-cheop's DNA analysis data in detail. Prof. Kang argued that replicability is the most important criterion for DNA testing. Replicability meant to him this—with the same sample, the same DNA data should be obtained in repeated analyses. However, as only one out of several tests produced readable marks, the entire testing failed to meet this criterion of replicability. PD Su-cheop suggested a possibility that Hwang's team intentionally gave them corrupted or insufficient sample DNAs to interfere with its DNA analysis. PD-Su-cheop repeated again their claim that Hwang's stem cells should be tested in a third DNA testing laboratory. The insurmountable gap between Hwang's team and PD Su-cheop was also reflected in the differences of opinion between experts. Dr. Lee Jung Bin, the director of the Forensic Medicine Lab at Seoul National University Hospital said that "if one obtained a single valid DNA data while other sets of data were unreadable, this valid data can be taken as true markers." Kang repudiated such a claim again, arguing that the entire test did not satisfy the criteria of replicability.

The media supported Hwang and severely blamed PD Su-cheop, imprinting a deep impression in the mind of the public that PD Su-cheop must have committed several amateurish mistakes in DNA testing. The public began to think that it was extremely absurd for amateurs like PD Su-cheop to attempt to verify or test Hwang's

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<sup>2</sup>Han Hak Soo, who was the principal producer of the PD Su-cheop's episodes on Dr. Hwang, published a detailed story of the Hwang scandal in Han (2007). This book also contains valuable records of interviews with various people involved in the Hwang scandal.

<sup>3</sup>For a more detailed discussion of this debate over the validity of the DNA testing and its implications for the replication of Hwang's stem cell research, see Hong (2006) and Han (2007).

scientific achievement, published in the prestigious journal *Science*. Many scientists added power to the public opinion. On December 5, National Association of Scientists and Engineers for the Better Society, which gathered two hundred well-known scientists and engineers as its founding members, held a press conference and blamed PD Su-cheop. Its president, Prof. Lee Byung Ki at Seoul National University, announced that “it is a pity that our society’s ignorance of science induced MBC PD Su-cheop, which is not a member of the scientific community, to judge the scientific validity of Hwang’s research.” The Association also made an official announcement that “the verification of a scientific discovery should be done by peer scientists through due procedures, and the need for such verification should also be decided by peer scientists.”

Next day, Prof. Lee Byung Chun of Seoul National University, Hwang’s junior collaborator and his ‘right-hand man’, announced that “it is a national shame if we accept PD Su-cheop’s request for retrial, as our paper was published in the world-prestigious journal *Science*,” adding that Hwang’s team would verify the existence of stem cells by follow-up experiments. Prof. Kang also said: “we discussed a plan for replicating the establishment of embryonic stem cells, but we decided not to replicate it. It is because the replication will be done by other foreign research teams in a few years, and our follow-up research will confirm that. Our decision [not to replicate the experiment] is grounded on our respect of the normal scientific verification system.” Not only scientists but also politicians and columnists blamed the idea of replicating and verifying Hwang’s experiment. In his public speech, Mr. Ryu Si Min, a famous MP, blamed PD Su-cheop for being ignorant: “PD Su-cheop deserves all the blame, for it agitated science in an inappropriate manner.” The Minister of Science and Technology, Mr. Oh Myung, also remarked that Hwang’s paper had already been verified by world-famous scientists when it was published in the world-top journal *Science*. Prof. Song Ho Gun of Seoul National University, a well-known political scientist and columnist, blamed the jealous and violent mentality of the producers of PD Su-cheop for reducing South Korea to an untrustworthy country, proclaiming that “You, the producers of PD Su-cheop, should publish your report in the journal *Science*, if you are really confident of your findings.”

A voice against Hwang was hardly found in major printed newspapers or on TV (Lee 2006). But it was getting more prevalent and was becoming the majority opinion on the Internet. On December 5, an anonymous posting on <Scieng>, an Internet site for young scientists and engineers, criticized the dominant opinion. According to the writer (whose ID was “Bystander”), the claim of Hwang team’s—that his research will be replicated and thus verified by other foreign researchers in 3 years—is no verification at all. He pointed out that the suspicion over DNA fingerprinting could not, and would not, be cleared through the replication of Hwang’s experiment by other researchers. He also criticized senior Korean scientists who opposed the reexamination of Hwang’s stem cells. On the same day, an anonymous writer (whose ID was ‘Anonymous’) posted a sensational posting on the BRIC website—an Internet site for the exchange of biological information among biomedical scientists. With its sarcastic title “The show must go on,” it showed in a very convincing manner that some photos of 11 stem cells printed in Hwang’s 2005 *Science* paper were skillfully manipulated by using PhotoShop. The posting, as well as those manipulated photos, was quickly copied by young ‘Netizens’ from websites

to websites. In just 24 h, the manipulated photos in Hwang's paper spread like an epidemic. Hwang's team quickly explained that as the duplicated pictures were mere mistakes, they had been taking steps to correct them. Next day, another anonymous posting on the BRIC site disclosed serious problems in Hwang's DNA fingerprinting data in his 2005 paper. In short, the DNA fingerprinting data from patients' cells and those from patient-specific stem cells matched too well and perfectly. The location of the peaks should be the same, as they are essentially the same cells, but due to the complex nature of the testing procedure, the height of the peaks and the background noise signals must be different. But even the height of the peaks and the background noises were exactly the same. After these exposures, it was highly likely that the most important data in Hwang's 2005 paper were either falsified or fabricated (for a detailed discussion, see Han 2007).

Until this time, Hwang and his team repeatedly claimed that the replication of DNA analysis, as well as the verification (or confirmation) of the veracity of the stem cells, were not necessary. They frequently used the term replication to mean the latter as well. Prof. Kang said that they would not follow PD Su-cheop's request for retrial, as their experiment would be replicated by other researchers working in the same field and, if so, firmly verified.<sup>4</sup> The public, as well as many scientists, supported Hwang's position, blaming amateurish PD Su-cheop for requesting a replication of Hwang's experiment. Replication (or replicability) of DNA testing and replication of scientific experiments were mixed up in the mind of the public. Although totally different opinions were dominant in the virtual world from 5 December, they were essentially anonymous and did not have enough credibility to persuade the public or the scientific community. BRIC's exposures, however, changed the mind of some handful university scientists and others.

On December 8, 30 young professors at Seoul National University, who majored in biological science, held a press conference and urged for the re-examination of Dr. Hwang's research. Many of them became highly suspicious of Hwang's work after reading BRIC's posts. The president of the university decided to form the SNU Investigation Committee on 11 December. Even at this time, most senior scientists and more than 50% of the public still thought that a re-examination of his paper would be absurd and meaningless. But things changed quickly. On December 13, Dr. Schatten actually admitted some scientific fraud in the 2005 *Science* paper, and requested to *Science* to retract his name from its co-authors. On 15 December, Dr. Noh Sung Il at the Mizmedi Women's Clinic, the most important collaborator of Hwang in Korea, confessed that Hwang had not cultivated any stem cells. The next day, Hwang admitted that his 2005 *Science* paper was manipulated; it contained some "irrecoverable intentional mistakes." However, he claimed that he had created stem cells, and still possessed the fundamental technology for establishing embryonic stem cells. The final report of the SNU Investigation Committee concluded that Hwang had falsified all the data in his 2005 *Science* paper. Not a single human embryonic stem cell existed. The committee concluded that results

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<sup>4</sup>The strategy of Hwang's team consisted in maintaining that since their experiment would be replicated by other research teams in the near future, the replication of DNA testing would be unnecessary. This strategy was publicly criticized by Hong (2005) on the basis of some insights gained from science and technology studies on replication.

described in 2004 *Science* article had also been fabricated (SNU Investigation Committee 2006).

Around the end of December, however, the debate over Hwang’s scientific achievement was virtually over. The scientific community quickly accepted that his two papers were fabricated and falsified. Some of the scientists who supported Hwang made a public apology. In 2006, Hwang was fired from Seoul National University, which was followed by the dismissal of Prof. Lee and Prof. Kang. It took, however, some time until the Korean public took Hwang’s fraud not as a conspiracy but as a fact. Some ardent supporters of Hwang organized several online communities and off-line organizations to support Hwang’s research. Hwang was charged by the prosecutor’s office for misappropriating his research fund, but he able to obtain private funding and lab facilities from his private sponsors. Some lay people still consider Hwang’s claim on the possession of fundamental technique to be important and claim that another chance should be given to Hwang.

The two papers in this special issue discuss gender issues in Hwang affair and the issue of nationalism, respectively. Besides, this affair also illustrates how a scientist like Hwang Woo Suk became a super hero in an East-Asian country like South Korea by mobilizing the hopes of influential politicians, bureaucrats, scientists, journalists, and the public—all were hoping South Korea to be a strong nation and catch up advanced countries by developing science, technology and economy. This affair also shows an important aspect of the public understanding (or rather misunderstanding) of science and the role of the media for it. The media played an important role in shaping the public conception of Hwang’s stem cell research and its enormous benefit in the future. The media almost exclusively used Hwang and his team members as their source. The homogeneity of the media’s source largely contributed to creating a simplified, exaggerated and distorted image of Hwang and his stem cell research. These issues need further research in the future.

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