

Radiation Protection and Health Management of Workers in Response to Fukushima Daiichi Nuclear Power Plant Accident

International Conference on Science and Technology for Sustainability2013

Theme: Colossal Multiple Disaster (Earthquake, Tsunami, and Nuclear Plant Accident)----

Repercussions, Countermeasures, and Future Policy Choices

Organizer: SCJ Co-Organizing Organizations: IAC, IAP, ICSU, UNU

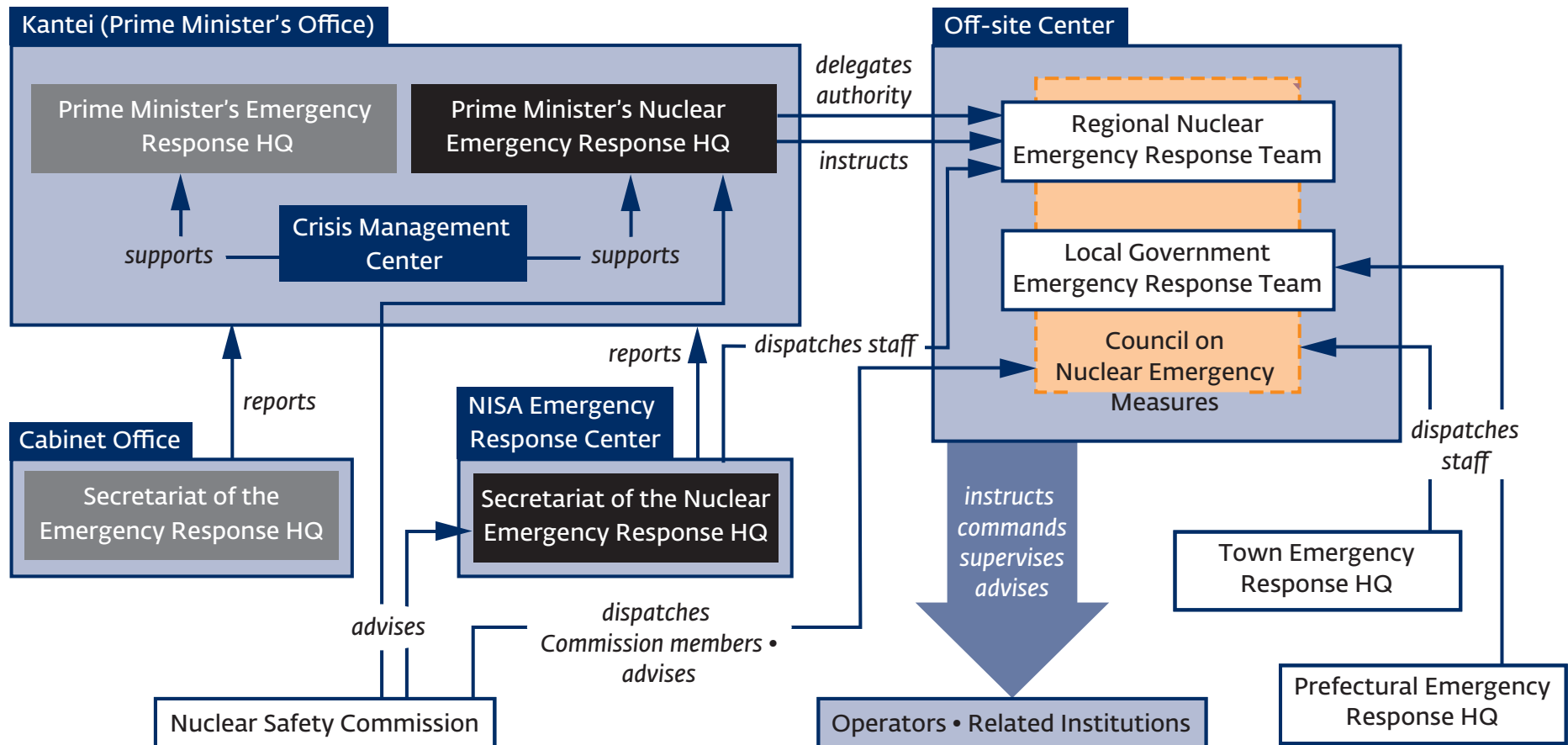
Date: October 9-10, 2013

Venue: Auditorium, Science Council of Japan

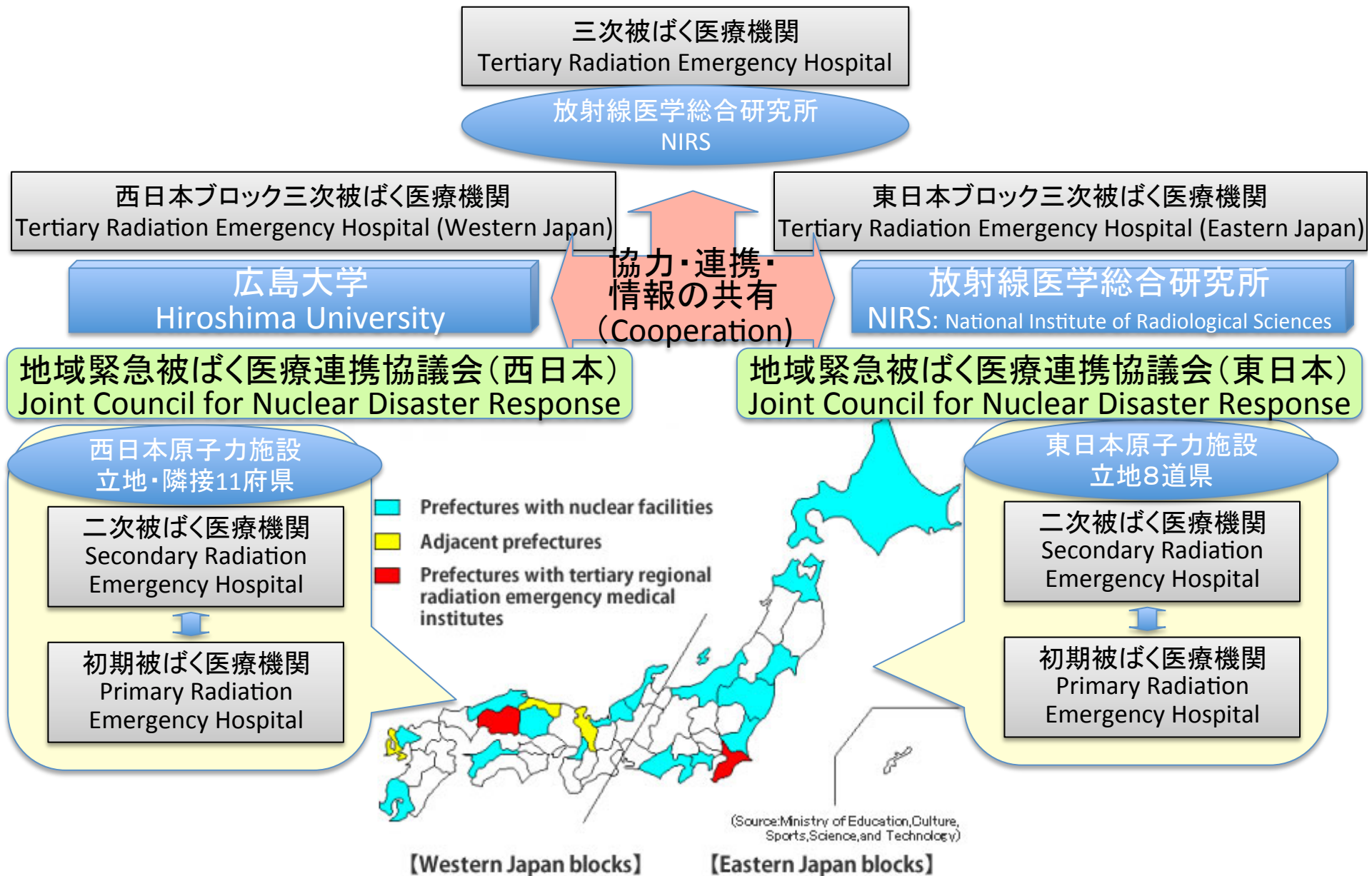


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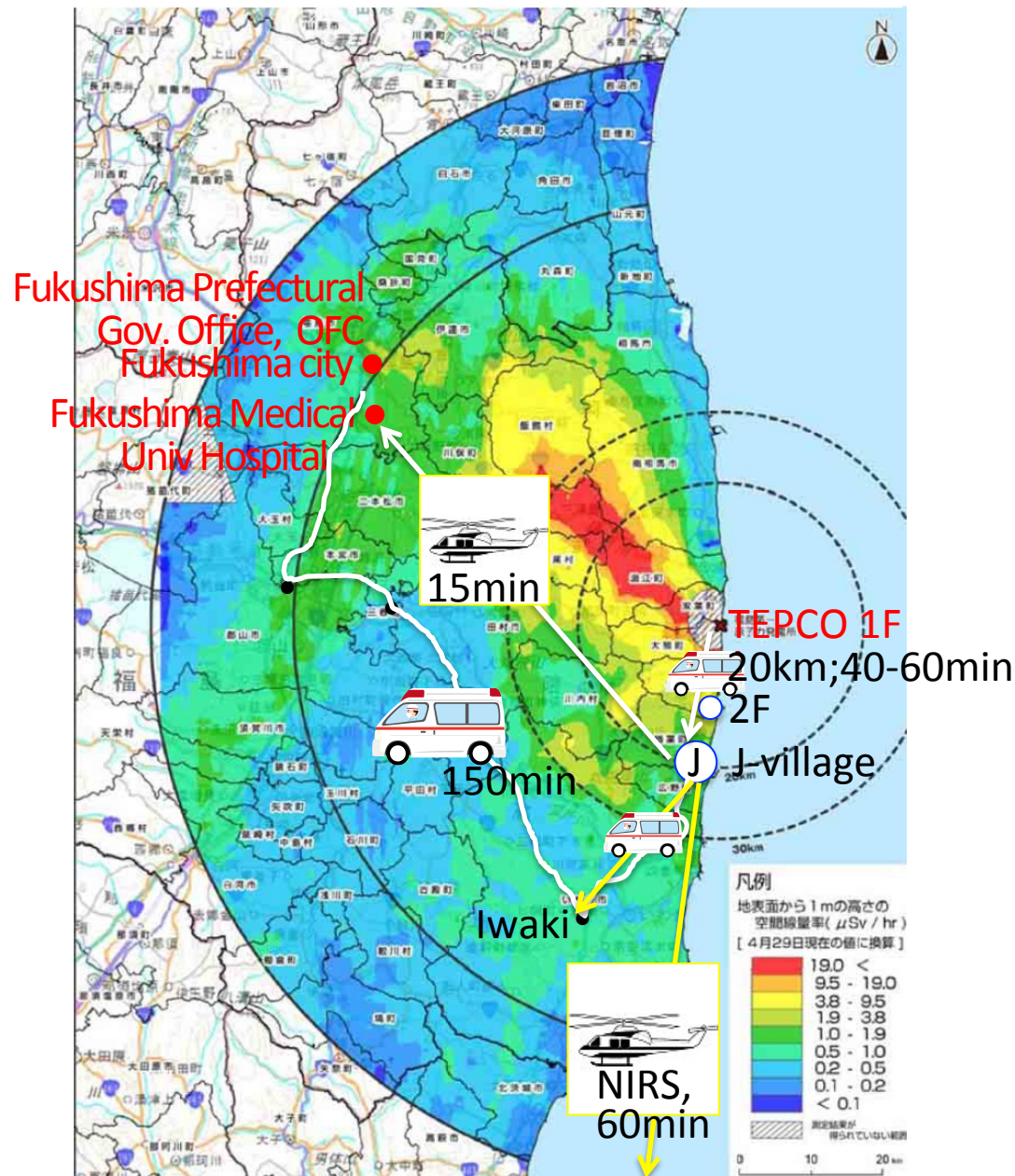
Diagram of the emergency communication protocol



Radiation Emergency Medicine Network



Medical responses for patients



Daiichi Nuclear Power Plant

OFC; Offsite Center

Joint Council for Nuclear Disaster Response

Headquarters

- Enhance cooperation between National Government and local governments

J-village

The base of emergency conveyance

- Triage the patient
- Decontamination, if necessary

Fukushima Medical Univ. Hospital

Secondary Radiation Emergency Hospital

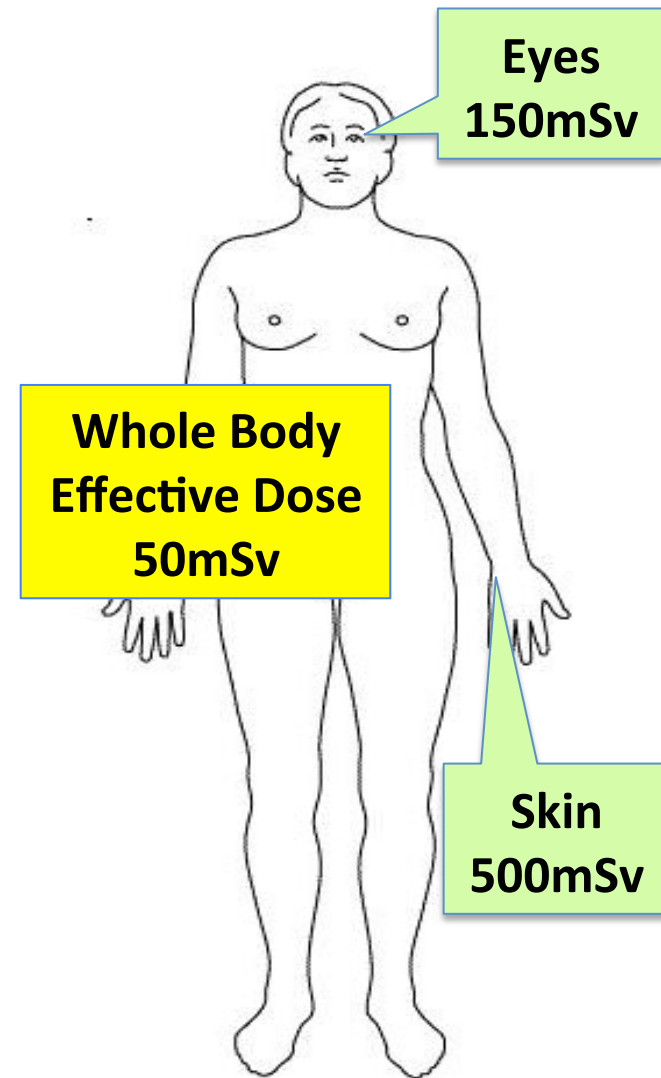
NIRS: National Institute of Radiological Sciences

Tertiary Radiation Emergency Hospital

Dose Limits for Radiation Workers

Many of the recommendations from the ICRP and other groups have been incorporated into the regulatory requirements of countries around the world. In Japan, the annual limit of exposure at the following:

Effective dose	<ul style="list-style-type: none"> ① 100mSv/5 years ② 50mSv/year ③ 5mSv/3 month for female ④ 1mSv for pregnant workers <p>(The dose limits for a radiation worker who has notified her employer that she is pregnant)</p>
Equivalent dose	<ul style="list-style-type: none"> ① Lens of Eye 150mSv/1year ② Skin 500mSv/1年 ③ surface of her abdomen for the remainder of her pregnancy 2mSv
Emergency worker	<ul style="list-style-type: none"> ① Effective dose 100mSv → 250mSv ② Lens of Eye 300mSv ③ Skin 1Sv



Status of Radiation Exposure Dose of TEPCO's Fukushima Daiichi NPP Combined Cumulative Effective Dose from March 2011 (Internal and external)

Effective Dose (E) mSv	March 2011-July 2013			
	TEPCO	Contractors	Total	
250<E	6	0	6	} <0.05%
200<E<=250	1	2	3	
150<E<=200	24	2	26	} <1%
100<E<=150	118	20	138	
75<E<=100	241	90	331	} 4.5%
50<E<=75	309	669	978	
20<E<=50	610	3833	4443	} 29%
10<E<=20	525	3557	4082	
5<E<=10	423	3378	3801	} 65%
1<E<=5	634	6414	7048	
E<= 1	964	7150	8114	
Total	3855	25115	28970	
Maximum(mSv)	678.80	238.42	678.80	
Average(mSv)	24.36	10.61	12.44	

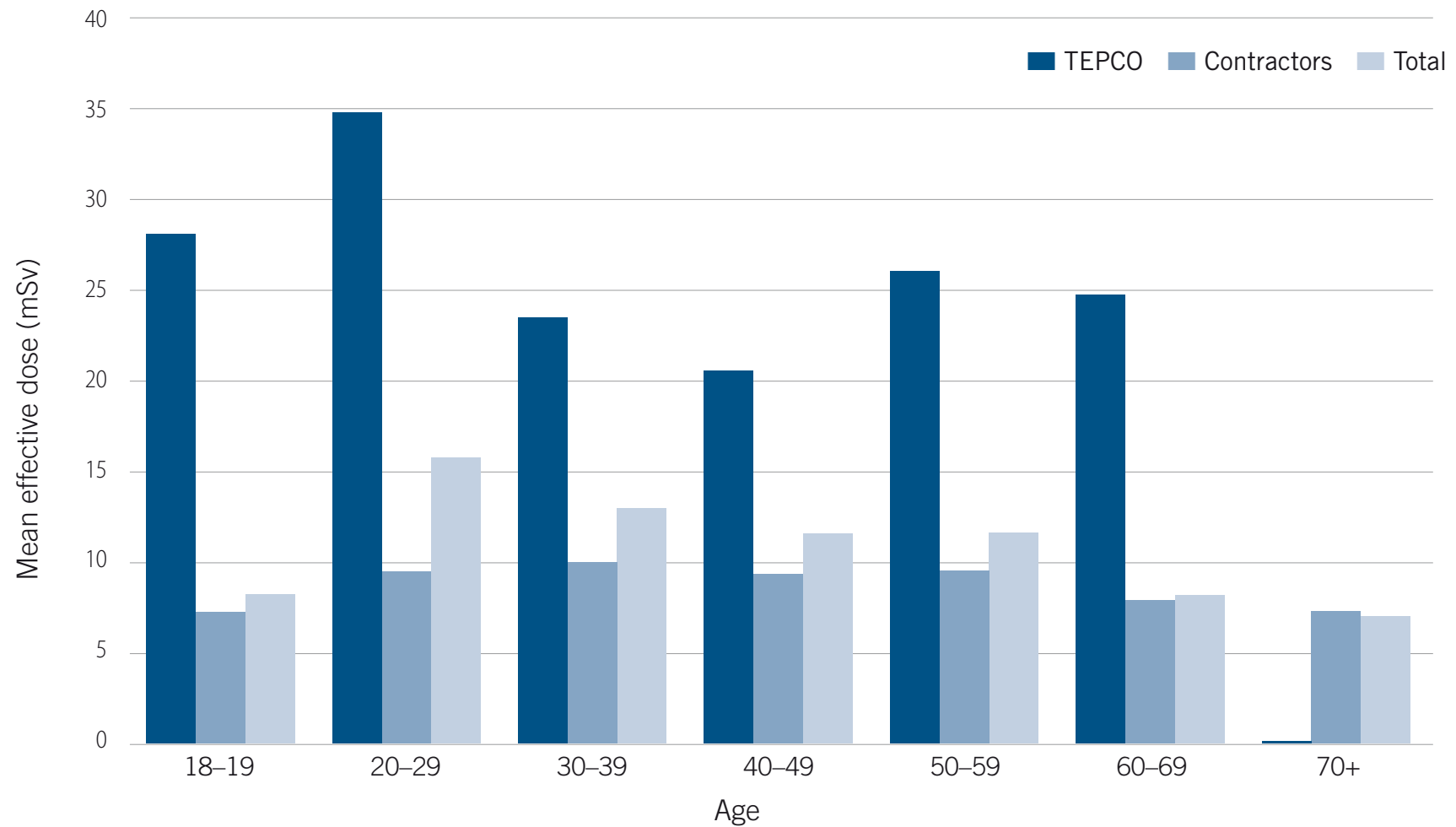
* External exposure was measured by PAD. *There has been no significant internal exposure reported since October 2011.

After the accident at the Chernobyl nuclear power plant in 1986, the average effective dose received by the 530,000 recovery operation workers between 1986 and 1990, mainly due to external irradiation, is estimated to have been about 120 mSv. (UNSCEAR 2008)

http://www.tepco.co.jp/cc/press/betu13_j/images/130830j0201.pdf

http://www.mhlw.go.jp/english/topics/2011eq/dl/update_August_28_2013.pdf

Dose distribution of workers by age group (data provided by TEPCO)



BIODOSIMETRY OF RESTORATION WORKERS FOR THE TEPCO

Suto Y, et al. Health Phys. 105(4):366-373; 2013

The results indicated that the estimated exposure doses for all individuals were lower than 300 mGy, with the mean value of about 101 mGy. These results by DCA were in accordance with those obtained by physical dosimetry based on personal dosimeter recording assessment. The results corroborate the fact that no acute radiation syndrome was observed among the workers examined.

Table 3. Results of biological dosimetry of restoration workers for the Fukushima Daiichi Nuclear Power Station accident examined by the dicentric chromosome assay (DCA) and records of physical dosimetry detected with alarm personal dosimeters (APDs).

ID ^a	APD record (mSv) ^a	No. of metaphases scored	Dicentric equivalent counts (DIC) ^b	DIC per metaphase	Dose estimated by DCA (mGy)	95% LCL ^c (mGy)	95% UCL ^d (mGy)
Fu-3	179	1,003	7	0.00698	170	77	298
Fu-4	180	1,000	7	0.00700	171	77	299
Fu-5	173	1,000	5	0.00500	129	45	255
Fu-6	87	1,036	1	0.00097	26	0	137
Fu-7	38	1,005	4	0.00398	105	29	230
Fu-8	102	1,013	4	0.00395	105	29	229
Fu-9	unknown	1,035	6	0.00580	146	59	271
Fu-10	17	1,037	3	0.00289	79	14	199
Fu-11	4	1,042	1	0.00096	26	0	136
Fu-12	unknown	1,004	2	0.00199	55	3	174

^aDetailed data and information of the alarm personal dosimeter (APD) record of each worker will be published elsewhere.

^bThe number of centromeres minus one in a multi-centric chromosome equals dicentric equivalent count.

^cLower confidence limit.

^dUpper confidence limit.

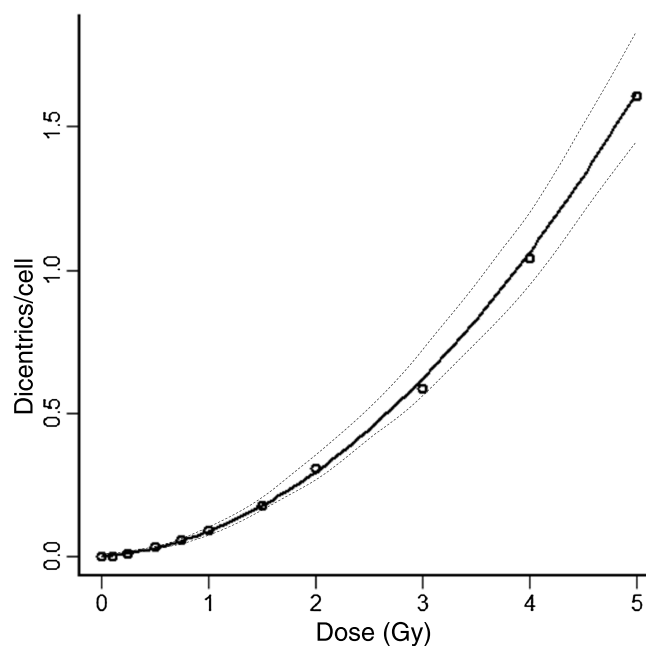


Fig. 1. Dose-response curve for the dicentric chromosome assay (DCA). $Y = (0.00015 \pm 0.00017) + (0.0302 \pm 0.0044) \times D + (0.0588 \pm 0.0028) \times D^2$; Y: dicentric yield, D: dose (Gy); p value of goodness of fit test : $p = 0.73$. Dotted lines denote 95% confidence limits.

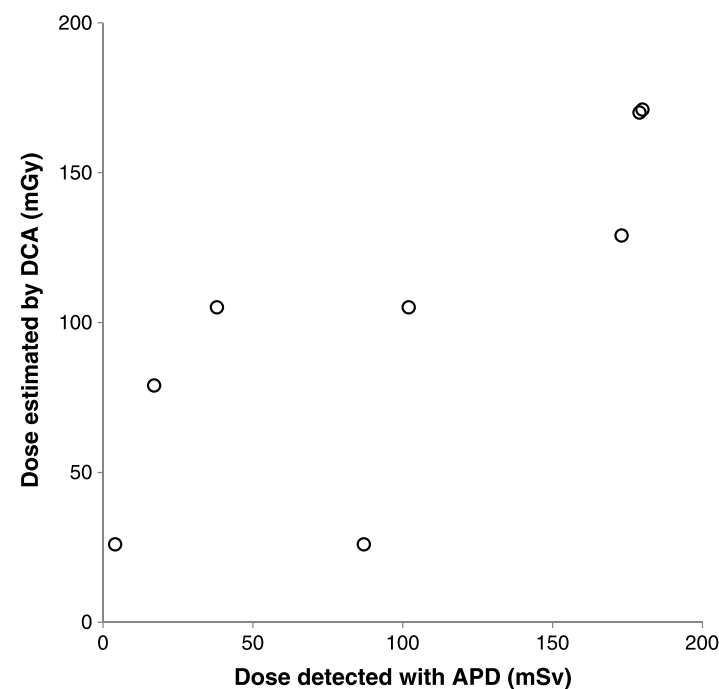
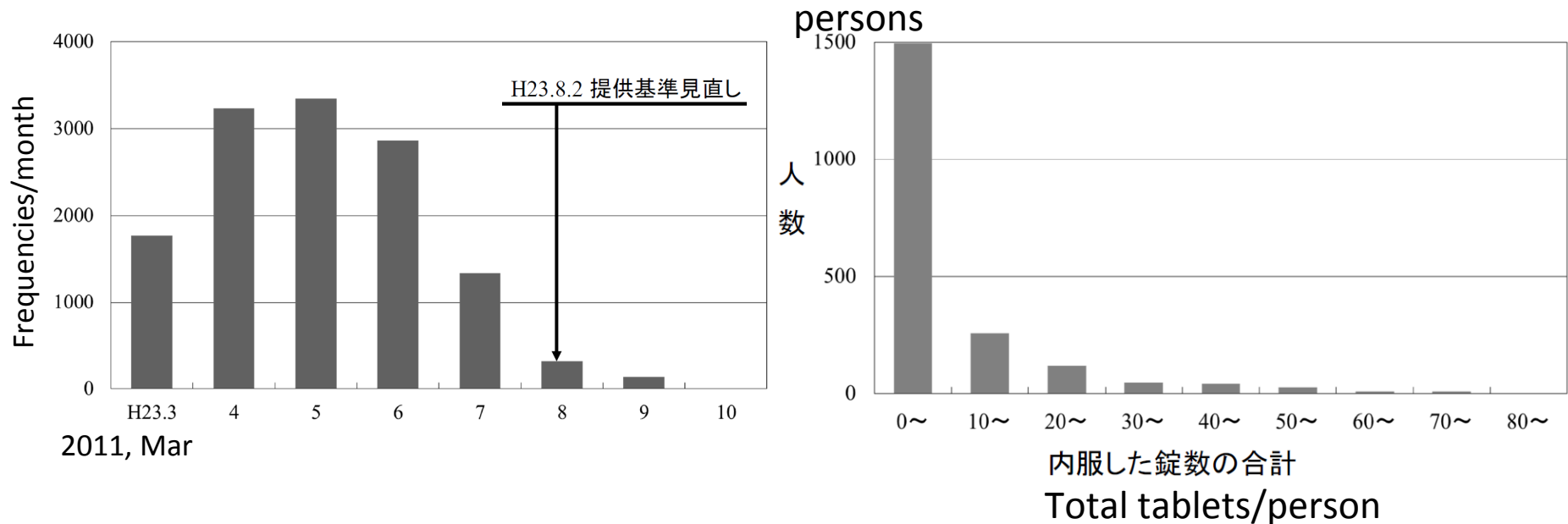


Fig. 2. Correlation between physical doses detected with alarm personal dosimeters (APDs) and biological doses estimated by the dicentric chromosome assay (DCA). The following linear regression was obtained: [physical dose (mSv)] = [biological dose (mGy)] \times $[1.03 \pm 0.33] - [7.07 \pm 37.70]$ ($p < 0.05$).

stable potassium iodide



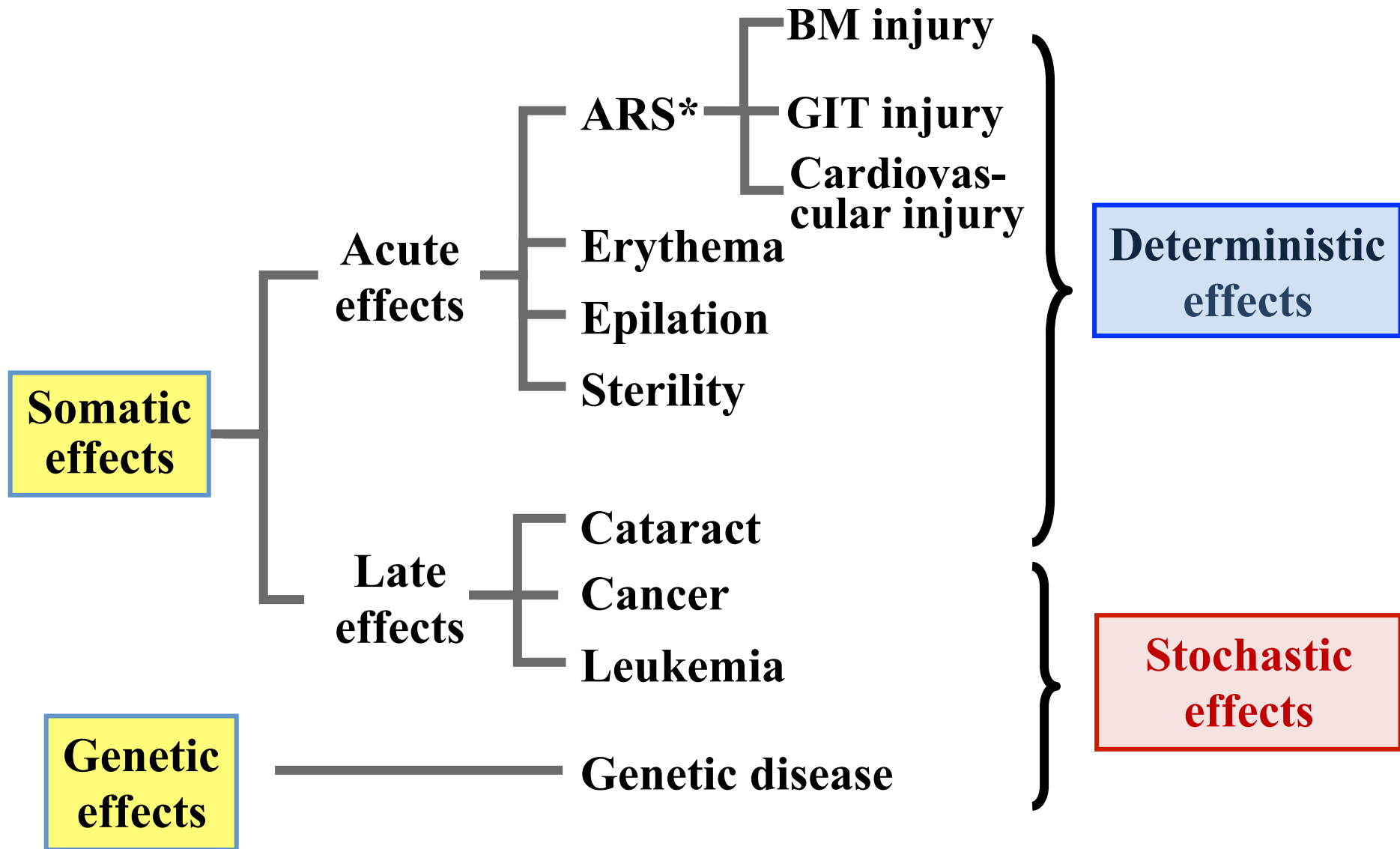
Thyroid dysfunction was reported in three workers as a result of repeated self-administration of stable potassium iodide for thyroid blocking against radioactive iodine. This effect was transient and thyroid function returned to normal once the administrations were stopped.

<http://www.nsr.go.jp/archive/nsc/senmon/shidai/hibakubun/hibakubun030/siryoy4-3.pdf>

原子力安全委員会 原子力施設等防災専門部会被ばく医療分科会第30回会合

東京電力本店産業医 菊地央 福島第一原子力発電所での緊急作業に従事した作業員の安定ヨウ素剤内服等について

Human Effects of Radiation



* acute radiation syndrome

Guidelines on Maintaining and Promoting the Health of Emergency workers at TEPCO's Fukushima Daiichi Nuclear Power Plant (October 11, 2011)

1 Development & management of database

Employers

- Name, address, name of company, etc.
- Exposure doses
- Medical examination results
- Health guidance
- Other information

Report/Submit

Ministry of Health, Labour and Welfare

- Database Maintenance
- Encouraging emergency workers to take cancer screening examination.
- Finance the examination expenses

2 Approaches to Long-Term Health Management

Administration of cancer screening examination, etc.

○ All emergency workers

- general medical examination and ionizing radiation medical examination by law
- Health guidance including mental health care

○ radiation effective dose of over 50 mSv

- examination of eyes for cataract using slit-lamp microscopy

○ radiation effective dose of over 100 mSv

- examination for thyroid, and cancer screening examination for gastric, lung, and colon cancer

“Handbook of Records of Exposure Doses, etc.”

“registration cards”

Administration of cancer screening examination, etc.

Examinations	Examination item
Thyroid examintaion	<ol style="list-style-type: none">1. Thyroid-stimulating hormone (TSH), free triiodothyronine (free T3) and free thyroxine (free T4)2. Ultrasound examination for Thyroid (as deemed necessary by the physician in charge with regard to results of the above examinations, exposure doses, etc.)
Gastric cancer screening examination	Gastro-fluorography or Gastro-endoscopy
Lung cancer screening examination	Chest X-ray and sputum cytological examination
Colon cancer screening examination	Fecal occult blood test

Implementation status of “Guidelines on Maintaining and Promoting the Health of Emergency workers ”

- 1) Of the 19,346 "emergency workers", "registration card" have been provided to 18,874 workers (97.6%).
- 2) Of the 903 "specified emergency workers" who have been exposed to effective dose of over 50 mSv, "Handbook of Records of Exposure Doses" have been provided to 747 workers (82.7%).
- 3) Registration to the database for medical examination, etc.
 - 1) Implementation rate of "general medical examination": 98.8% (687/695)
 - 2) Implementation rate of "ionizing radiation medical examination": 98.1% (682/695)
 - 3) Registration of the results of "general medical examination": 64.1% (7,683/11,980)
 - 4) Registration of the results of "ionizing radiation medical examination": 76.6% (9,172/11,980)
 - 5) Implementation rate of "examination of eyes for cataract using slit-lamp microscopy": 68.3% (589/863)
 - 6) Implementation rate of "cancer screening examination": 94.7% (162/171)

Conclusions

- Taking into account that 99% of workers were exposed to low doses (< 100 mSv), non-cancer risks are less relevant than cancer risks in terms of health impact.
- None of several reported deaths among emergency workers is attributable to radiation exposure.
- Because tissue doses received were below threshold doses, no deterministic effects of radiation are expected in the workers, apart from possible thyroid disorders in those few workers who inhaled significant quantities of radioactive iodine.
- For many people including the workers, the Fukushima Daiichi NPP accident resulted in many stressors that constitute a potentially traumatic situation.
- It is necessary to continue registration of radiation doses for all workers to exposed to radiation and to facilitate suitable healthcare management in the future.
- It is important to provide effective systems not only for the prevention of radiation exposure but also for the general management of other health risks, such as heat disorders and infections (Refer to the next presentation).