The psychological impact management and reassurance of public after the Fukushima accident.

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I was born and raised in Nagasaki city. After graduating from the Nagasaki university, I became a ‘public health nurse’ of the national qualification.
Hiroshima and Nagasaki Atomic Bomb, (Aug, 1945)

- Nagasaki became the second city after Hiroshima to be destroyed by an atomic bomb towards the end of World War II.

![Image of atomic bomb explosion]

<table>
<thead>
<tr>
<th>After bombing</th>
<th>Nowadays</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Image of Nagasaki after bomb]</td>
<td>![Image of Nagasaki nowadays]</td>
</tr>
</tbody>
</table>
Atomic Bomb Disease Institute, Nagasaki University

Atomic Bomb Disease Institute, Nagasaki University was established in 1962, for the purpose of universal basic research with regard to radiation medicine and the late effects of radiation on the human body.

We have expanded our research activities from the late effect of radiation on atomic bomb survivors in Nagasaki to international ‘Hibakusha’ medicine and molecular epidemiology at Chernobyl and Semipalatinsk.

Furthermore, after Fukushima crisis in 2011, we have been contributing re-establishment of medical service to emergency radiation exposure, radiation-risk communication.
The Great East Japan Earthquake

- The Great East Japan Earthquake occurred on March 11, 2011
- Magnitude of Earthquake was 9.0, the largest in Japan’s recorded history
- Tsunami in a series of seven waves, resulting in the inundation of an area 400km.
The Great East Japan Earthquake

- Cars, ships and buildings were swept away by a wall of water.

- The National Police Agency has confirmed 15,894 deaths, 6,152 injured, and 2,562 missing. (March, 2016)
Fukushima Daiichi Nuclear Power Plant Accident

The natural disaster led to severe damage to the Plant, which caused subsequent release of large amounts of radionuclides into the environment.
At 14:46, 11 March FDNPP under operation automatically shut down by earthquake. All six external power supply sources were lost by earthquake.

At 15:27 and 15:35, 11 March Emergency diesel generators, and distribution boards, seawater pumps, were submerged because of the tsunami strike and all emergency diesel power generators stopped.

All AC power supplies were lost. Nuclear fuel in each core was not covered by water.

The steam was filled in the building by the core melt down caused by the dysfunction of the cooling system.

Lots of radioactive materials were scattered in the environment thorough “vent” to reduce the internal pressure and the hydroponic explosions of the nuclear reactors.

(INVESTIGATION COMMITTEE ON THE ACCIDENT AT THE FNPS)
<table>
<thead>
<tr>
<th>Radionuclides released by the accident at Chernobyl and Fukushima</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chernobyl</strong></td>
</tr>
<tr>
<td>5,200 (x6.8)</td>
</tr>
<tr>
<td>1,800 (x11.3)</td>
</tr>
<tr>
<td>44 (x2.4)</td>
</tr>
<tr>
<td>85 (x5.7)</td>
</tr>
<tr>
<td>8.0 (x57)</td>
</tr>
<tr>
<td>0.03 (x10,000)</td>
</tr>
</tbody>
</table>
The released radionuclides around the nuclear power plant at the initial phase of the accident

1. Hydrogen explosion at Unit 1 at 15:36, March 12, 2011.
2. Hydrogen explosion at Unit 3 at 11:01, March 14, 2011.
3. Hydrogen explosion at Unit 4 at 06:14, March 15, 2011.
   a. Opened the vent at Unit 1 at 10:17, March 12, 2011
   b. Opened the vent at Unit 3 at 08:41, March 13, 2011
   c. Opened the vent at Unit 2 at 11:00, March 13, 2011
   d. Opened the vent at Unit 3 at 05:20, March 14, 2011
   e. Opened the vent at Unit 2 at 00:02, March 15, 2011
Countermeasures of the accident for external radiation exposure

Instructions to evacuate or remain in homes were issued by the director general of the nuclear emergency response headquarters as follows:

- Areas located within a 2 km (20:50, March 11), 3 km (21:23, March 11), 10 km (March 12, AM) and 20 km (March 12, PM) from the FNPP were designated as evacuation zones.

- On March 15, those living within 20 km to 30 km were instructed to seek shelter inside houses.

(Investigation Committee on the Accident at the FNPS)
Airborne monitoring and areas of evacuation on April 22, 2011

Restricted area (blue), deliberate evacuation area (red), and evacuation prepared area (yellow)
On March 17, the government initiated “food control” to minimize internal radiation exposure.

The health ministry established provisional limits (500 Bq/kg) and notified prefectural governments on March 24.
Fukushima Health Management Survey

**Basic Survey**
Subjects: Residents (2 million) as of March 11, 2011
Method: Self-administered questionnaire survey
Content: Details of whereabouts and daily routine from March 11 onwards to estimate exposure.

**Detailed Surveys**

- **Thyroid Ultrasound Examination**
  Subjects: Residents aged 18 years or younger
  Content: Ultrasound examination
  Survey period: Three years

- **Comprehensive Health Check**
  Subjects: Residents in evacuation zones
  Content: General health checkup items with differential leukocyte count

- **Health Management File**
  - To keep health checkup records
  - To provide information on radiation

- **Database**
  - To provide long-term monitoring of residents' health
  - To guide treatment
  - To inform and guide future generations

- **Mental Health and Lifestyle Survey**

- **Pregnancy and Birth Survey**

- **Follow-up**
  - Consultation and support
  - Follow-up
  - Treatment
External radiation exposure dose in Fukushima Prefecture (463,394 residents)

Average: 0.8 mSv
Maximum: 25 mSv

(Fukushima Health Survey Management, September 2016)
Distribution of thyroid equivalent doses estimated by the results of the screening survey in Iitate village, Kawamata Town and Iwaki city

- 0mSv: 55.4%
- <5mSv: 85.1%
- <10mSv: 95.7%
- <15mSv: 98.8%
- >50mSv: none

(Nagataki et al. 2013)
Number of participants according to internal exposure dose of the Fukushima residents

<table>
<thead>
<tr>
<th>Dose</th>
<th>Number of residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 mSv</td>
<td>302,977</td>
</tr>
<tr>
<td>1-2 mSv</td>
<td>14</td>
</tr>
<tr>
<td>2-3 mSv</td>
<td>10</td>
</tr>
<tr>
<td>3 mSv-</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>303,003</td>
</tr>
</tbody>
</table>

(Fukushima Health Management Survey, September 2016)
Deliberate Evacuation Areas

Evacuation Order Areas

Date City
Kawamata Town
Iitate Village
Minamisoma City

Katsurao Village
Namie Town
Futaba Town

Tamura City
Okuma Town

Kawauchi Village
Tomioka Town
Naraha Town

Hirono Town

FNPP

(As of September 2014.)
Rearrangement of Evacuation order areas (2012~)

**Area 1**
- Areas in which evacuation orders are ready to be lifted

**Area 2**
- Areas in which the residents are not permitted to live

**Area 3**
- Areas where it is expected that the residents have difficulties in returning for a long time

(As of September 2014.)
Status of evacuation areas and numbers of evacuees before the evacuation order was lifted

Evacuees from Pref. Fukushima 121 thousands.

- Ecasmues from the Evacuation Areas 80 thousands.
- Other Evacuees from Pref. Fukushima 41 thousands.

Area 1: 32,000
: Areas in which evacuation orders are ready to be lifted

Area 2: 23,000
: Areas in which the residents are not permitted to live

Area 3: 25,000
: Areas where it is expected that the residents have difficulties in returning for a long time

Worldwide experience following accidents has shown that individuals are not willing to leave affected areas. In addition, people wish to live life that is as normal as possible. Therefore, a long-term goal should be to rehabilitate areas to allow people to return to their normal habits.

→What most people really want is to continue living their lives.….
EXECUTIVE SUMMARY

(e) Past experience of existing exposure situations resulting from a nuclear accident or a radiological emergency has revealed that all dimensions of the daily life of the inhabitants within the contaminated areas, as well as the social and economic activities, are affected. These are complex situations which cannot be managed with radiation protection considerations alone, and must address all relevant dimensions such as health, environmental, economic, social, psychological, cultural, ethical, political, etc.

Accident at Fukushima Daiichi Nuclear Power Plant caused extensive human suffering and revealed the need for more effective means of communicating health risks to the public.
For acceleration the reconstruction of Fukushima

Lifting of Evacuation orders and enhancement of initiatives for Evacuees’ returning home: **Cabinet Decision**

(1) Measures to ensure safety and security. (reduction of radiation exposure and health consultation)

(2) Development of an environment for evacuees’ returning home.

(3) Decontamination work in tandem with the move toward the reconstruction.

Realization of the lifting of evacuation orders in consultation with local communities.

(Cabinet office, 2013)
Kawauchi Village, Fukushima Prefecture
Kawauchi Village, Fukushima Prefecture
The Evacuation of Kawauchi Village

- March 11, 14:46: Great East Japan Earthquake occurred
- March 12, 05:44: The residents of Tomioka Town were evacuated to Kawauchi due to a evacuation order to within 10-km radius from Fukushima1 Nuclear Power Plant.
- March 12, Evacuation Order was extended to a 20-km radius.
- March 15, 11:00: Sheltering Order was issued to a 20- to 30-km radius. The village government of Kawauchi decided to evacuate.
- March 16, 06:00: All residents were evacuated to Koriyama City.
Declaration of returning hometown
Process for the reconstruction of the village

Decontamination

Restarting of elementary and junior high schools

(Kawauchi village office)
Resumption of Agriculture and Forestry (Kawauchi village office)
Employment Creation
Decontamination of the living environment

- Decontamination of residential houses has been conducted since mid-2011.
- Decontaminate the areas that the residents most frequently use (such as schools and residential houses) prior to other places.
- Decontamination of residential houses and other buildings in the village is completed.
Outline of decontamination in Kawauchi Village

Diagram showing the process of decontamination, including the use of large bags to collect materials.
Rate of residents who returned back to Kawauchi Village (April 2013)

(Kawauchi village office)
Rate of residents returning to Kawauchi Village (April, 2016)

Rate of return

- Not returned
- Returned

Age group

- Rate of return
- Not returned
- Returned

(Kawauchi village office)
Factors not to return to hometown
(February, 2012)

1. Scary damage caused by radiation: 161 persons (15.50%)
2. Access to medical facilities: 201 persons (19.35%)
3. Anxiety in the living environment: 135 persons (12.99%)
4. Working environment in the village: 125 persons (12.03%)
5. Anxiety in the education: 110 persons (10.59%)

Total number 1,039

(Kawauchi village office)
Establishment of Nagasaki University/ Kawauchi Village Reconstruction Promotion Base in Kawauchi Village (April 2013)

Mission

1. Evaluation of effectiveness of decontamination through the measurement of radionuclides in soils.

2. Evaluation of risks of internal exposure through the measurement of foods and waters.

3. Health consultation with inhabitants according to the results of above mentioned measurements.

4. Health promotion of inhabitants.
Individual consultation on radiation exposure and health effects
Frequently Asked Questions

• What is the difference between radioactive material and radiation?

• What is the purpose of the decontamination?

• Water and rice is safe?

• Is it safe for children to play outside?
【Q】What is the difference between radioactive material and radiation?

【A】
Materials or substances that emit radiation, such as radioactive cesium, are known as radioactive materials.

Radioactivity refers to the energy in radioactive materials that emits radiation. Radioactivity is measured in becquerels (Bq).

The radiation emitted by radioactive materials may include small particles, such as alpha rays or beta rays, such as gamma rays and x-rays. The effect of this radiation on the human body is measured in sieverts (Sv).
EXECUTIVE SUMMARY

In the case of an existing exposure situation, the Commission recommends that the individuals concerned should receive general information on the exposure situation and the means of reducing their doses. In situations where individual lifestyles are key drivers of the exposure, individual monitoring is an important requirement, coupled with an information programme.
Frequently Asked Questions

- Water and rice is safe?
- What is the level of concentration of radiocesium in local produced foods?
Measurement for radionuclides of local produced foods in the village.
## Detection rate of radiocesium in local foods

<table>
<thead>
<tr>
<th>Food group</th>
<th>Number</th>
<th>Number with detected radiocesium (Detection rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>4080</td>
<td>5 (0.1%)</td>
</tr>
<tr>
<td>Fruits</td>
<td>647</td>
<td>8 (1.2%)</td>
</tr>
<tr>
<td>Wild vegetables・Mushrooms</td>
<td>1986</td>
<td>652 (32.8%)</td>
</tr>
<tr>
<td>Freshwater fishes</td>
<td>36</td>
<td>14 (38.9%)</td>
</tr>
<tr>
<td>Meats</td>
<td>172</td>
<td>155 (90.1%)</td>
</tr>
<tr>
<td>Cereals</td>
<td>296</td>
<td>32 (10.8%)</td>
</tr>
<tr>
<td>Others</td>
<td>451</td>
<td>106 (23.5%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7668</td>
<td>972 (12.7%)</td>
</tr>
</tbody>
</table>

(Orita et. al, Scientific Reports, 2016)
“Mushroom map” in the village based on the measurement of radiocesium concentrations in dried mushrooms

(Nakashima et al., Peer J, 2015)
Frequently Asked Questions

- What is mean the baseline of 1 mSv/year?
- What is the level of radiation exposure in evacuation order area of the village?
- Why are radiation levels at monitoring posts and for individuals different?
Guideline of Radiation Protection during Radiation Emergency

[Normal Period]

(a) Dose limitation to minimize the radiation exposure at the initial phase
Indoor evacuation: 10mSv
Evacuation: 50mSv

(b) Dose limitation during the emergency
20-100mSv/year

(c) Dose limitation after the emergency
1-20mSv/year

Final goal: 1mSv/year

[After the accident]

Dose

Normal Period: 1mSv/year

Accident

Termination of the emergency

Days
Rearrangement of evacuation order areas (March, 2012~)

30 September, 2011

1 April, 2012
Area 1:
Areas in which evacuation orders are ready to be lifted

Area 2:
Areas in which the residents are not permitted to live

Area 3:
Areas where it is expected that the residents have difficulties in returning for a long time
The evacuation order area of the village

(April 2013 ~ September 2014)
Measurement of Individual Doses of Radiation by Personal Dosimeter is Important for the Return of Residents.

1. Measurement of individual doses using personal dosimeters.
3. Measurement of doses estimated from the concentrations of radionuclides in the soil around the residential houses.
Cumulative individual doses, cumulative ambient doses in front of the entrance, in the backyard, and field.

(Orita et al. Plos One. 2015)
Restructuring of the evacuation order area (March, 2012~)
Restructuring of the evacuation order area (October, 2015～)

Area 1
Area 2
Area 3

Restructuring of the evacuation order area (October, 2015～)
Frequently Asked Questions

• We are worried about the health effects of radiation in our children.

• Is it safe for children to play outside?
Evaluation environmental and individual doses at the attraction field of the village where elementary and junior high school children visit as studies trips

Start (Walking)

Required time: 9:20~11:40 (2h 20m)

Ambient dose rates (Maximum): 0.65μSv/h

Cumulate individual dose: 0.46μSv
Evaluation environmental and individual doses at the attraction field of the village where elementary and junior high school children visit as studies trips.

<table>
<thead>
<tr>
<th>Route</th>
<th>Measurement time</th>
<th>Cumulate individual doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>1h,7m</td>
<td>0.33 μSv</td>
</tr>
<tr>
<td>②</td>
<td>2h,9m</td>
<td>0.37 μSv</td>
</tr>
<tr>
<td>③</td>
<td>1h,21m</td>
<td>0.23 μSv</td>
</tr>
<tr>
<td>④</td>
<td>1h,3m</td>
<td>0.10 μSv</td>
</tr>
</tbody>
</table>
Risk perception regarding radiation and health effect
Fukushima Health Management Survey

External Exposure Estimation

**Basic Survey**
- Subjects: Residents (2 million) as of March 11, 2011
- Method: Self-administered questionnaire survey
- Content: Details of whereabouts and daily routine from March 11 onwards to estimate exposure.

**Detailed Surveys**
- Thyroid Ultrasound Examination
  - Subjects: Residents aged 18 years or younger
  - Content: Ultrasound examination
  - Survey period: Three years
- Comprehensive Health Check
  - Subjects: Residents in evacuation zones
  - Content: General health checkup items with differential leukocyte count
- Mental Health and Lifestyle Survey
  - To keep health checkup records
  - To provide information on radiation
  - To inform and guide future generations

Follow-ups

**Database**
- To provide long-term monitoring of residents' health
- To guide treatment
- To inform and guide future generations

Promotion of municipal and workplace health checkups

Additional health checkups to reach residents not included in current services

Pregnancy and Birth Survey

Consultation and support

Follow-up

Treatment
### Risk perception on the health effects of radiation exposure in Fukushima Prefecture (2012)

<table>
<thead>
<tr>
<th></th>
<th>Do you think that acute radiation syndrome such as hair loss and nasal bleeding occur due to radiation exposure in Fukushima?</th>
<th>Very low possibility</th>
<th>Very high possibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>19,114 (58.5%)</td>
<td>3,259 (10.0%)</td>
</tr>
<tr>
<td></td>
<td>Do you think that late health effects such as malignancies will occur due to radiation exposure in Fukushima?</td>
<td>10,225 (31.4%)</td>
<td>6,488 (19.9%)</td>
</tr>
<tr>
<td>2</td>
<td>Do you think that genetic effects in offspring will occur due to radiation exposure in Fukushima?</td>
<td>7,857 (24.3%)</td>
<td>7,331 (22.6%)</td>
</tr>
</tbody>
</table>

(persons, %)

(Fukushima Health Management Survey Mental Health and Lifestyle Survey.)
Risk perception on the radiation health effects in Kawauchi village (May 2014, n=285)

1. Do you think that about the acute radiation syndrome might occur due to the radiation exposure following the accident?

2. Do you have anxiety about the health effects of radiation in children?

3. Do you have anxiety about the health effects of radiation in offspring?

1. 
- Probably yes: 20.7%
- Probably no: 40.4%
- Yes: 9.1%
- No: 29.8%

2. 
- Yes: 26.3%
- No: 27.7%
- Probably no: 36.1%
- Probably yes: 9.8%

3. 
- Yes: 27.7%
- No: 40.7%
- Probably no: 10.2%
- Probably yes: 40.7%

(Orita et al. Plos ONE 2015)
Risk perception on the radiation health effects in Kawauchi village (May 2014, n=285)

1. Do you have anxiety about the health effects of radiation for general population by living the environment ambient dose rate is 0.23µSv/hour for one year (equivalent with 1mSv/year)?
   - Yes: 14.0%
   - No: 17.2%
   - Probably yes: 23.5%
   - Probably no: 45.3%

2. Do you have anxiety about the health effects of radiation for general population by eating 100Bq/kg of mushrooms for one year (current regulation value of radiocesium for foods)?
   - Yes: 21.8%
   - No: 11.2%
   - Probably yes: 31.2%
   - Probably no: 35.8%
Risk perception on the radiation health effects in Kawauchi village

- Our results showed that the bipolarization of risk perception of health effects due to radiation exposure in Fukushima. Concepts of radiation protection were not fully understood by many residents.

- Bipolarization of the risk perception of the health effects of radiation might have a major impact on long-term social well-being after the Fukushima accident.

- It is needed for specialists to pursue a risk communication strategy that overcoming the gap between the documented risk perception of residents and presenting scientific evidence.
The Committee’s understanding of the exposure is that they fell well below the thresholds for deterministic effects. This was consistent with no acute health effects having been reported that could have been attributed to radiation exposure.

A general radiation-related increase in the incidence of health effects among the exposed population would not be expected to be discernible over the baseline level.

Mental health problems and impaired social well-being were the major health impacts observed following the accident. They were the results of understandable reactions to the enormous impacts of nuclear accident, as well as fear and stigma associated with radiation exposure.
EXECUTIVE SUMMARY

(v) In recent years, stakeholder engagement has moved steadily to the forefront of policy decisions. Such engagement is considered by the Commission as key to the development and implementation of radiological protection strategies for most existing exposure situations. As experience in stakeholder engagement has grown, it has been possible to use many of the lessons learned as a basis for the development of best practice among the radiation protection community.
We hope that the village-university collaboration provides a model for a multidisciplinary approach to public policy during the recovery phase of a nuclear accident.
Future tasks

- Evaluation of the health effects of radiation exposure through the measurement of environment and individual doses.

- Continuous health consultation with residents according to the results of above mentioned measurements.

- Human resource development
Importance of capacity building in the field of radiation health sciences

During Fukushima’s compound disaster (earthquake, tsunami, and nuclear power plant accident), it became clear that there was a shortage of medical science professionals knowledgeable about radiation health sciences.

- People to provide emergency medical care for radiation exposure
- People to measure and assess the amount of radioactivity and exposure to radiation in the environment
- People with medical knowledge to carry out rescue operations
- People to provide healthcare to many affected residents in shelters
- People to measure and assess the amount of radioactivity and environmental radiation exposure
- People to communicate the health risks of radiation
- People to provide long-term support to affected residents

**Just After the Disaster From Chaos to Stability To Restoration**

- Establish emergency medical facilities to treat radiation exposure.
- Evaluate radioactive material in the soil in the initial days after the accident.
- Emergency monitoring and decontamination.
- Rescue operations for victims caught in the earthquake or tsunami.
- Validation of feedback through the assessment of radiation levels.
- Transfer and admission of in-patients to hospitals.
- Medical support and provision of healthcare in shelters.
- Assessment of internal levels of radiation exposure.
- People to provide emergency medical care for radiation exposure
- People to measure and assess the amount of radioactivity and exposure to radiation in the environment
- People with medical knowledge to carry out rescue operations
- People to provide healthcare to many affected residents in shelters
- People to measure and assess the amount of radioactivity and environmental radiation exposure
- People to communicate the health risks of radiation
- People to provide long-term support to affected residents

**To Restoration**

- Restoration support in Kawauchi village provided through restoration promotion centers.
- Long-term healthcare for residents.
Disaster and Radiation Medical Sciences (Master’s Degree)

Nagasaki University
- Atomic Bomb Disease Institute
- Graduate School of Biomedical Sciences
- Medical Science Course

Fukushima Medical University
- Graduate School of Medicine
- Health Nursing Science Course
- Fukushima International Medical Science Center

Introduction of English lectures and training materials by top level staff from international organizations

World Health Organization (WHO, Geneva)

International Atomic Energy Agency (IAEA, Vienna)
Conclusion

- Countermeasures to minimize the damage of nuclear disaster, the risk communication and the dialogue is essential, and lessons from the nuclear disasters provide key-information on the communication.

- We hope to provide a model for multidisciplinary approach to the formulation and implementation of policy in the recovery phase of the nuclear accident through our experience.