We would like to offer silent prayer in sorrow for the victims of the disaster.
Japan deeply appreciates for the assistance offered from 156 countries and regions and 41 international organizations.

Rescue teams were sent from 28 countries, regions and international organizations.

(As of May 9th, 2011)
Fukushima Nuclear Power Plant Accident and Comprehensive Health Risk Management

To aid a recovery on behalf of the Fukushima Medical University group

Shunichi Yamashita, MD, PhD, Nagasaki University
Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University
Human Health Effects of Radiation Exposure

Somatic effects

Acute effects
- ARS*
  - BM injury
  - GIT injury
  - Cardiovascular injury
- Erythema
- Epilation
- Sterility

Late effects
- Cataract
- Cancer
- Leukemia
- Genetic disease

Genetic effects

Deterministic effects

Stochastic effects

* acute radiation syndrome
Radiation Dose Response (Stochastic effects)

Background

- Limitation of low-dose epidemiological studies related to Atomic bomb survivors data and even from Chernobyl because of various type of heterogeneity in population and non-specificity of radiogenic cancer
- Limitation of science for contribution to risk assessment for the uncertainty because of no direct evidence of radiation-induced cancers
Radiation epidemiology

Radiation exposure of the thyroid at young age is the most clearly defined environmental factor associated with thyroid cancer.

**External radiation exposure**
- A-bomb survivors
- Marshall Islanders (fall-out)
- Children exposed to EBT

\[
\text{ERR/Gy} \approx 7.7 \ [1.1 – 32]
\]

**Internal radiation exposure**
- Therapeutic radioiodine
- Hanford (fall-out)
- Chernobyl

\[
\text{OR at 1 Gy} \approx 5.5 – 8.4 \ [\text{ERR/Gy} \ 1.9 – 19]
\]

E.Ron 2002

---

V.Ivanov 2010
Lesson Learned from Chernobyl to Fukushima

- Information Blockade during the Cold War
- Man-made Disaster
- Not well done for *public protection against short-lived radioactive iodines and internal exposure subsequently by radioactive cesiums*
- Breakdown of the USSR
- Psycho-social and Mental Consequences
Difference between Chernobyl and Fukushima

Similarity between Chernobyl and Fukushima; psycho-social and mental impact
Estimated average thyroid doses to children and adolescents around Chernobyl

UNSCEAR 2008 Report Annex D
Increase of Childhood Thyroid Cancers in Belarus

Cases per 100,000

(Demidchik Yu, Saenko V, Yamashita S. ABEM 2007 51:748-62)
# Frequency of Childhood Thyroid Cancer in the Gomel region of Belarus (1998-2000)

<table>
<thead>
<tr>
<th>Date of Birth</th>
<th>Number of thyroid cancers/number of children screened</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Jan 1983 ~ 26 Apr 1986</td>
<td>31 / 9720</td>
</tr>
<tr>
<td>27 Apr 1986 ~ 31 Dec 1986</td>
<td>1 / 2409</td>
</tr>
<tr>
<td>1 Jan 1987 ~ 31 Dec 1989</td>
<td>0 / 9472</td>
</tr>
</tbody>
</table>

No evidence of Cs-137-induced solid cancer risks including thyroid cancers

Risk of Childhood Thyroid Cancer around Chernobyl

276 cases of childhood Thyroid cancer
1300 cases of controls

Age at the time of Accident, less than 15 year-old

Thyroid dose in the children between Chernobyl and Fukushima

**Chernobyl**

- Number of cases: 1576 cases
- Mean Thyroid Effective Dose: 490 mSv
- Maximum: 35 mSv but almost all less than 1 mSv

**Fukushima**

- Number of cases: 1080 cases
- Thyroid Effective Dose: 3/24-30NaI direct measurement
- Maximum: 35 mSv but almost all less than 1 mSv
Effect of iodine deficiency and of stable iodine consumption

Table 4. Estimated risk of developing thyroid cancer after a radiation dose of 1 Gy, by level of soil iodine in the settlement of residence at the time of the accident and by potassium iodide (i.e., antistrumin) consumption status (analyses restricted to subjects with radiation doses to the thyroid of less than 2 Gy)*

<table>
<thead>
<tr>
<th>Consumption of potassium iodide</th>
<th>Highest two tertiles of soil iodine</th>
<th>Lowest tertile of soil iodine</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>3.5 (1.8 to 7.0)</td>
<td>10.8 (5.6 to 20.8)</td>
</tr>
<tr>
<td>Yes</td>
<td>1.1 (0.3 to 3.6)</td>
<td>3.3 (1.0 to 10.6)</td>
</tr>
</tbody>
</table>

*Levels of iodine in soil in settlement of residence at time of accident were divided into tertiles. OR = odds ratio at 1 Gy compared with no exposure; CI = confidence interval.
Incidence of thyroid cancer in residents of radiocontaminated territories

Belarus

Ukraine

Russia

Three countries
Major radiation epidemiology conclusions

Dose-response relationship (up to 2 Gy)

- Young age at exposure is a risk factor (0-5 y.o.)
- Latency may be short (4-5 years)
- Iodine deficiency increases risk (~3-fold)
- No significant risk for thyroid cancer for radiation doses below 100 mSv
- No increase in cancer incidence in the population with accumulated doses <100 mSv during 25 years
- No increase in cancer incidence in emergency workers with doses <150 mSv

OR at 1 Gy~5.5 – 8.4 [ERR/Gy 1.9 – 19]

Chernobyl (0-17 y.o.)

V.Ivanov 2010
Characteristics of Chernobyl Thyroid Cancers

- the best possible diagnostic service
- specimens of thyroid cancer are properly described and sampled
- archive of data generated from research studies carried out

Funding: EU, NCI (USA), SMHF (Japan)

http://www.chernobyltissuebank.com
Pathological and clinical characteristics of Chernobyl PTC

Pathology: 2478 PTC cases from Ukraine

<table>
<thead>
<tr>
<th>Component</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pap</td>
<td>30%</td>
</tr>
<tr>
<td>Fol</td>
<td>18%</td>
</tr>
<tr>
<td>Sol</td>
<td>8%</td>
</tr>
<tr>
<td>Mix</td>
<td>42%</td>
</tr>
<tr>
<td>DSV</td>
<td>1%</td>
</tr>
<tr>
<td>Other</td>
<td>1%</td>
</tr>
</tbody>
</table>

Time-related trends

- Prevalence of less differentiated structures (solid component) decreases
- Pathological aggressiveness (extrathyroidal extension, vascular invasion and nodal disease) declines
- Proportion of encapsulated and small tumors increases

Age-related trend

Pathologically, the aggressiveness declines in the row children > adolescents > adults

Radiation-induced PTC may be pathologically more aggressive than sporadic PTC in age-matched groups

Clinics: risk for recurrence

497 PTC cases from Russia (172 Rad + 325 Spor, matched)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Comparison</th>
<th>P</th>
<th>HR</th>
<th>Wald’s CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation exposure</td>
<td>yes vs no</td>
<td>0.104</td>
<td>0.54</td>
<td>0.26–1.13</td>
</tr>
<tr>
<td>Tumor size &gt;10 mm</td>
<td>yes vs no</td>
<td>0.472</td>
<td>1.47</td>
<td>0.51–4.20</td>
</tr>
<tr>
<td>pN</td>
<td>Na+Nb vs N0</td>
<td>0.0053</td>
<td>5.21</td>
<td>1.63–16.7</td>
</tr>
<tr>
<td>Tumor capsule</td>
<td>yes vs no</td>
<td>0.0003</td>
<td>0.17</td>
<td>0.06–0.45</td>
</tr>
<tr>
<td>Treatment according to the Guidelines</td>
<td>yes vs no</td>
<td>0.0002</td>
<td>0.16</td>
<td>0.06–0.42</td>
</tr>
</tbody>
</table>

HR=0.702 [0.465-1.090], $P=0.118$ (Logrank test)

- No etiology-specific risk factors for recurrence
- Chance of recurrence is comparable in RAD and SPOR PTC

Radiation-induced thyroid cancer is suggested to be treated and followed in the same way as sporadic thyroid cancer

Courtesy T.Bogdanova

Rumyantsev et al., 2011
Molecular characteristics of PTC

MAP kinase pathway activation in PTC

From A. Chiloeches, R. Marais
Evolution of mutational events in time

**Chernobyl**

- **RET/PTC3**
- **RET/PTC1**
- **BRAF, RAS**

**Japanese Hibakusha**

- **Williams 2008**
- **Nakachi 2006**

**Major oncogenic events in PTC**

<table>
<thead>
<tr>
<th>Alteration</th>
<th>Chernobyl PTC</th>
<th>Sporadic PTC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RET/PTC</strong></td>
<td>50-86%</td>
<td>13-43%</td>
</tr>
<tr>
<td><strong>NTRK1</strong></td>
<td>3%</td>
<td>5-13%</td>
</tr>
<tr>
<td><strong>AKAP9/BRAF</strong></td>
<td>11%</td>
<td>1%</td>
</tr>
<tr>
<td><strong>BRAFT1799A</strong></td>
<td>0-16%</td>
<td>29-69%</td>
</tr>
<tr>
<td><strong>RAS family</strong></td>
<td>0-10%</td>
<td>0-21%</td>
</tr>
</tbody>
</table>

**Morphology**

- Sol, Sol-Fol
- Classic
- Classic, Encaps

**Clinical course**

- Aggressive↑
- Typical
- Aggressive↓

**Latency, years**

- 4 - 10
- 7 - 17
- 15 - …
Molecular Epidemiological Studies on Chernobyl Thyroid Cancers

Map from UNSCEAR 2008 Report Annex D

- 448 controls from the previous study
- 620 controls from the previous study
- Cases, approx 30 persons
- Controls, approx 30 persons

District average thyroid doses (Gy):
- <0.01
- 0.01-0.03
- 0.03-0.15
- 0.15-0.65
- >0.65

State border
Oblast border
Oblast centre
**Result: pooled analysis**

**FOXE1** locus at 9q22.33 is confirmed as the strongest

NO association with 2q35 (*DIRC3*) and 14q13.3 (*NKX2-1* or MBIP)

Weak association with *NRG1* at 8p12

All SNPs associating with radiation-induced PTC also associate with sporadic PTC
## Final analysis

Cases: 953(Bel) + 145(Ukr) = **1098 (1057 after QC)**

Controls: 1084(Bel) + 157(Ukr) + 448(Rus) + 620(Pol) = **2309 (2287 after QC)**

<table>
<thead>
<tr>
<th>rs#</th>
<th>Chr</th>
<th>Gene</th>
<th>GWAS Ctr</th>
<th>Validation Ctr</th>
<th>Meta</th>
<th>OR (95% CI)</th>
<th>OR published</th>
<th>Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>rs965513</td>
<td>9q22.33</td>
<td>FOXE1 upstream</td>
<td>1.13E-16</td>
<td>3.62E-04</td>
<td>5.80E-19</td>
<td>1.69 (1.51-1.90)</td>
<td>1.75 / 1.69</td>
<td>Sp &amp; Rad</td>
</tr>
<tr>
<td>rs1867277</td>
<td>9q22.33</td>
<td>FOXE1 5'UTR</td>
<td>7.50E-03</td>
<td>3.75E-04</td>
<td>1.38E-05</td>
<td>1.52 (1.26-1.83)</td>
<td>1.49</td>
<td>Sp &amp; Rad</td>
</tr>
<tr>
<td>rs944289</td>
<td>14q13.3</td>
<td>NKX2-1 or MBIP</td>
<td>0.0208</td>
<td>0.093</td>
<td>4.50E-03</td>
<td>1.17 (1.05-1.30)</td>
<td>1.37</td>
<td>Sp</td>
</tr>
<tr>
<td>rs1169909374</td>
<td>14q13.3</td>
<td>MBIP</td>
<td>0.0438</td>
<td>0.0756</td>
<td>0.0169</td>
<td>2.19 (1.15-4.16)</td>
<td>2.09</td>
<td>Sp</td>
</tr>
<tr>
<td>rs2439302</td>
<td>8p12</td>
<td>NRG1</td>
<td>8.85E-04</td>
<td>0.0182</td>
<td>9.11E-05</td>
<td>1.35 (1.16-1.57)</td>
<td>1.36</td>
<td>Sp &amp; Rad</td>
</tr>
<tr>
<td>rs966423</td>
<td>2q35</td>
<td>DIRC3</td>
<td>0.235</td>
<td>0.316</td>
<td>0.125</td>
<td>1.9 (0.98-1.21)</td>
<td>1.34</td>
<td>Sp</td>
</tr>
</tbody>
</table>

### Candidates in Chernobyl PTC

<table>
<thead>
<tr>
<th>rs#</th>
<th>Chr</th>
<th>Gene</th>
<th>GWAS Ctr</th>
<th>Validation Ctr</th>
<th>Meta</th>
<th>OR (95% CI)</th>
<th>OR published</th>
<th>Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>rs6920544</td>
<td>6q21</td>
<td>LOC442245</td>
<td>4.71E-07</td>
<td>0.645</td>
<td>6.03E-06</td>
<td></td>
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<tr>
<td>rs4697477</td>
<td>4p15.2</td>
<td>ATP5LP3</td>
<td>1.19E-05</td>
<td>0.417</td>
<td>5.03E-05</td>
<td></td>
<td></td>
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<tr>
<td>rs10455038</td>
<td>5q23.2</td>
<td>PPIC</td>
<td>2.57E-06</td>
<td>0.0703</td>
<td>1.55E-03</td>
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<td></td>
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<tr>
<td>rs7666030</td>
<td>4p15.3-p15.1</td>
<td>SOD3</td>
<td>1.13E-04</td>
<td>0.618</td>
<td>7.59E-04</td>
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<tr>
<td>rs3014966</td>
<td>13q14.13</td>
<td>COG3</td>
<td>5.33E-06</td>
<td>0.190</td>
<td>8.67E-04</td>
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<tr>
<td>rs11197463</td>
<td>10q26</td>
<td>ATRNL1</td>
<td>1.60E-04</td>
<td>0.371</td>
<td>4.97E-03</td>
<td></td>
<td></td>
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<tr>
<td>rs7199669</td>
<td>16p13.12</td>
<td>ERCC4</td>
<td>4.42E-05</td>
<td>0.505</td>
<td>1.31E-04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rs7861296</td>
<td>9p21.2</td>
<td>LRRN6C</td>
<td>7.40E-07</td>
<td>0.716</td>
<td>1.01E-05</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>rs7241128</td>
<td>18q11.2</td>
<td>LOC390843</td>
<td>2.15E-05</td>
<td>0.944</td>
<td>1.90E-04</td>
<td></td>
<td></td>
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<tr>
<td>rs2691546</td>
<td>7q21</td>
<td>MAGI2</td>
<td>4.59E-05</td>
<td>0.624</td>
<td>1.21E-03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rs2691542</td>
<td>7q21</td>
<td>MAGI2</td>
<td>1.08E-05</td>
<td>0.710</td>
<td>9.41E-05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The **FOXE1** locus is a major genetic determinant for radiation-related thyroid carcinoma in Chernobyl

Meiko Takahashi¹,²,†, Vladimir A. Saenko³,†, Tatiana I. Rogounovitch⁴, Takahisa Kawaguchi¹,², Valentina M. Drozd⁵, Hisako Takigawa-Imamura¹, Natallia M. Akulevich⁴, Chanavee Ratanajaraya¹, Norisato Mitsutake⁴, Noboru Takamura⁴, Larisa I. Danilova⁶, Maxim L. Lushchik⁵, Yuri E. Demidchik⁷, Simon Heath⁸, Ryo Yamada¹, Mark Lathrop⁸,⁹, Fumihiko Matsuda¹,²,* and Shunichi Yamashita³,⁴

¹Center for Genomic Medicine and ²Institut National de la Santé et de la Recherche Médicale (INSERM) Unit U852, Kyoto University Graduate School of Medicine, Kyoto 606-8501, Japan, ³Department of International Health and Radiation Research and ⁴Department of Molecular Medicine, Atomic Bomb Disease Institute, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki 852-8523, Japan, ⁵Department of Thyroid Disease Research, ⁶Department of Endocrinology and ⁷Belarusian Medical Academy for Postgraduate Education, Minsk 220013, Republic of Belarus, ⁸Centre National de Génotypage, Institut Génomique, Commissariat à l’Énergie Atomique, Evry 91000, France and ⁹Fondation Jean Dausset-CEPH, Paris 75010, France

Received January 18, 2010; Revised and Accepted March 17, 2010
# FOXE1 and NKX2-1 loci with sporadic and Chernobyl thyroid cancer

<table>
<thead>
<tr>
<th>Findings</th>
<th>FOXE1 (9q22.33)</th>
<th>NKX2-1 (14q13.3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Study: Gudmundsson 2009, Nat Genet; European decent</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAF Cases/Controls</td>
<td>0.490 / 0.352</td>
<td>0.650 / 0.558</td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td>1.75 (1.59, 1.94)</td>
<td>1.37 (1.24, 1.52)</td>
</tr>
<tr>
<td>$P$-value</td>
<td>$1.7 \times 10^{-27}$</td>
<td>$2.0 \times 10^{-9}$</td>
</tr>
<tr>
<td><strong>Our Study: Matsuse 2011, J Med Genet; Japanese</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAF Cases/Controls</td>
<td>0.090 / 0.057</td>
<td>0.466 / 0.411</td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td>1.69 (1.29, 2.21)</td>
<td>1.21 (1.04, 1.39)</td>
</tr>
<tr>
<td>$P$-value</td>
<td>$1.3 \times 10^{-4}$</td>
<td>0.012</td>
</tr>
<tr>
<td><strong>Our study: Takahashi 2010, Hum Mol Genet; Chernobyl</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAF Cases/Controls</td>
<td>0.474 / 0.357</td>
<td>0.616 / 0.583</td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td>1.65 (1.43, 1.91)</td>
<td>1.13 (0.95, 1.36)</td>
</tr>
<tr>
<td>$P$-value</td>
<td>$4.8 \times 10^{-12}$</td>
<td>0.17</td>
</tr>
</tbody>
</table>
“Great East Japan Earthquake”
Triple Disasters in Fukushima

1,301 deaths were disaster-related deaths.

1,599 died and 211 are still lost due to Earthquake and/or Tsunami.

Earthquake

Tsunami

Nuclear Power Plant Accident

Fukushima City

Minami-soma City

Fukushima Dai-ichi Nuclear Power Plant
Fukushima Daiichi-Nuclear Power Plant

- All operating units when earthquake occurred were automatically shut down safely.
- Emergency D/Gs have worked properly until the tsunami attack.

1. Loss of offsite power due to the earthquake
2. D/G Inoperable due to Tsunami flood

① + ② ⇒ Station Black Out

All Motor Operated pumps (including ECCS pumps) became inoperable.

(Source: NISA)
Evacuations and Sheltering at the Initial Period Successfully handled by the Government

1) Instructions of Evacuation, etc. Issued by the Director General of the Nuclear Emergency Response Headquarters Regarding Fukushima Dai-ichi Nuclear Power Station

March 11  [21:23]
Instruction of evacuation to the residents living within a radius of 3 km from the NPS was issued.
Instruction of stay in-house to the residents living within a radius of 3 to 10 km from the NPS was issued.

March 12  [05:44]
Instruction of evacuation to the residents living within a radius of 10 km from the NPS was issued.
[18:25]
Instruction of evacuation to the residents living within a radius of 20 km from the NPS was issued.

March 15  [11:00]
Instruction of stay in-house to the residents living within a radius of 20 to 30 km from the NPS was issued.
Radioactive Materials on the Ground
Radioactivity expressed as $\mu$Sv/hour at 1 m from the ground
Airborne monitoring on April 29th    Monitoring points in Fukushima in April
After the great earthquake and tsunami in eastern Japan, the NPP(Fukushima-Daiichi) was severely damaged and a significant amount of radioactive material was released to the environment. (*Industrial Crisis and Environmental Damage*)

In order to limit and reduce the exposures, countermeasures including evacuation from surrounding area, sheltering, restrictions on consumption of water and certain food products were taken by the government in an appropriate manner.

With regard to the workers, operational staff and emergency response personnel were exposed to certain levels of radiation in managing the emergency situation.

Since there has been much concern about the levels of exposure and effects both on general public and workers, we are prepared to collect and offer further information to the world.
• Public concerns about the long-term health effects of radioactive contamination have increased considerably since March 11, 2011, sparking anger, anxiety and distrust towards the government’s handling of the crisis and fueling support for renewable energy alternatives.

• Bans on food shipments from contaminated areas due to anxieties about food safety are ruining farmers’ livelihoods and raise concerns about their ability to resume their livelihoods.

• The role of experts and academic societies are important but reliability/creditability has been lost by confusion and misunderstanding partly due to an inappropriate and immature media literacy.
Fukushima Medical University

- Clinical divisions: 31
- Central clinical facilities: 14
- Hospital beds: 778

Number of patients per day:
- In-patients: 623
- Out-patients: 1,553

Number of hospital staff: 1,661
- Doctors: 498
- Nurses: 743
- Technicians: 198
- Officers, etc.: 222
Earthquake and Tsunami Victims

180 medical professionals of 35 DMAT team + FMU doctors, interns, nurses, technicians and students

168 cases of triage (93 Green, 44 Yellow, 30 Red, and 1 Black) over 3 days and more than 500 evacuees accepted and triaged.
Larage-scale patient transfer and screening of radiation exposure

175 patients were temporary accepted (of which 125 were hospitalized) ca. 500 people were screened, of which 10 were decontaminated
Results of the Airborne Monitoring Survey by MEXT as of November 1, 2011
(Total accumulation of Cs-134 and Cs-137 on the ground surface)

Fukushima Dai-ichi NPP

Bq/m²
3,000K<
1,000-3,000K
600-1,000K
300-600K
100-300K
60-100K
30-60K

(Source: MEXT)
Results of the Airborne Monitoring Survey by MEXT as of February 1, 2012
(Total accumulation of Cs-134 and Cs-137 on the ground surface)

(Source: MEXT)
Preliminary report on dose estimation by WHO, May 2012

IN THE ZONE

Most residents and nuclear workers in the Fukushima region received modest radiation doses from the power-plant meltdown, and in April the Japanese government lifted some restrictions on citizens’ access to their homes. But residents of Iitate and Namie may have received higher doses.

10–50 mSv
Estimated effective dose to evacuees after one year

FUKUSHIMA PLANT–WORKER DOSES

- 10 workers who received:
  - <10 mSv
  - 10–20 mSv (= a single full-body CT scan)
  - 20–50 mSv (= annual exposure limit for nuclear workers)
  - 50–100 mSv
  - 100–150 mSv (= slight increase in cancer risk)
  - 150–200 mSv
  - 200–250 mSv (= maximum allowed dose for emergency workers)
  - >250 mSv

mSv = milliSievert
Evacuation Status of Residents in Fukushima

Number of evacuees from designated evacuation areas:

- Restricted Area: about 77,000
- Deliberate Evacuation Area: about 10,000
- Evacuation-Prepared Area: about 26,000

Total: about 113,000

(Source: Cabinet Office, Feb 2012)
# Countermeasures on different targets

<table>
<thead>
<tr>
<th>Object</th>
<th>Situation</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant workers</td>
<td>High risk in radiation exposure &amp; contamination, accident</td>
<td>Radiation Emergency Medicine</td>
</tr>
<tr>
<td>Emergency responder</td>
<td>High risk in radiation exposure &amp; contamination</td>
<td>Consultation clinic for mental, physical, radiation</td>
</tr>
<tr>
<td>Residents</td>
<td>Chronic low dose exposure, stress/fear for risks</td>
<td>education/communication/information</td>
</tr>
</tbody>
</table>
Fukushima Disaster causes

• Uncertain health effects; acute and chronic?
• Psychological and metal effects; anxieties, anger, sleep disturbance, post-traumatic stress diseases
• Environmental effects; soil and food contamination continued
• Social and economical effects; decontamination, compensation, safeguard
There are uncertainties about the risks of chronic low-dose radiation exposure for human health but *no alternative than to take responsibility to monitor health condition* of local residents in Fukushima and to *promote their health* based on the common concept of early diagnosis and treatment for any radiation-related disease exists.

This is an unprecedented health management program for a 2 million population for almost whole lifespan.
The design of the health management is divided into two categories: a basic survey medical sheet for all the residents and further examination of target populations.
Basic survey
Subjects: 2.02 million people living in Fukushima
Method: self-administered Questionnaire

Health management file
(provisional name)
☆ Results of health surveys and examinations recorded and retained by individuals
☆ Increase awareness of radiation

Creation of a database
◆ Utilized for long-term healthcare and medical treatment of Fukushima prefecture residents
◆ Knowledge acquired in providing healthcare will be used for future generations

Thyroid ultrasound examination
Subjects: 360,000 children aged 18 years or younger as of March 11, 2011

Comprehensive medical checkups
Subjects: Residents residing in evacuation areas, etc
Details: General medical checkup items as well as differential white blood count, etc.
Subjects: Residents not residing in evacuation areas
Details: General medical checkup items
Having workplace medical checkups, municipal medical checkups and/or cancer screening helps ensure early detection and early treatment of diseases.
Conducting of medical checkups for Fukushima prefecture

Mental health and lifestyle survey
Survey on pregnant women and nursing mothers

Consultation and support
Follow-up
Treatment
Objectives:

• To monitor long-term health condition of resident in Fukushima and to promote their health
• To investigate whether a long-term low-dose radiation exposure has an effect on their health

Contents:

1. Basic survey (subjects: 2 million all resident in Fukushima)
2. Detailed survey
   • Thyroid examination by ultrasonography (360,000; 0-18 y/o)
   • Comprehensive medical checkups (210,000 ; Evacuees)
   • Mental health and lifestyle survey (210,000 ; Evacuees)
   • Survey on pregnant women and nursing mothers (16,000)
Basic Survey

• Estimated External Dose from 12 Mar to 11 July 2011
• Annual estimation dose = (a) first 4 M + (b) remained 8 M

Air dose rate in Fukushima city
(from Mar 2011 to Mar 2012)
Basic Survey
Estimation of individual radiation dose as baseline data for the long-term health

Fukushima Health Management Survey

Survey Questionnaire (Record of movements)

<table>
<thead>
<tr>
<th>Place / Facility</th>
<th>March 11 (Fri)</th>
<th>March 12 (Sat)</th>
<th>March 13 (Sun)</th>
<th>March 14 (Mon)</th>
<th>March 15 (Tue)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Place of employment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evacuation center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>District community center car park</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evacuation center (city gymnasium) (C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Temporary returned home (Caring for pets, etc.)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Place of employment (company, ltd.) 60, cecho, oo City</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City, oo Prefecture</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Study period: 11 March 2011 – 11 July 2011 (four months)

Target population:
- Residents of Fukushima officially registered between 11 March and 11 July 2011
- Residents of other prefectures who stayed, worked or studied in Fukushima between 11 March and 11 July 2011 (upon request)
- Visitors to Fukushima between 11 and 25 March 2011 (upon request)

Target area:
Preceding Survey: Yamakiya; Namie; and Iitate (29,000 people)
Full-scale Survey: Rest of Fukushima

Individual external exposure was estimated using the for external exposure dose assessment developed by the National Institute of Radiological Sciences.
How to analyze radiation dose

To establish database for long-term health management

Questionnaire

Movement & behavior

Time-course of air dose map

Estimation dose calculating combined above two information by NIRS

To help understanding of individual first 4M dose

To help understanding of radiation-related health risk

To establish database for long-term health management
Distribution of External Exposure Dose (mSv) (Cumulative effective dose from March 11 to July 11)

- 14,412 persons (Kawamata, Namie, Iitate Districts) (http://wwwcms.pref.fukushima.jp/)

![Graph showing distribution of external exposure dose (mSv)](http://wwwcms.pref.fukushima.jp/)
Distribution of External Exposure Dose (mSv)
(Estimated Cumulative effective dose from March 11 to July 11)

- Number of responses; 386,572
  - < 1mSv 66.3%
  - < 2mSv 95.0%
  - < 5mSv 99.8%
- Maximum 25mSv

(data released at 21 Feb 2013)

Estimated from location and time course on questionnaire
FIG. 4. Excess relative risk (ERR) for all solid cancer in relation to radiation exposure. The black circles represent ERR and 95% CI for the dose categories, together with trend estimates based on linear (L) with 95% CI (dotted lines) and linear-quadratic (LQ) models using the full dose range, and LQ model for the data restricted to dose <2 Gy.
The Fukushima Health Survey (2)

• Secondarily, further examination has been introduced for each different target population.

• The most important targets are children and pregnant women at the time of accident. The risk of radioactive iodines on the thyroid will be examined in all the children (age less than 18 years old, about 360,000 in population) by sophisticated thyroid ultrasound screening periodically. The bio-samples together with medical records will be collected after the informed consent.
Flow Chart of Thyroid Ultrasound Examination

First Screening (Portable US machine)

Nodule

Yes

Precise US examination, Blood and Urine analysis

FNAB

Malignant

Surgical Treatment

Explanation Examination

Benign

Follow-up (2,5)

Follow-up

Secondary Screening

Criteri a
Childhood Cyst and Nodule

Solid finding within cyst judged as a nodule

Colloid cyst less than 5 mm
Commonly seen as multiple cysts
Residual or Ectopic Thymus suspected
Colloid Cyst
(Cyst with Colloid Clot)

Comet Tail Sign
Colloid Cyst
(Cyst with Colloid Clot)
Case of 3-year-old girl
Childhood Thyroid Cancer and Thymus
# Results of Detailed Thyroid Survey by Ultrasonography Screening until the middle of January 2013

<table>
<thead>
<tr>
<th>Judgment</th>
<th>Interpretation</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A subtotal</strong></td>
<td>Within normal range</td>
<td>132,354</td>
<td>99.5%</td>
</tr>
<tr>
<td><strong>A (A1)</strong></td>
<td>No specific finding</td>
<td>77,497</td>
<td>58.3%</td>
</tr>
<tr>
<td><strong>A (A2)</strong></td>
<td>Nodule with ≤5.0mm or/and Cyst with ≤20.1mm</td>
<td>54,857</td>
<td>41.2%</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>Nodule with ≥5.0mm or/and Cyst with ≥20.1mm</td>
<td>734</td>
<td>0.5%</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>Needed further examination</td>
<td>1</td>
<td>0.001%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>133,089</td>
<td>100%</td>
</tr>
</tbody>
</table>

(Data are available at [http://wwwcms.pref.fukushima.jp/](http://wwwcms.pref.fukushima.jp/))
# Results of First Screening of Preliminary Survey (1st Survey) from October 9, 2011 to the End of March 2012

<table>
<thead>
<tr>
<th>Judgment</th>
<th>Interpretation</th>
<th>N</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A subtotal</strong></td>
<td></td>
<td>37,928</td>
<td>99.5%</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>(A1) No nodule and/or Cyst</td>
<td>24,468</td>
<td>64.2%</td>
</tr>
<tr>
<td></td>
<td>(A2) Nodule with ≤5.0mm and/or Cyst with ≤20.0mm</td>
<td>13,460</td>
<td>35.3%</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>Nodule with ≥5.1mm and/or Cyst with ≥20.1mm</td>
<td>186</td>
<td>0.5%</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td>Requires immediate examination</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>38,114*</td>
<td></td>
</tr>
</tbody>
</table>

(Data available at [http://wwwcms.pref.fukushima.jp/](http://wwwcms.pref.fukushima.jp/))

* Participation rate : 80%
Secondary Examination (Confirmatory Examination) started from March 2012

<table>
<thead>
<tr>
<th></th>
<th>No. of persons scheduled Secondary Examination (a)</th>
<th>No. of persons Performed Secondary Examination (b)</th>
<th>Implementation rate of Secondary Examination (%) (b/a)</th>
<th>No. of Re-examination</th>
<th>No. of Secondary Examination result decision</th>
<th>Total No. of Second Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Down staging ※1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td>1st Preliminary Survey</td>
<td>186</td>
<td>162</td>
<td>87.1</td>
<td>11</td>
<td>151</td>
<td>11</td>
</tr>
<tr>
<td>2nd Preliminary Survey</td>
<td>549</td>
<td>56</td>
<td>10.2</td>
<td>20</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>735</td>
<td>218</td>
<td>29.7</td>
<td>31</td>
<td>187</td>
<td>11</td>
</tr>
</tbody>
</table>

※1 The cases recommended a next full scale survey starting April 2014 as they were re-judged by A1 and A2 to be without abnormal findings.
※2 The cases are going to shift to the usual medical examination and be re-consulted in six months or one year.

Of the 76 cases in which FNAC was performed in 1st Preliminary Survey, 10 cases were diagnosed as malignant or suspected for malignancy, and thyroid cancer was already confirmed in 3 of the 10 cases after thyroid surgery.
Incidence of Thyroid Cancer in Japan
–Estimated incidence rate stratified by age per 100,000–

Screening effects?

Fukushima now
10/38000
from 2011-March 2012

(Death 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.1 0.1 0.1 0.3 0.8 1.1 2.0 2.8 4.8 7.7 12.2)

(National Cancer Center in JAPAN)
Sensational News by Media

• Over a third of Fukushima children at risk of developing cancer (June 2012)

• Fukushima kids have skyrocketing number of thyroid abnormalities (February 2013)

Sophisticated mass screening activities in Fukushima has lead to an increase in the incidence of thyroid nodules/cysts, and cancer due to earlier detection of non-symptomatic cases. It is therefore not be possible to compare the future observed thyroid cancer incidence with the figures of any previous report, as the baseline risk changes due to the screening activities.
The 2011 Comprehensive Health Check clarified the general health conditions of evacuees from the government-designated evacuation zone after the Great East Japan Disaster. Obesity and hyperlipidemia exist even at young ages and increase in both male and female adults. Liver dysfunction and hyperuricemia increase at relatively young ages in male. Furthermore, hypertension, glucose dysmetabolism, and renal dysfunction increase in adulthood and are most common at older ages.

We compared the comprehensive health check results after the disaster with the results of health examinations performed before the disaster in children and adults. The results suggested that the rates of obesity, glucose metabolic dysfunction, hyperlipidemia, and liver dysfunction after the disaster were high, at least in part, compared with those before the disaster. Regarding the factors that contributed to these results, changes of lifestyle, diet, exercise, and other personal habits caused by forced evacuation are suggested, although there were interfering factors such as the difference of health check period, age distribution, region distribution and participation rate.

Based on the results of the health check carried out in 2011, we are continuing the comprehensive health check long term and maintaining the system to prevent various diseases, including life-style related disease of participants.
In children

• The most remarkable issues are physical symptoms, influences at school performance, irritation, anxiety & depression, and sensitivity to earthquakes & radiation taken from the category of “Reactions amongst Children due to 3.11 Disaster”.

In adults

• The most remarkable issues are sleep issues, physical problems, depression, fear of future, and agitation, discount of evacuation life, taken from the category of “Reaction to Self from the 3.11 Disaster”.
• **There are neither any increase of miscarriage nor artificial abortion** owing to the extensive efforts of the Japanese Medical Association, especially Obstetricians and Gynecologists.

• Furthermore by the Japan Association of Obstetricians and Gynecologists (JAOG), the congenital malformations were evaluated in babies delivered in Fukushima prefecture.

• There is **no obvious increased prevalence rate of congenital malformations** at the present time compared with the rate of Birth Defects Monitoring of JAOG. However, it is necessary to gather more cases to draw a conclusion.
What's New

News

- 25-27 Feb 2013  International Academic Conference on Radiation Health Risk Management in Fukushima will be livestreamed via USTREAM
- 23 Jan 2013  IARC/FMU Letter of Collaboration was signed.
- 15 Dec 2012  NCKU-FMU Bilateral University Conference successfully concluded.
- 15 Dec 2012  Fukushima/IAEA MOC was ratified.
- 17-18 Nov 2012  Dr. Emilie van Deventer of WHO and Dr. Joao B. Reis of IARC visited FMU.
- 02 Nov 2012  ICRP-FMU Joint Seminar successfully concluded.
- 04 Oct 2012  Dr. Zhanat Carr of WHO visited FMU.
- 13 Sep 2012  Delegation from Sweden visited FMU.
- 30 Aug 2012  Ministry of Environment Expert Discussion Session FMU.
- 31 July 2012  Thyroid specialists from Russia and Belarus visited FMU.

http://fukushima-mimamori.jp/
ISSUES to be newly discussed and changed after FUKUSHIMA

**Issue 1:** Emergency Planning Zones and Protective Action and Guidelines

**Issue 2:** Potassium Iodine (KI) Policy

**Issue 3:** Communications and Public Health Education (Countermeasures against radiophobia)

**Issue 4:** Reentry and Recovery Policy

In order to improve Global Radiation Protection Culture, Fukushima is now responsible as a focal point and world-leader to work together with NCRP and international related organizations and research/education universities/institutes; radiation risk analysis, risk communication, risk management, health care, risk education/training............
International Academic Conference on Radiation Health Risk Management in Fukushima

Organized by Fukushima Medical University with the cooperation of Fukushima Prefecture and the Subcommittee of Clinical Medicine: "Radiation Protection and Risk Management", Science Council of Japan

Scope of the conference: Radiation health risk related to the Fukushima accident will be discussed by the international experts.

Date: 25 (Mon) – 27 (Wed) February 2013

Venue: 3F West Building, Fukushima View Hotel

Language: English (no simultaneous translation)

For further information please contact:
Department of International Cooperation, Radiation Medical Science Center for the Fukushima Health Management Survey, Fukushima Medical University
Email: kikenk@mu.ac.jp
Phone: +81-24-573-1501

Day 1, Monday 25 February

<table>
<thead>
<tr>
<th>Time</th>
<th>Session 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:15 – 10:05</td>
<td>Initial Medical Response to the Fukushima Nuclear Accident</td>
</tr>
<tr>
<td></td>
<td>Co-chairs: Kazuhiro Matkawa (University of Tokyo)</td>
</tr>
<tr>
<td></td>
<td>Fred A. Mettler, Jr. (University of New Mexico, USA)</td>
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<tr>
<td></td>
<td>Speakers: Koji Tanigawa (Fukushima University)</td>
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<tr>
<td></td>
<td>Akinori Hasigawa (Fukushima Medical University)</td>
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<tr>
<td>10:05 – 12:35</td>
<td>Current Actions of the Fukushima Health Management Survey</td>
</tr>
<tr>
<td></td>
<td>Co-chairs: Christopher Clement (ICRCP)</td>
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<td></td>
<td>Shunichi Yamauchi (Fukushima Medical University)</td>
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<td></td>
<td>Speakers: Seiji Yasumura (Fukushima Medical University)</td>
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<td>Akira Onitsuru (Fukushima Medical University)</td>
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<td>Shintaro Suzuki (Fukushima Medical University)</td>
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<td>Mitsuaki Hosoya (Fukushima Medical University)</td>
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<td>Katsuya Fujimori (Fukushima Medical University)</td>
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<td></td>
<td>Hironori Naka (Fukushima Medical University)</td>
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<td>13:30 – 15:30</td>
<td>Coordination and Cooperation with Domestic Members (1)</td>
</tr>
<tr>
<td></td>
<td>Co-chairs: André Bouville (US National Cancer Institute, retired)</td>
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<td></td>
<td>Reiko Kanda (National Institute of Radiological Sciences)</td>
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<td>Speakers: Noboru Takamasa (Kagoshima University)</td>
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<td></td>
<td>Makoto Akashi (National Institute of Radiological Sciences)</td>
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<td>Katsuyoshi Kishikawa (Hiroshima University)</td>
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<td>Keitarō Akahane (National Institute of Radiological Sciences)</td>
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<td>Kenji Kamiya (Toho University)</td>
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<td>Kazunori Kodama (Radiation Effects Research Foundation)</td>
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<tr>
<td>15:30 – 15:50</td>
<td>Coffee Break</td>
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<tr>
<td>16:00 – 18:10</td>
<td>Coordination and Cooperation with Domestic Members (2)</td>
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<tr>
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<td>Co-chairs: John D. Bokoe, Jr. (Rensselaer Polytechnic Institute, USA)</td>
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<td>Tsuyoshi Oikawa (Radiation Effects Research Foundation)</td>
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<td>Speakers: Tomohiro Makiyama (Kyoto University)</td>
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<td>Nakashiro Yasuda (University of Fukui)</td>
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<td>Hideaki Kikuchi (Institute of Environmental Sciences)</td>
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<td>Ryuich Shimaizu (Utsunomiya University for Promotion of Science)</td>
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<td></td>
<td>Takayuki Takahashi (Fukushima Medical University)</td>
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<td>Hidaka Hoshi (Hoshi General Hospital Foundation)</td>
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<td></td>
<td>Yasuhito Sasaki (Science Council of Japan)</td>
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