Environmental Pollution and Related Diseases Reported in Japan: From an Era of “Risk Evaluation” to an Era of “Risk Management”

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Introduction

Japan’s history of environmental pollution goes back to 1868 when the country initiated its industrialization -- “Fukoku Kyohei” (Enrich the Country, Strengthen the Military) under the Meiji regime. As Japan’s economy went through periods of heavy industrial development and high economic growth the country also experienced environmental issues caused by mining, heavy industry, and the increased number of automobiles. Many environmental pollution-related diseases including asthma, Minamata Disease*, Itai Itai Disease**, (see box under next section) and cancer have been recognized in Japan.

In this paper, we review Japan’s history of environmental pollution and government responses and we advocate a shift in our stance toward environmental pollution-related diseases: from an era of “risk evaluation” to an era of “risk management”.

A brief history of environmental pollution in Japan

1. Types of environmental pollution, major cases and related diseases

Japan has experienced two major types of environmental pollution: industrial pollution and

automotive pollution, along with other environmental issues.

1) Industrial pollution

The Ashio Copper Mine Pollution Incident, which started in the 1880s in Tochigi prefecture, is considered the first serious industrial pollution case in Japan. Deforestation resulted from meeting the mine’s timber demand and this, in turn, caused chronic flooding; sulfurous acid gas destroyed crops and harmed the health of local residents. Other mines, such as Besshi Copper Mine and Hitachi Copper Mine caused similar problems as well. Along with mining, the development of heavy industry also caused severe industrial pollution. Since coal was the main energy resource, soot and sulfur dioxide pollution remained serious until the mid-1960s, especially in the industrial centers of Mie prefecture, and the cities of Kita-Kyushu, Yokohama and Osaka.

Japan’s economy experienced a period of high growth, from 1954 to 1972, before the 1st Oil Shock. During this period, Japan’s economy continued to grow rapidly, while industrial pollution became a nationwide problem. Lawsuits were filed; pollution-related diseases were recognized; compensation

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was paid to victims. Itai Itai Disease*, Minamata Disease**, Niigata Minamata Disease and Yokkaichi Asthma (caused by sulfur dioxide) were later called the “Four Major Pollution-Related Diseases” in Japan.

*Minamata disease is a toxic neuropathy caused by the ingestion of methylmercury compounds (as in contaminated seafood) and characterized by impairment of cerebral functions, constriction of the visual field, and progressive weakening of muscles (Merriam-Webster’s Medical Dictionary). It was first reported in Minamata of Kumamoto Prefecture in the year 1956, and later in Niigata Prefecture as well.

**Itai Itai Disease (“it hurts-it hurts disease”) is an extremely painful condition characterized by bone decalcification caused by poisoning following the ingestion of cadmium (Merriam-Webster’s Medical Dictionary). This name was given to the mass cadmium poisoning of Toyama Prefecture, starting around 1912. Only in 1955 did Dr. Hagino and his colleagues first suspect cadmium as the cause of the disease.

The Japanese economy continued to grow after the 1st Oil Shock (1973), but entered a long period of low economic growth after the economic bubble burst in 1991. However, environmental pollution continued. In addition to the typical industrial water and industrial air pollution, there were two cases involving chemical carcinogens: (1) the Kubota Asbestos Disaster (“Kubota Shock”) in 2005, caused by cumulative exposure to asbestos and (2) cholangiocarcinoma among offset printing workers in 2012, caused by cumulative exposure to dichloromethane/1,2-dichloropropane.

2) Automotive and other environmental pollution

As the number of vehicles grew from approximately 8 million in 1966 to more than 70 million in 1996, and then reached more than 80 million in 2016 (Ministry of Land, Infrastructure, Transport and Tourism), the total emissions of nitrogen oxides (NOx) and particulate matter (PM) increased dramatically. During a time, when industrial pollution was under control in the 1980s, photochemical smog became severe, along with noise issues. Suginami (Tokyo Metropolitan) photochem-

ical smog of 1970 and low-frequency noise pollution of West Nagoya-Osaka Highway in the 1970s were among these issues.

Major environmental pollution cases and resulting diseases reported in Japan are listed below (Table-1, next page). The so-called Japanese “Four Major Pollution-Related Diseases” (Itai Itai Disease, Minamata Disease, Yokkaichi Asthma and Niigata Minamata Disease) are highlighted.

2. Government responses to environmental issues

Brought to the attention of the Japanese central government in the 1880s, the Ashio Copper Mine Incident is considered to be the first environmental pollution case in Japan. Victims in the Ashio Copper Mine vicinity suffered severe health problems and lost their farming and fishing resources mainly because of the sulfur dioxide and cadmium emitted during the process of copper refinery. Although the central government hesitated to directly intervene in the beginning, public awareness of environment protection grew nationwide.

As more mines, refineries, coal power plants, factories, and waste incinerators were built across Japan, farmers and citizens began to protest against the rising industrial pollution. As the number of vehicles increased, smog and noise issues increasingly affected people’s daily lives. A large number of lawsuits were filed against corporations accused of producing pollution, and compensation was required. As responses, a series of regulations and laws were established as follows:

(1) Regarding industrial pollution

- *Soot and Smoke Control Regulations* (Osaka, 1932)
- *Industrial Pollution Control Ordinance* (Tokyo, 1949)
- *Soot and Smoke Control Ordinance* (Tokyo, 1955)
- *Smoke and Soot Regulation Law* (1962)
- *Basic Law for Environmental Pollution Control* (1967)
- *Air Pollution Control Act* (1968)
- *Pollution-Related Health Damage Compensation Law* (1973)
- *Basic Environment Law* (1993)
- *Act on Asbestos Health Damage Relief* (2006)

(2) Regarding automobile environmental issues

- *Noise Regulation Act* (1968)

Table-1 Major Environmental Pollution Cases / Pollution-Related Diseases in Japan

Year of report/ Incident period	Major environmental pollution cases/ Pollution-related diseases (English)	Major environmental pollution cases/ Pollution-related diseases (Japanese)
1880s~	The Ashio Copper Mine Pollution Incident	足尾鉍毒事件
1883	Asano Cement Dust Pollution	浅野セメント降灰問題
1888	Osaka Soot Pollution	大阪煤煙問題
1893	Besshi Copper Mine Air Pollution	別子銅山煙害
1901	Takasago Water Pollution	高砂流毒問題
1901	Kosaka Mine Air Pollution	小坂鉍山煙害
1903	The Osaka Alkali Incident	大阪アルカリ事件
1905	Shisakajima Island Air Pollution	四阪島煙害
1907	Hitachi Copper Mine Air Pollution	日立鉍山煙害
1914	Sewage Pollution by Factories along the Aratagawa River	荒田川工場排水
1916	Air Pollution of Hydrogen Chloride Gas (by the forerunner of Ajinomoto)	鈴木商店 (味の素) 排出の塩酸ガスによる農作物被害
1937	Annaka Pollution	安中公害
1940	Pulp Waste Pollution of the Ishigari River	石狩川パルプ工場排水問題
1955	Itai Itai Disease	イタイイタイ病
1955	The Morinaga Milk Arsenic Poisoning Incident	森永ヒ素ミルク中毒
1956	Minamata Disease	水俣病
1958	Fishery Damages of the Edogawa River	江戸川漁業被害
1959	Yokohama Asthma	横浜ぜんそく
1961	Yokkaichi Asthma	四日市ぜんそく
1961	Tobata (currently Kita-Kyushu city) Soot Pollution	旧戸畑市煤煙問題
1965	Niigata Minamata Disease	第二水俣病
1967	Well Water Cyanide Contamination	八王子市井戸水のシアン汚染事件
1968	Sewage Pollution by Ishihara Sangyo	石原産業排水タレ流し事件
1968	The Kanemi Rice Bran Oil Poisoning Incident (PCB Contaminated)	カネミ油症事件
1969	The Osaka Airport Noise Pollution Lawsuit	大阪空港訴訟
1969	Yawata Steel Works Soot and Water Pollution	八幡製鉄所煤塵水質汚濁問題
1969	Miyata Yosui Water System Pollution	宮田用水汚濁問題
1970	Tagonoura Port Sludge Pollution	田子の浦港ヘドロ公害
1970	Suginami Photochemical Smog	杉並光化学スモッグ
1970	Lead Poisoning (Ushigome-Yanagi, Shinjuku, Tokyo)	新宿・牛込柳町鉛中毒
1970s	Studded Tire-Generated Dust Pollution	スパイクタイヤによる粉塵公害
1970s	Low-Frequency Noise Pollution of West Nagoya-Osaka Highway	西名阪道路公害訴訟
1971	Toroku Arsenic Poisoning	土呂久砒素公害
1972	Matsuo Arsenic Poisoning	旧松尾鉍山ヒ素公害
1973	Sasagaya Arsenic Poisoning	笹ヶ谷鉍害
1973	Hexavalent Chromium Pollution in Edogawa Ward	江戸川区六価クロム廃棄事件
1973	High Level Mercury Poisoning	鹿児島高濃度水銀汚染
1974	Nagoya Shingansen Noise Pollution	名古屋新幹線公害
1974	Chlorine Gas Leak by Nippon Aerosil	日本アエロジル塩素ガス流出
1975	Soot Pollution by Kawasaki Steel Co.	千葉市川崎製鉄のばい煙問題
1975	Naoetsu High Level Mercury Poisoning	直江津高濃度水銀汚染
1975	The Teshima Incident (Illegal Dumping of Industrial Waste in Teshima Island)	豊島事件
1978	Nishiyodogawa Air Pollution	西淀川公害

1982	Kadena Air Base Noise Pollution	嘉手納基地爆音公害
1982	Kawasaki Air Pollution	川崎公害
1988	Amagasaki Air Pollution	尼崎公害
1989	Southern Nagoya Air Pollution	名古屋南部大気汚染公害
1996	The Tokyo Air Pollution Lawsuit	東京大気汚染訴訟
1999	The Tokaimura JCO Criticality Accident	東海村JCO臨界事故
2000	The Hikijikawa River Dioxin Contamination Incident	引地川ダイオキシン汚染事件
2002	Environmental Damages caused by Coordinated Sediment Flushing Operations in the Kurobekawa River	黒部川連携排砂公害
2002	Suginami Disease (Caused by Toxic Fumes from a Waste Facility in Suginami, Tokyo)	杉並病
2003	The Kamisushi Arsenic Incident	神栖ヒ素事件
2005	The Kubota Asbestos Disaster ("Kubota Shock")	クボタ神崎工場アスベスト事件
2009	The Sannokawa River Dichloromethane Contamination Incident	山王川水質汚濁事件
2011	Radioactive Contamination after The Fukushima Daiichi Nuclear Power Plant Accident	福島第一原子力発電所事故による放射能汚染
2012	Cholangiocarcinoma among Offset Printing Workers (Caused by Cumulative Exposure to Dichloromethane/1,2-Dichloropropane, Osaka)	胆管がん問題（大阪の印刷業者）

Source: Ministry of the Environment, Ministry of Economy, Trade and Industry, Ministry of Health and Welfare.

Total Number of Compensated Pollution-Related Victims
asthma (1974-1988)

Total Number of Compensated Pollution-Related Victims
Minamata Disease and Itai Itai Disease (1974-2013)

Source: Environmental Restoration and Conservation Agency of Japan

- *Studded Tires Regulation Law* (1990)
- *The Law Concerning Special Measures for total Emission Reduction of Nitrogen Oxides and Particulate Matter from Automobiles in Specified Areas (The Automobile NOx/PM Law)* (1992)
- *Act on Regulation, etc. of Emissions from Non-Road Special Motor Vehicles (The "Off-Road Act")* (2005)

Among the regulations and laws, the Japanese central and local governments enacted, the *Pollution-Related Health Damage Compensation Law* (1973) established clear measures to designate victims of environmental pollution and set up a

compensation scheme accordingly. The above charts illustrate the total number of compensated victims of pollution-related Asthma, Minamata Disease, and Itai Itai Disease.

On environmental pollution-related diseases reported in Japan: from an era of "risk evaluation" to an era of "risk management"

As documented in the cases of the "Four Major Pollution-Related Diseases", medical evidence was clear between the pollutants and the induced diseases: inhalation of soot and sulfur dioxide posed risks to the human respiratory systems; cadmium poisoning affected to the kidneys, skeletal and

respiratory systems; and methylmercury poisoning threatened the nervous, digestive and immune systems.

While the “Four Major Pollution-Related Diseases” were being managed according to established industrial regulation and victim compensation laws in Japan, the so-called “Kubota Shock” occurred in 2005. Since then, the media outlets in Japan have shown noticeable interest and reported widescale “mesothelioma caused by asbestos”. The *Act on Asbestos Health Damage Relief* was enacted in 2006. Through 2015, more than 10,900 people exposed to asbestos who developed mesothelioma, lung cancer, asbestosis, or diffuse pleural thickening (DPT), have been compensated (Ministry of the Environment).

This is truly ironic, in light of the fact that Japan was a pioneering nation in chemical-induced carcinogenesis research. In 1915, Katsusaburo Yamagiwa (1863-1930) accomplished a pioneering milestone in chemical (coal tar)-induced carcinogenesis by formative stimulation following the hypothesis of Virchow (1821-1902). How, then, should we approach such a critical problem? What lessons must we learn from these past mistakes in order that we do not make the same kinds of mistakes in the future?

Chemicals, such as asbestos, pose risks to human health. These risks are determined by the chemical-specific hazardous properties and the extent of exposure to the chemicals. In terms of “hazardous properties”, International Agency for Research on Cancer (IARC) pointed out the higher risk of lung cancer and mesothelioma for laborers in asbestos mines. In addition, in 1987 IARC classified asbestos as a Group I carcinogen, defined as “exposure circumstance entails exposures that are carcinogenic” based on literature that found an increased risk of lung cancer for laborers working at factories making asbestos products.

In reality, “extent of exposure”--the length and amount of exposure deemed “dangerous” to cause cancer--involves some degree of vagueness. The fact that carcinoma takes long periods of time to develop after exposure (20 - 30 years) contributes to this vagueness. Nevertheless, to prevent asbestos-related diseases, WHO recommended the cessation of all types of manufacturing with asbestos, replacing asbestos with safer substitutes, and

taking measures to prevent exposure.

Concerning asbestos, our preventative measures and practical responses are decades behind, despite the fact that there was pathological and epidemiological evidence pointing to “risk”. Ironically, asbestos import reached its peak in Japan in 1974, and only in 1995 was the most carcinogenic blue asbestos banned from production and use. By this time, however, many mesothelioma patients were already emerging. Although all types of asbestos and related products have been banned since 2006 (Ministry of Health, Labour and Welfares), exposure to asbestos is still possible. A typical occasion arises when an earthquake occurs, for example, where workers who clean the rubble face a risk of inhaling asbestos fibers emitted from old buildings.

Japan’s asbestos tragedy was multiplied by factors including asbestos producers’ inadequate risk awareness, researchers’ deficiencies in communicating relevant risk information to third parties, and the government’s delayed risk management and regulation. As the Japanese government and industry have worked collaboratively and banned all production and use of asbestos, we stand at the current position of effectively managing the risks, which involves “improving early diagnosis, treatment, social and medical rehabilitation of asbestos-related diseases and establishing registries of people with past and/or current exposure to asbestos” (WHO).

In terms of early diagnosis and treatment, in studying rats genetically predisposed to develop kidney cancer, we found that the Erc gene product is often shed into the bloodstream at detectable levels as cancer progresses, thereby providing a possible method for blood diagnosis. Furthermore, because human ERC homologue (mesothelin) is expressed in the normal human mesothelium, including pleura, peritoneum, pericardium and tunica vaginalis, and it could be speculated that mesothelioma derived from the mesothelium should demonstrate overexpression of mesothelin, this method could possibly be used to diagnose mesothelioma. Indeed, we also reported that a diagnostic kit was being developed and researched. This is a real-life example of translational research.

Not only pertaining to asbestos, risk management of all hazardous chemicals requires open and transparent communication among the government,

academia, industry and citizenry. By working together, the whole of society would be aware of the health risks of hazardous chemicals, eliminating the exposure to them, and providing effective early diagnoses and treatments to victims.

Conclusion

Japan's industrialization has come at a high price--severe environmental pollution--to society. Since the 1880s, approximately 60 environmental pollution incidents have occurred across Japan. Pollution-related diseases such as asthma, Minamata Disease, Itai Itai Disease and mesothelioma have been recognized. The Japanese government has consistently disclosed related information and acknowledged its responsibility in providing relief to victims. Indeed, a significantly large number of victims have been compensated.

By the mid-1950s, there were still doubts about the scientific evidence for causal linkage between pollutants and diseases. However, research on pollution-related diseases, carcinogens, and environmental carcinogenesis have progressed greatly since then. The reason we are dealing with asbestos-induced mesothelioma and lung cancer in the 21st century is partially due to the inadequacy of communication among researchers, the government, industry and the citizenry.

To avoid these mistakes in the future, there must

be an approach that includes exchange, evaluation and management of risk information. For this to be effective, there needs to be an officially chartered organization to air concerns and build consensus across society. This organization would bring not only the government, but also academia, industry and labor, as well as consumer groups. Regarding environmental pollution and related diseases reported in Japan, we're moving from an era of "risk evaluation" to a new era of "risk management".

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