

Chapter 6

The Great East Japan Earthquake and the Fukushima Daiichi Nuclear Power Plant Accident



Abstract The Great East Japan Earthquake on March 11, 2011 caused a massive tsunami that led to the nuclear meltdown at the Fukushima Daiichi Nuclear Power Plant. This horrific accident revealed many systemic flaws, including a weak government program for emergency crisis management, non-transparency within governmental information control, and unscientific approaches to epidemiological research and government funding policy.

Following World War II, Japan prioritized economic recovery over many other things, including preparation for severe natural disasters. My aim is to show how the government handled these emergencies and issues related to research ethics. I will address and criticize the non-transparency of the government's evacuation policy, the secretive position taken by researchers and the government, and the unethical epidemiological research studies conducted under the guise of health surveillance, in particular, child thyroid screening.

I will also discuss the closed nature of the population in Japan's "Village Society." Although Japanese people are known internationally for their courtesy and hospitality, I will discuss the dark side of these traits.

Finally, I discuss environmental ethics, focusing on both animal and intergenerational ethics that were brought to light through the Fukushima accident.

On March 11, 2011, Japan experienced a massive earthquake, magnitude 9.0. As an after effect of the earthquake, the Fukushima Daiichi Nuclear Power Plant was damaged by a tsunami, resulting in a nuclear meltdown. The government's response was by no means laudable, but in fairness the earthquake was of unprecedented severity. Notwithstanding, preparations were insufficient. The reasons for this are based in Japan's prioritization of economic growth after World War II, above all other consideration.

6.1 Lack of Transparency

One major issue following the earthquake concerned the management of information. Japanese television broadcasting companies, that is all local channels and NHK, the public broadcasting company, continuously broadcast calming imagery, and only made known a small part of the damage. At the same time, the media overseas broadcast images of corpses washed out to sea by the tsunami, or the terrifying conditions of the sites that experienced the earthquake. It was in fact the overseas coverage that created the main impetus for so many to offer international support for restoration and recovery.

The flow of information concerning the status of damage at the Fukushima Daiichi Nuclear Power Plant was infuriating, even to the Japanese media. Detailed, accurate, and real-time information was hidden, particularly by Tokyo Electric Power Company (TEPCO), and residents of Fukushima, who had already been shaken by the disasters were left uninformed, as the area descended further into chaos. There were, in fact, some parallels with what happened 1986 in Chernobyl, but the experiences and lessons learned there were not applied in Fukushima.

The evacuation policy was also poor. After learning of the radiation leak, the government issued an evacuation directive for residents within 20 km of the plant one day after the earthquake. Approximately one month later, this area was designated a ‘high alert zone’ and effectively sealed off. A colleague and I examined these measures from an ethical perspective and argued that if the government’s aim was to avoid health risks posed by radiation exposure, then ordering compulsory expulsion of all residents cannot be ethically justified [1]. It is possible that the government may not have ordered the mandatory evacuation solely based on health risks, but rather to maintain public order. Careful scrutiny of the case revealed that this intervention involved an objective completely unrelated to public health, and that disguising these policies using the purpose of public health made it easier to justify undue restriction of individual liberty.

6.1.1 *Closedmindedness, Impenetrability and Secrecy Are Significant Characteristics of Japanese Society*

As Oe criticized Kawabata’s stance (Chap. 5), likening it to the “flight of Japan to its own vague world, where the possibility for foreigners to gain a correct understanding of Japan is closed off,” this impenetrability is evident throughout Japan’s history. Japan closed its doors to the rest of the world for over 200 years (1639–1854). During that period, the West made great leaps forward in modernization through the industrial revolution. This “impenetrability” is still present in Japan, even in the age of globalization.

After the Fukushima accident occurred, local residents experienced great distress. However, there was one good that might have emerged: namely, the collection

of scientific evidence using empirical and epidemiological methods to measure the (still unclear) effects of low-dose radiation exposure on thyroid cancer development in children. Having observed the confusion between the government and TEPCO immediately after the Fukushima accident, it was my belief that Japan could not singlehandedly conduct such an epidemiological survey. I therefore, through the journal *Science*, called for international collaboration in this research [2].

Given the current confusion and disorder, it would be difficult for Japanese researchers and the Japanese government to execute such a study singlehandedly. However, they should not have to organize the effort alone. The risk of childhood exposure to radiation is a real one for people living in any region of the world. It is time to organize an international joint research team supported by countries worldwide to uncover lessons to be learned from Fukushima for the sake of future humanity (p. 696).

The response from overseas was overwhelming, and some researchers even offered funding. When invited to serve as a committee member to determine governmental support of the survey of the post-earthquake Tohoku/Fukushima area, I approved governmental support under the following conditions: (1) appropriate relationships are cultivated with residents of Fukushima, (2) sufficient informed consent protocols are conducted, and (3) international cooperation was sought. The principal investigator agreed to all of my stipulations.

However, while foreign researchers were included as advisors, the group in Japan did not seek to make this project an international collaborative study. The most plausible reason for this is that they thought, “What could we gain from these foreigners? They are neither natives of the nuclear disaster-stricken country, nor did they experience the nuclear disaster themselves.” This is an example of the closed-mindedness of Japanese society

6.2 The Fukushima Thyroid Screening Study

How much valuable scientific data on low-dose radiation effects have been obtained, or might be obtained through this Fukushima thyroid screening study? In January 2019, a group from Fukushima Medical University (FMU) published the results of the first (2011–2013) and second (2014–2015) rounds of screening for thyroid cancer in *JAMA Otolaryngology-Head & Neck Surgery* [3]. My colleagues and I pointed out several concerns [4].

First, this cohort study was originally designed to obtain scientific data on the effects of low-dose radiation exposure on the thyroid gland in children. Thus, the protocol previously had control groups in Aomori, Yamanashi, and Nagasaki prefectures, which are far from Fukushima prefecture and unaffected by the radiation. However, the sample size ($n = 4,365$) in the control areas was too small to serve as a legitimate comparison to the sample size of those in Fukushima ($n=360,000$). Therefore, this design has been subject to criticism [5]. Without large-scale controls, the effect of low-dose radiation is difficult to analyze. The FMU group chose to abandon the small control group, and instead used data from the first and second

rounds as a baseline. Following the Chernobyl accident, which involved high-dose radiation exposure, the latency of the onset of thyroid cancer was short, roughly 3–4 years after exposure. The estimated latency among people who are iodine sufficient at the time of radiation exposure is thought to be longer, at 5–10 years [6]. Accordingly, the FMU group expected the latency period for the development of thyroid cancer in Fukushima to be 5–10 years, and considered data from the first round (2 years post-disaster) and second round (4 years post-disaster) as the baseline [6]. However, the FMU group paper [3] concluded that ‘Large-scale mass US (ultrasound) screening of young people resulted in the diagnosis of a number of thyroid cancers, with no major changes in overall characteristics within 5 years of the 2011 Fukushima nuclear power plant accident,’ as if the detected thyroid cancer cases and low-dose radiation exposure were highly unlikely to be related.

There is another serious issue aside from the FMU group using data from the first and second rounds as the baseline. As stated above, if the latency period for the development of thyroid cancer is expected to be 5–10 years, then any effects of the low-dose radiation exposure would begin to show at this time. However, participation rates declined from 81.7% in the first round (2011–2013) and 71.0% in the second round (2014–2015) to 64.6% in the third round (2016–2018). Nonetheless, the FMU authors decided not to show the results from the third round, even though they were available at the time of submission of the manuscript. With this decline in participation rates, precise detection of changes in the onset of thyroid cancer in subsequent rounds is difficult to track.

Among the 202 participants diagnosed with cancer by the second round, more than 80% have undergone surgery. It is highly likely that the participation rates will be much lower for the fourth and fifth round screenings, which will cover 10 years since exposure. This low participation rate is a critical concern.¹

In maintaining its ‘closemindedness,’ Japan failed to collect valuable scientific data, potentially the one major contribution to the betterment of humankind that could have been achieved through this disaster.

6.3 Why Less Scientifically Meaningful Data? What About the Victims?

Scientifically speaking, an even more problematic epidemiological survey was undertaken, supported by public funding. Some readers may remember the term, ‘*Fukushima 50*,’ which was a label given to the many workers who helped to restore the contaminated site. As they exposed themselves to a highly radioactive environment, they were applauded as heroes. From March 2019, a cohort study targeting

¹ In the addendum, I will show an original paper that will explain the decline in participation rates, and inappropriateness of informed consent forms.

those emergency workers was commenced, funded by the Japanese government and conducted by the Radiation Effects Research Foundation based in Hiroshima.

My colleagues and I objected to this study on ethical grounds [7].

Firstly, the low study participation rate is a serious problem. As of March 2018, of the 19,808 workers, 3,400 (17.2%) refused to participate, 7400 (37.4%) did not respond, and 1700 (8.6%) could not be reached. This leaves only 7000 (35.3%) participating workers, most of whom are TEPCO employees. We suspect that the low participation rate may be due to social stigma and fear concerning nuclear power.

Secondly, the unscientific nature of the cohort design further undermines the ethical basis for conducting it. Given the normal statistical variability in cancer incidence and other risk factors, it is unlikely that such increased incidence of cancer due to irradiation would be discernible. The question remains: why did Japanese epidemiologists defend this large-scale cohort study?

We believe that the study should be terminated and the public funding applied instead to activities that truly benefit the workers at the power plant, such as free lifelong health care services and financial compensation.

The Village Society Again: The Case of the Young Woman.

It was my personal experience with a particular young woman that led me to write this chapter.

The story dates back to when I worked part-time at a mental health clinic. To protect the privacy of personal information, the patient's identity and other details are not revealed, but I have tried to present the patient's words exactly as they were spoken. I have also obtained the patient's written informed consent to use her words.

6.3.1 Case

In late 2018, 7 years after the earthquake, I met with a single female patient in her early 30s who had been subjected to harassment in her workplace. She was suffering from insomnia, anxiety, and mild depression. I surmised that she was suffering from an adjustment disorder and began filling out her medical chart accordingly. It was when we got to questions on family composition that I learned that her mother had died, and her father was disabled due to high blood pressure and diabetes. She began to explain that her hometown was in Iwate (Tohoku prefecture). She then shared that the tsunami from the 2011 earthquake not only demolished her entire house, but also washed her mother and a younger female cousin out to sea. Since then, her younger sister had not worked, and instead stayed at home locked up inside, taking care of their father, who is weakened by illness. At this point, my patient began crying uncontrollably. She told me that at her previous workplace, a superior told her, "You are using the earthquake as a crutch." She began to exhibit signs of panic, as I had unintentionally evoked a flashback. This is a typical presentation of PTSD.

My patient told me that she felt her supervisor's statement: "You are using the earthquake as a crutch" was incredibly insensitive. She noted that "when I

remember this, I realize that my current workplace is somewhat better than the previous workplace,” thus changing her initial complaint.

Hearing the words of her former supervisor made me painfully aware of the reality that Japan’s village society possesses a system of cultural stigma in common with most other village societies. To her superior, this woman is not his family, so her emotional state is someone else’s problem. The plight of the 2011 earthquake victims was in no way the fault of the victims themselves. However, through this tragedy, the victims came to be differentiated from non-victims, and isolated themselves from the community. This is typical behavior in a village society, in that a portion of the community that has been set apart for whatever reason is discriminated against or ostracized. The government has been more than willing to invest massive amounts of public funding into post-disaster research studies that are merely epidemiological investigations posing as health surveys, but has not reached out to the many victims who still suffer from the after-effects of the earthquake.

6.4 Animal Ethics and Intergenerational Ethics

Finally, let me address animal ethics and intergenerational ethics. As of April 2019, a large area of Fukushima has been designated as a ‘high alert zone’ and sealed-off. However, animals including pets, livestock and wildlife had all been left in area where there was high radiation. This in it of itself is unethical from the perspective of animal ethics. One research group has examined raccoon teeth to test the presence of a ‘dicentric chromosome,’ an abnormal chromosome which appears after radiation exposure. In Fukushima, 0.6% of raccoons exhibited this abnormality, while the percentage was 0.0% among raccoons in Aomori (control area, 430 km north of Fukushima).

This finding concerning animal radiation exposure has significant implications for the next generation. Firstly, one imminent issue is that radiation exposure in animals will directly lead to nuclear contamination in surrounding areas. As animals move freely from Fukushima to other regions outside of the high radiation zone, those with high levels of radiation could end up anywhere in Japan. This is problematic for humans and animals alike

Secondly, there is no information on the effects of nuclear radiation exposure on the reproductive systems of small animals. Even larger animals like cows could have reproductive damage that could be passed down to future generations.

By 2020, a wide swath of the area surrounding Fukushima Daiichi Nuclear Power Plant will remain a no-entry zone due to high levels of radiation. Japanese people living today will be leaving the next generation to bear this negative inheritance. Intergenerational ethics is also a globally important issue. Will this culture of “closedmindedness” prioritize “the responsibility for the next generation” or “the values of those of us living now”?

Original Article

Lessons Learned from Fukushima: Thyroid Cancer Screening Preparedness for Radiation Exposure

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Abstract The 2011 Fukushima nuclear power plant accident prompted much debate among the healthcare sector, especially regarding thyroid gland radiation exposure and follow-up examination. Here, we focus on expertly preparing healthcare systems to address national radiation emergencies, including distinguishing health and epidemiological research, informed consent, and access to services. Drawing on both Japan's experience from the Hiroshima and Nagasaki bombings and its experience in the wake of the Fukushima nuclear accident, we propose key steps for healthcare system readiness. Our proposals will help to improve readiness in the event of future nuclear disasters.

Keywords Fukushima, thyroid screening, epidemiology, health surveillance, informed consent

In the seven years since the 2011 Fukushima nuclear accident in Japan, the academic literature on thyroid screening has grown and public debates within Japan about radiation risk have occurred [1, 2]. Despite greater attention, misunderstandings continue and valuable lessons have yet to be learned and incorporated into policies governing future disaster readiness.

Drawing first on lessons learned from Fukushima we note that the latest Fukushima Report shows 360,000 affected parties and detected 187 malignant or suspicious cases [3]. Among these, more than 50 cases were without sign of invasion or metastasis. At least 11 (over 20%) of 50 participants opted for surgery over the recommended, non-surgical follow-up, based on social and personal reasons, such as parental preference, or no longer residing in the vicinity of Fukushima.

A key report was published offering helpful preparedness advice, especially as it relates to post-accident thyroid cancer screening. The July 2017 EU-OPERA SHAMISEN project report, which sets forth 28 general recommendations, also documents victim fear in the aftermath of radiation accidents [4]. Of the 28 recommendations, the following two pertain specifically to thyroid cancer screening.

R2: Recognise the difference between health/medical surveillance and epidemiology, and their different objectives and data needs.

The objectives of health/medical surveillance are to evaluate whether individuals affected by an accident suffer from some health condition.....In contrast, the objectives of post-accident epidemiology studies are 1) to evaluate whether the radiation exposure/accident has impacted disease rate/risk through “epidemiological surveillance”, using population hospital/health-insurance registries; and 2), if possible, to improve our knowledge on effects of radiation, using analytical epidemiological approaches.....

R25: Launch systematic health screening based on appropriate justification and design. Do not recommend systematic thyroid cancer screening, but make it available (with appropriate counselling) to those who request it.

Given the challenge and adverse effects noted above, thyroid cancer screening should be proposed, on a voluntary basis, for those who wish to be monitored, as long as it is accompanied with appropriate information and support.

Here, we reflect on the Fukushima experience and propose healthcare system protocols to expertly prepare healthcare systems for the possibility of future radiation exposures. In particular, we flag ethical considerations related to the distinction between surveillance and research, including informed consent and respect for patient/research subject autonomy.

Epidemiological Surveillance

From the start of the Fukushima study, the boundary between health surveillance and epidemiology research was unclear. Table 6.1 tracks changes in the explanation and informed consent forms provided to participants of three successive studies performed in Fukushima to date.

Table 6.1 Fukushima Medical University’s Thyroid Screening Consent Form

During round one (2011–2014), the informed consent document refers to health surveillance [5]. During the second round (2014–2016), the word research appears for the first time in the consent form [6]. The informed consent document explicitly excludes participants from receiving thyroid examinations without consenting to having their data used for research purposes. Epidemiological research thus seems to have commenced as soon as research subjects consented to treatment. During the third round (2016–*), the informed consent document changes again. This time, it clearly states that the thyroid examination is *not* for the purpose of investigating radiation effects on the thyroid gland [7, 8]; as it appears, the form denies that participants are research subjects in a post-disaster epidemiological study. Yet, at the same time, the round three consent form includes a box to check whether participants ‘Agree’ or ‘Disagree.’ This indicates an opt-out format of the third-round. Clearly, the entire process is inconsistent, confusing, and misleading. Whenever a participant opts out of research, it seems they become ineligible for thyroid cancer examination, despite the denial (during round three) that research is ongoing.

Notice regarding Thyroid Gland Examination for the Prefectural Resident Health Survey (2011)

To the guardians of those undergoing the thyroid gland examination:

Because of the radioactive contamination within the prefecture due to the Tokyo Electric Power Company Fukushima nuclear plant accident associated with the Great East Japan Earthquake, Fukushima Prefecture is conducting the Fukushima Prefectural Resident Health Survey, which targets all residents of the prefecture with the aim to secure their safety and relief, and to carry out current and future health management.

As part of the Prefectural Resident Health Survey, in order to carry out the health management of children, Fukushima Medical University (FMU) has been commissioned to conduct thyroid gland examinations that aim to gain an understanding of the current state of their thyroid glands, follow their health throughout life, and provide them and their parents with some peace of mind. The examination is scheduled for October 2011 and will target children from and in the order of Kawamata Town of Yamakita District, Namie Town, and Iitate Village.

The thyroid gland examination will be conducted according to the following operating procedure. Please review the procedure and consider undergoing the examination.

Consent Form for Examination

To Governor, Fukushima Prefecture

To President, Fukushima Medical University

This thyroid gland examination aims to understand the present state of your child's thyroid gland as part of your child's health management. You will be notified of the examination results, which will also be stored at FMU. This will be done in a manner that ensures privacy, and names will not be traceable. A portion of the examination results might be made public and used as basic information for continuous health management and statistical analysis.

I have read and understand the above, and I provide consent, as guardian, for my (relation) _____, (name) _____, to undergo the thyroid gland ultrasound examination as part of the Prefectural Resident Health Survey at the location and date and time indicated on the Notice.

Furthermore, it is noted that my consent is based on the conditions listed below.

Note

(Conditions for consent)

1. I (if an adult, then the person himself/herself) can rescind my consent at any time for any reason.
 2. My child(ren) and I will not be disadvantaged in any way if consent is rescinded.
 3. Information regarding my child (if an adult, then the person himself/herself) will be provided at any time upon request.
 4. Personal information obtained during the present survey about me and my child(ren) will be strictly protected.
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Table 6.1 Notices and Consent Sheets used at Fukushima Study from 2011 to 2018

Notice regarding the Second Thyroid Gland Examination (2014)

To those undergoing the thyroid gland examination and guardians:

Because of the Tokyo Electric Power Company Fukushima nuclear plant accident, Fukushima Prefecture and FMU are conducting thyroid gland examinations to track the long-term health of children.

To this end, following the first examination (baseline screening), we will be conducting the second (full-scale) examination in order to obtain continuous confirmation of the state of the thyroid gland, as described below. We recommend undergoing the examination regardless of the attendance to or results of the first examination.

Therefore, please review the enclosed “Notice regarding the 2014 Thyroid Gland Examination” and return the necessary information using the self-addressed stamped envelope (also enclosed).

Consent Confirmation Form/Medical Questionnaire for the Prefectural Resident Health Survey Thyroid Gland Examination

To Governor, Fukushima Prefecture

To President, Fukushima Medical University

This thyroid gland examination is an examination to track your (the patient himself/herself) health. You will need to submit this consent confirmation form each time you undergo an examination. In addition to notifying you of the examination results, data obtained up until now and in the future in the Prefectural Resident Health Survey will be stored by FMU and used for the following purposes.

- Purposes for your health management
- Management/operation for the survey
- Data provision to external physicians and specialists when opinions and advice are sought
- Collaboration between medical facilities relevant to your examination
- Data provision to municipality in order to offer you appropriate support for health, medical care, welfare, and daily living
- Other purposes
- Use as a basic resource in performing continuous health management for prefectural residents
- Use as a basic resource to further improve and maintain the health survey in the future
- As an educational/training/practicum tool for those conducting the thyroid gland examination
- Use for academic research, public health education or awareness programs, protecting your anonymity
- Use for publication (e.g. statistical analysis), protecting your anonymity

Table 6.1 (continued)

Note

1. You or a legal representative can rescind this consent at any time, and you will not be disadvantaged in any way if consent is rescinded.
 2. Information regarding participant will be provided at any time upon request by you or a legal representative.
 3. Personal information obtained during the present survey about you and a legal representative will be strictly protected.
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Notice regarding the Thyroid Gland Examination (2016)

To those undergoing the thyroid gland examination and guardians:

Because of the Tokyo Electric Power Company Fukushima nuclear plant accident, Fukushima Prefecture and FMU are conducting thyroid gland examinations to track the long-term health of children. This examination aims to observe the state of each individual's thyroid gland in the long-term, to connect this with support that would enable the examinees to live a healthy life, and to aid in a survey regarding future health effects.

This examination will assess the state of the thyroid gland by, e.g., an ultrasound examination, but is not meant to assess the effects of radiation exposure on an individual basis. Since some information regarding the state of the thyroid gland can be obtained from the examination, we will provide you with the results. Although the examination might identify changes that require treatment, which could potentially lead to early detection and treatment, given the characteristics of the thyroid gland, many changes that do not require treatment may also be identified, which may generate some concern. For this very reason, examination of the thyroid gland by ultrasound has not been conducted in general.

Whether or not to undergo the examination depends on the subject's wishes (for those aged 20 years and under, the subject and guardian). Therefore, please consider the contents and significance of the examination and provide us with a reply as to whether you wish to undergo the examination.

Consent Confirmation Form/Medical Questionnaire for the Prefectural Resident Health Survey Thyroid Gland Examination

Same as one used in 2014 except: 'Agree' or 'Disagree' boxes are added.

Updated information in the FMU's Website on May 30, 2016.

In completing the consent form, we have found that some forget to check the box "Agree" or "Disagree." With the exception of those who checked the box "Disagree," we consider even incomplete forms to represent your basic consent to undergo the examination (including the use of data obtained from the testing).

(Authors' translation. Underlined by authors.)

Table 6.1 (continued)

It appears the problems noted above are ongoing. During a 2018 Sectional Meeting of Thyroid Examination Evaluation, a fourth round of the study was discussed, and a new draft informed consent document presented [9]. This draft states, "The aims of this study are to minimize the radiation effects on the thyroid gland,

and to correctly evaluate the relationship between radiation exposure and thyroid cancer.” In this way, medical surveillance and post-disaster epidemiological study are conflated.

The participation rate in the Fukushima program has declined from 81.7% in the first round to 70.9% in the second round, and to 54% in the third round [3]. This decline can best be explained by a loss of public trust in the research enterprise, as well as fears of over-diagnosis and overtreatment. Moreover, we suspect that the design barring participants from receiving a thyroid ultrasound examination without consenting to research may contribute to explaining the study’s low participation rate. As an alternative, one non-profit organization is offering free ultrasound examinations to parents of children who declined participation in the Fukushima study, but would like their children’s thyroids examined [10].

Following the bombings at Nagasaki and Hiroshima in 1945, the Japanese government granted survivors an *Atomic Bomb Survivor's Healthcare Certificate*, guaranteeing life-long free medical services including coverage of a funeral fee [11]. This policy, we believe, facilitated long-term follow-up of survivors’ health. The Japanese government also compensated victims, on the premise that governments bear primary responsibility for war and all of its effects. Despite this, the Fukushima study does not cover treatment costs. If victims suffer suspected radiation-related thyroid cancer or leukemia, they themselves must shoulder treatment costs. In a Japanese context, national health insurance system generally covers 70%, and patients are required to pay the remaining 30%. Atomic bomb survivors are exempt from these costs, even if their health problems cannot be shown to originate from radiation exposure.

As of August 6, 2018, the senior management team of Tokyo Electric Power Company (TEPCO) was criminally accused of “professional negligence resulting in death and injury.” If the court decides against TEPCO, the company will likely be required to compensate victims for the remainder of their lives, given the magnitude of damages, not only with respect to health, but also quality of daily life, including job and housing losses.

Proposed Health System Protocols

To ensure readiness of healthcare systems for possible future radiation accidents, we propose the following health care system protocols for health surveillance, treatment, and epidemiological study.

Health Surveillance and Treatment Protocols

1. Issue certificates and health notes to all victims to ensure free access to health care services for radiation exposure-related health problems.
2. Conduct health surveillance for victims who consent without linking surveillance to treatment.
3. Clarify evidence-based medical indications for surgical management of thyroid cancer when nodules or cysts are detected by ultrasound examination.

4. Cover treatment costs for radiation exposure-related health problems. Share costs among responsible parties.
5. Assure life-long free treatment for at least thyroid cancer and leukemia, including follow-up for victims outside the disaster-stricken area who remain in Japan. The national government should partly fund follow-up health/medical surveillance to assure nationwide coordination and quality.

Epidemiological Study Protocols

1. Invite child victims together with parents or legal guardians to participate in thyroid cohort research.
2. Use an *opt-out* format for informed consent that assumes consent in the absence of refusal.
3. Distinguish health surveillance and epidemiological research during the recruitment phase. For example, use separate and consistent informed consent sheets.
4. Assure victims during recruitment and treatment that they are eligible to receive thyroid examinations irrespective of whether they opt-in or opt-out of research.
5. Educate participants about the purpose of epidemiological research and emphasize the value of reporting and monitoring precise radiation exposure.

These proposals for improving health system readiness are drawn from Japan's difficult experience of radiation exposure during the Fukushima experiences. Our aim is to help Japan and other nations take necessary steps to become optimally prepared for future radiation disasters.

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