Experiences of radiation emergency medicine

National Institutes for Quantum and Radiological Science and Technology (QST)

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TEPCO Fukushima NPP accident in 2011

- There were no patient highly exposed in this accident.
- QST has provided radiation emergency medicine for injured person with contaminated wounds, heavily contaminated workers, and internally exposed workers.
Radiation emergency medical response system in FUKUSHIMA

- **Primary level**
  - TEPCO Fukushima Daiichi NPP
  - Close to the OFC
  - Only for mass casualty event

- **Secondary level**
  - Fukushima Medical University hosp

- **Tertiary level**
  - National Institute of Radiological Sciences
  - Not functioning due to earthquake and tsunami due to earthquake and tsunami

National Institute for Quantum and Radiological Science and Technology
Sending REMAT to Fukushima

- 2011 March 12 8:10am
  (17 hours after the earthquake)
- First dispatching of REMAT from NIRS to Fukushima by a helicopter of Japan Self Defense Force
Case Report 1
# The number of clinic or hospital visits

Number of people who visited clinics or hospitals from the Fukushima Daiichi from 11 to 31 March, 2011

<table>
<thead>
<tr>
<th>Date</th>
<th>Trauma</th>
<th>Internal disease</th>
<th>Total</th>
<th>Transport destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 11</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>Hospital</td>
</tr>
<tr>
<td>March 12</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>Hospital, Kawauchi Clinic, Clinic in 2F, OFC</td>
</tr>
<tr>
<td>March 13</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>Clinic in 2F</td>
</tr>
<tr>
<td>March 14</td>
<td>11</td>
<td>0</td>
<td>11</td>
<td>OFC, Clinic in 2F, Fukushima Med. Univ. NIRS</td>
</tr>
<tr>
<td>March 23</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>Clinic in 2F</td>
</tr>
<tr>
<td>March 24</td>
<td>3*</td>
<td>0</td>
<td>3</td>
<td>Fukushima Med. Univ. → NIRS</td>
</tr>
</tbody>
</table>

*Two were heavily contaminated and one was not contaminated on body surface.*
Patients of hydrogen explosion

- At 11:01 March 14, 2011
- No.3 reactor building
- 7 workers and 4 Japan Self-Defense Forces (JSDF) personnel were injured (Pieces of concrete hit the JSDF personnel)
  - 7 workers were transported to a clinic in TEPCO Fukushima Daini NPP (2F)
  - The 4 injured JSDF personnel were brought to OFC by track with other member
Protective equipment

- Took stable iodine before the mission in Fukushima Daiichi NPP
- Hydrogen explosion occurred an hour and 20 minutes after taking stable iodine
- Wore protective gear on his camouflaged uniform, and equipped a full face mask
- Personal dosimeter (PD)
Patients of hydrogen explosion

- Arrival of four JSDF personnel at OFC at 11:35
- Soon after arrival they were directed to move to the decontamination facility because the entrance of OFC was closed due to protection from radiation contamination after the explosion
- All of them showed heavy contamination on their protective gear
  - 1 mSv/h at 10 cm

Removing all clothes and taking shower
Status of patients

- Contamination on face and wound were still observed after removal of their protective gear and shower
- Five minutes after removal of protective gear, their personal dosimeter alarmed due to over 20 mSv
- One of injured JSDF personnel had pain on neck and paralysis on arm
- One of the patients had a contaminated wound on the right thigh
- Other two had bruise or pain on shoulder
Diagnosis of patients

- One of injured JSDF personnel had pain on neck and paralysis on arm
  - Transferred to the Fukushima Medical University Hospital by ambulance and diagnosed with brachial plexus injury
- One of the other patients had a contaminated wound on the right thigh
  - Transferred to NIRS by JSDF helicopter
- Other two had bruise or pain on shoulder
  - Transferred to a clinic in Fukushima Daini NPP
Receiving a contaminated injured JSDF member at NIRS

- Arrival at NIRS by JSDF helicopter at 20:30
- Body surface was surveyed with GM counter and the level of external contamination was under 100 kcpm, whereas almost whole body was contaminated
- Level on right thigh wound was 2500 cpm
- Levels of abdominal part was the most prominent (31 kcpm)
- I-131, Te-132 and I-132 were detected from right nasal swab
- Admitted to NIRS hospital
- The exposed doses of experts who took care of patients with contamination were only a few tens of μSv
Clinical course

- **Treatment**
  - Cefcapene 100mg po administration for three times a day
  - Loxoprofen 60mg po administration for three times a day
  - Bed rest
  - Shower for decontamination every day
  - Dressing change

- **Clinical course**
  - Pain was reduced
  - Able to walk
  - Reduce subcutaneous induration on right thigh
  - Wound showed a tendency of epithelialization
  - Reduce surface contamination
  - Discharged on 17 March
Case Report 2
Heavy contamination

- On March 24, 3 workers accidentally put their feet in the water containing high concentrations of radioactive materials at the Unit 3 of NPS
- Two of them were contaminated on the feet since the water came into their boots
- They worked for 30 min soaking their feet in contaminated water and ignoring the alarm of personal dosimeters
- They were transported to Fukushima Medical University and then to NIRS
At Fukushima Medical University Hospital

- Experts from NIRS and Hiroshima University were dispatched to Fukushima Medical University Hospital
- At 18:40 workers arrived
Skin contamination

Worker A

Thyroid: 4 μSv/h (Nal (TL) scintillation detector)

γ-ray was detected from urine

Worker B

Thyroid: 2 μSv/h (Nal (TL) scintillation detector)

measured by GM survey meter
Skin contamination
- survey at NIRS -

- The lower part of leg was soaked and heavily contaminated
- The proximal part was contaminated due to wet underwear
- Sole was most heavily contaminated exceeding 100 kcpm with the GM counter
Clinical laboratory findings

- Leukocyte, neutrophil, and lymphocyte count were normal range
- No other physical symptoms
Clinical course

- No cutaneous radiation injury
  - No erythema on their feet
- No specific treatment
- Shower for decontamination every day
- Contamination of sole was decontaminated and reduced to under 100 kcpm with GM
- Discharged on March 28
- Observation for 2 weeks showed no erythema
Dose estimation

- External exposure dose: Reading of PD
- Skin equivalent dose: Calculation from concentration of contaminated water and working time
- Committed effective dose: Based on measurements by WBC and radionuclide intake scenario of each person
- Thyroid equivalent dose: Based on measurements by thyroid monitor by intake scenario of each person (Only for I-131)
Exposure doses of workers
Radiation exposure of workers

• Regulation on the dose limit for emergency workers was revised from 100 mSv to 250 mSv on March 14th 2011.

• This new regulation is applied only for the emergency workers of this accident.
Doses of internal and external exposure

<table>
<thead>
<tr>
<th>Classification (mSv)</th>
<th>March 2011-December 2012</th>
<th>March 2011-January 2013</th>
<th>Fluctuation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TEPCO</td>
<td>Contractor</td>
<td>Total</td>
</tr>
<tr>
<td>Over 250</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>200-250</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>150-200</td>
<td>22</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>100-150</td>
<td>117</td>
<td>17</td>
<td>134</td>
</tr>
<tr>
<td>75-100</td>
<td>225</td>
<td>66</td>
<td>291</td>
</tr>
<tr>
<td>50-75</td>
<td>303</td>
<td>437</td>
<td>740</td>
</tr>
<tr>
<td>20-50</td>
<td>598</td>
<td>3,032</td>
<td>3,630</td>
</tr>
<tr>
<td>10-20</td>
<td>484</td>
<td>3,250</td>
<td>3,734</td>
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<tr>
<td>5-10</td>
<td>392</td>
<td>2,978</td>
<td>3,370</td>
</tr>
<tr>
<td>1-5</td>
<td>601</td>
<td>5,754</td>
<td>6,355</td>
</tr>
<tr>
<td>1 or less</td>
<td>882</td>
<td>6,229</td>
<td>7,111</td>
</tr>
<tr>
<td>Total</td>
<td>3,631</td>
<td>21,767</td>
<td>25,398</td>
</tr>
<tr>
<td>Max. (mSv)</td>
<td>678.80</td>
<td>238.42</td>
<td>678.80</td>
</tr>
<tr>
<td>Ave. (mSv)</td>
<td>24.79</td>
<td>9.74</td>
<td>11.89</td>
</tr>
</tbody>
</table>

(As of January 31, 2013)

Estimation of internal exposure dose for workers

- The committed effective dose of internal contamination was estimated at NIRS for 7 workers who had worked at TEPCO Fukushima Dai-ichi NPS after 11th March.
- The function of thyroid of all workers was normal.
- No clinical symptoms and no radiation injury up to now.
Summary

• In this accident, the response system for radiation emergency medicine was not functional since community lifelines such as water supply and electricity were severely damaged.

• Workers, operational staff and emergency response personnel were exposed to radiation and/or contaminated but there were no workers or responders requiring treatment for ARS.

• Basic education on radiation and radiation emergency medicine is essential for all health care providers, staff of hospital and first responders.