Potential worker and public health impacts from the Fukushima accident

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Topics

• Health impacts from the Chernobyl accident
• Potential health impacts from the Fukushima accident
Chernobyl Nuclear Accident

On April 26, 1986 an accident occurred at the Chernobyl nuclear power plant in northern Ukraine. In addition to 28 near-term deaths due to radiation, the accident resulted in the exposure of 6 million people in Belarus, Russia and Ukraine to fallout from the accident, principally radiocldines.

This exposure has led to substantial epidemiological research, especially among cleanup workers and children. Over the past 25 years, the governments of Ukraine, Belarus and the United States*, and research partners, have been conducting such research.

Explore this site further to read about our radiation epidemiology and dosimetry studies, find out what is known, and learn what we are still studying.

* Radiation Epidemiology Branch, Division of Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Department of Health and Human Services.
NCI leukemia study in clean-up workers, Ukraine

- Nested case-control study (Romanenko, 2008)
  - Incident cases confirmed by an international review
  - Bone marrow doses reconstructed by RADRUE model using retrospective interview data on clean-up work history
  - Significant dose response for leukemia – CLL as well as non-CLL:
    - CLL ERR/Gy = 4.09 (<0, 14.41)
    - Non-CLL ERR/Gy = 2.73 (<0, 13.5)

RADRUE: Realistic Analytical Dose Reconstruction with Uncertainty Estimation)
Thyroid cancer in the public

• Two cohort studies, currently underway in Ukraine and Belarus
  – 25,000 persons exposed to I-131 as a child or adolescent
• Dose estimates based on measured thyroid activity and personal interview data (residence, milk consumption, etc)
• Follow-up by biennial thyroid screening, 1996 - 2007
• Cohort study of in-utero exposures, Ukraine
Thyroid cancer risk

- Significant linear dose response
  - ERR = 1.91
  - The risk is still present at 20 years after the accident (Brenner, 2011)

- A-bomb study
Other health impacts of Chernobyl

• Lens opacities (cataract) in clean-up workers, suggesting risk at low dose (Worgul, 2007)
• Increased levels of depression, anxiety (incl. post-traumatic symptoms) – not conclusively attributable to radiation (WHO Chernobyl Forum, 2006)
• Increased risk of cardiovascular disease in clean-up workers, possibly confounded by other factors
How does Fukushima compare to Chernobyl or other accidents?
Estimates of Iodine-131 released to the environment by nuclear testing and various reactor accidents

<table>
<thead>
<tr>
<th>I-131 (Ci x 10³) Released</th>
<th>I-131 (Bq x 10¹⁵) Released</th>
<th>Site</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>7,500,000</td>
<td>280,000</td>
<td>Marshall Islands</td>
<td>1946-1958</td>
</tr>
<tr>
<td>150,000</td>
<td>5,600</td>
<td>Nevada Test Site</td>
<td>1952-1970</td>
</tr>
<tr>
<td>50,000</td>
<td>1,900</td>
<td>Chernobyl (Ukraine)</td>
<td>1986</td>
</tr>
<tr>
<td>~5,000 **</td>
<td>190</td>
<td>Fukushima NPP (Japan)</td>
<td>2011</td>
</tr>
<tr>
<td>740</td>
<td>27</td>
<td>Hanford Reservation, WA</td>
<td>1944-1972</td>
</tr>
<tr>
<td>60</td>
<td>2.2</td>
<td>Savannah River Site, SC</td>
<td>1955-1990</td>
</tr>
<tr>
<td>8 – 42</td>
<td>0.3 – 1.6</td>
<td>Oak Ridge National Laboratory, TN</td>
<td>1944-1956</td>
</tr>
<tr>
<td>20</td>
<td>0.74</td>
<td>Windscale, UK</td>
<td>1957</td>
</tr>
<tr>
<td>0.015-0.021</td>
<td>0.00055 - 0.0007</td>
<td>Three Mile Island, PA</td>
<td>1979</td>
</tr>
</tbody>
</table>

** approximation based on early reports
Source: ATSDR, NCI, Govt. of Japan and other sources
Comparison of Size of Regions Contaminated with Cs-137 (MBq/m²) at Fukushima and in Chernobyl Region

Note: Map shown at scale for observing detail.
Comparison of Size of Regions Contaminated with Cs-137 (MBq/m²) at Fukushima and in Chernobyl Region

Note: maps shown to same distance scale.
Populations of interest in Fukushima -1

- Emergency workers
  - Number of emergency workers still not clear (to us)
  - Available data suggest low whole-body exposures
  - Reactors highly damaged, continuing exposure will occur from necessary decontamination and repair activities

21 emergency workers with >100 mSv between 3/13 and 5/6, 2011 (IAEA)

<table>
<thead>
<tr>
<th>Dose, mSv</th>
<th>No. workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-150</td>
<td>11</td>
</tr>
<tr>
<td>150-200</td>
<td>8</td>
</tr>
<tr>
<td>200-250</td>
<td>2</td>
</tr>
</tbody>
</table>
Populations of interest in Fukushima - 2

• Public
  – Evacuees, n = 87,200
    • Compulsory, <20 km; n = 42,000; 100% evacuation
    • Voluntary, 20-30 km; n = 43,200; % unknown
    • Planned, >20 mSv/yr; n = 890; % unknown
    • Outside 30 km; n = 970
    • Unclear where to?
  – People residing 30 to 50 km
    • Several hundred thousands (no official evacuation)
Population size and evacuated number

<table>
<thead>
<tr>
<th>Population Evacuated</th>
<th>Population</th>
<th>Evacuated</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;20 km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Futaba</td>
<td>6,900</td>
<td>7,100</td>
</tr>
<tr>
<td>Ookuma</td>
<td>11,500</td>
<td>11,500</td>
</tr>
<tr>
<td>Tomioka</td>
<td>16,000</td>
<td>15,500</td>
</tr>
<tr>
<td>Naraha</td>
<td>7,700</td>
<td>8,000</td>
</tr>
<tr>
<td>20-30 km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Namie</td>
<td>20,900</td>
<td>21,400</td>
</tr>
<tr>
<td>Kawauchi</td>
<td>2,800</td>
<td>350</td>
</tr>
<tr>
<td>Hirono</td>
<td>5,400</td>
<td>5,400</td>
</tr>
<tr>
<td>Minami Soma</td>
<td>70,900</td>
<td>14,300</td>
</tr>
<tr>
<td>Tamura</td>
<td>40,400</td>
<td>1,700</td>
</tr>
<tr>
<td>&gt;20 mSv/yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iitate</td>
<td>6,200</td>
<td>60</td>
</tr>
<tr>
<td>Katsurao</td>
<td>1,500</td>
<td>80</td>
</tr>
<tr>
<td>Kawamata</td>
<td>15,600</td>
<td>740</td>
</tr>
<tr>
<td>&gt;30 km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iwaki</td>
<td>342,200</td>
<td>970</td>
</tr>
</tbody>
</table>

As of May 23, 2011
A Study to be launched in Fukushima

- Cohort of 150,000 residents including evacuees
- 30-year follow-up
- Including periodic health examinations
- At Fukushima Prefectural Medical College
  - Support from RERF, NIRS, Hiroshima U, Nagasaki U
Challenges for the study

• Dosimetry
  – Capture of true exposures due to change in residence, shielding factors (for external) and dietary factors (internal)

• Follow-up
  – Continuing ascertainment of cancer incidence and other disease morbidity
  – Lifestyle and other risk factors

Comment: There is sufficient infrastructure to overcome these challenges
Health concerns elsewhere

- Tokyo
  - Data confirms very minor contamination reached the largest population center
  - Well below concern and suggests no rationale for cancer risk studies