9. Radiation Emergency Medical Preparedness in India

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9.1 Bhabha Atomic Research Centre (BARC), Bombay

It is one of the pioneer and prestigious Research and Development Centres of Government of India

In India, there are 160,000 radiation workers. They are working in nuclear installations (nuclear power stations) research nuclear reactors, research laboratories, industries and radiology and radiotherapy departments of various hospitals.

About 17,000 radiation workers are working in various sections of Department of Atomic Energy About 44,000 radiation workers are monitored by RPS Division of BARC.

9.2 Nuclear Reactor Sites

Tarapur, Kakarapar, Rajasthan, Narora and Madras - situated at different states of country.

Facilities: Each reactor site, we are having following facilities for radiation emergency.

a) First aid post
b) Personnel Decontamination Centre
c) Site Hospital

a) First aid post is located inside the plant. It provides first aid treatment to persons having conventional injuries, minor external contamination, prophylaxis for internal contamination and triage when required

b) Site personnel decontamination centre: It is located near plant with Occupational Health Unit/Dispensary.

The decontamination centre is designed and equipped in order to manage the cases of radioactive contamination both external and internal. Facilities exist for providing shower bath, a whole length tub with hand showers and wash basins for carrying out decontamination with soap and water It has water closets for collection of urine and stool samples to be sent for bio-assay.

A contamination monitor for assessment of radioactive contamination is available.

It is equipped with necessary and specific anti-dote drugs with proper labeling and direction.

i) KI Tabs - for Iodine
ii) Radio-gardasse (Prussian blue - Ferric ferrocyanide) for Cs
iii) Ca DTPA injections for Pu
iv) Antacids, Cal-alginate/K Rhodizonate crystals for Sr.
v) Amps for Soda-bi-carbonate injections - for U
vi) Other life saving drugs

It also has the aerosol generation system. It is well equipped with necessary instruments for doing minor surgical work like venesection etc. It is also having respiratory masks, O_2 cylinders, large polythene bags for collection of contaminated clothing and other material Necessary facilities for collection of blood for various laboratory bio-chemical investigations including cytogenetic studies are available

The decontamination centre is designed in such a way that it has washable floors and walls with false ceiling and all the drains outlet of the centre are connected to "Waste Management" collection tanks.

Each decontamination centre is having one ambulance with necessary polythene sheets to cover the interior of ambulance while transporting the contaminated casualty. The ambulance is provided with first aid box and O_2 cylinder along with necessary "Emergency drug kit."

c) Site Hospital: Each reactor is having a site Hospital away from plant and near to the colony of employees. These hospitals are having facilities to handle all types of cases of radiation injuries with or without trauma Specialists, radiological and pathological labs are available.

At present no sterile, isolated wards are available. This facility is coming up at BARC Hospital which is Central Hospital for all Units. At these site Hospitals cases with a dose of less than 2 Gy (for treatment) and more than 10 Gy (for terminal care) can be taken care of and other cases (between 2 and 10 Gy) are referred to BARC (Central) Hospital.

Onsite and offsite emergency plans have been worked out and are available for each major nuclear facility, where training courses and drills are imparted regularly.

9.3 Facilities and Emergency Preparedness at BARC

a) BARC Hospital (Central Hospital)

Radiation casualties are handled by trained first aider, nurses, physicians, occupational health physician, surgeons, anesthetist, hematologist, plastic surgeons and other consultants or specialists.

BARC Hospital is located in Bombay It is 292 bedded hospital having facilities to take care of all kind of emergencies with the help of its own specialists and panel specialists from other hospitals of Bombay.

As far as radiation injuries are concerned the hospital is having:

I) Decontamination Centre: A wing on the ground floor of new expansion has been ear marked for decontamination centre with all the facilities required for decontamination centre.

ii) Radiation Ward: In another wing, on the ground floor, there is a ward having isolated sterile rooms with reverse nursing barrier to take care of special cases like skin graft, burn cases and radiation injuries.

iii) It has got 7 bedded Intensive Care Unit (ICU) which is fully equipped and staffed to take care of critical patients.

iv) Fully equipped operation theater with U.V. sterilization facility and specialist is available all the time.

v) Well developed and equipped Pathology and Radiology department are available round the clock

vi) Transport: 3 ambulances are available at present for emergencies.

9.4 Other Facilities at BARC

9.4.1 a) Personnel Decontamination Centre - which is part of Occupational Health Unit at site is fully equipped and manned with trained persons.

b) Occupational Health Unit and Dispensary - has managed many referred radiation burn cases following industrial radiography accidents, as well as successfully treated cases of external and internal radioactive contamination. The unit is having trained and experienced personnel.

Facilities are being developed to handle TBI.

9.4.2 Monitoring Facilities at BARC

Fully equipped and efficient Health Physics Unit of which Dr U.C. Mishra is the Director, is having following monitoring facilities:

i) Personnel monitoring based on TLD and film badge
ii) Whole body counting/internal dosimetry section
iii) Radiation surveillance through a mobile van equipped with monitoring instruments
iv) Bio-assay of urine, stool and blood

9.4.3 Clinical biology dosimetry at BARC - Following clinical biological dosimetry facilities are available at BARC.

i) Haematological dosimetry
ii) Cytogenetic dosimetry
iii) Micronucleus assay
iv) Biochemical indicators
v) Electron spin resonance

9.5 Outside BARC (Related to BARC) Facilities

I) Radiation Medicine Centre (RMC) already recognised by WHO as regional centre for Nuclear Medicine, is having facilities of investigating and managing all the Thyroid problem.

ii) Tata Memorial Hospital (TMH) - where Bone Marrow Transplant facilities are available.

9.6 Other Activities and Preparedness

Training Courses and Drills: We are conducting regular training courses to train physicians to manage radiation accidents and conducting regular drills (stay in, sheltering evacuation).

10. Radiation Accidents and Medical Preparedness in China[1]

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Since 1963, 11 major radiation accidents resulting in personal radiation syndrome have occurred in China, and the diagnosis of acute or subacute radiation sickness was made in 44 of the victims (Table 1). They were treated under one of the following conditions: (1) being admitted to the North Tai-Ping Road Hospital (NTPH) and treated by the staff of IRMB and NTPH; (2) being treated in local hospitals by a big team of specialists from IRMB+NTPH, jointly with the staff of the local hospitals; (3) being handled by the staff of the local hospitals with a small group of or individual specialist mainly from IRMB for dosimetric and medical assistance or consultation.

Major radiation accidents resulting in total body irradiation to human beings in China

Accident	No. of ARS cases	Condition of handling	No. of death
1963 Sanli'an	6	a*	2
1966 66.12	2	b*	0
1972 Wuhan	15	b*	3
1980 Shanghai	1	a*	0
1985 Mudanjian	3	a*	1 (late)
1986 Kaifeng	2	a*	0
1987 Zhengzhou	1		0
1988 Tianjin	1		0
1990 Shanghai 6.25	7	b*	2
1992 Shanxi	4	c*	3
1992 Wuhan 11.13	2	c*	0

* a: Treated under the condition (1) as described in the text
b: Treated under the condition (2) as described in the text
c: Treated under the condition (3) as described in the text

For the emergency medical preparedness against nuclear accidents, a State Leadership Group for Nuclear Accident Emergency Medical Assistance headed by Dr. Chen Min-Zhang (the Minister of Public Health) has been set up, a group of 10 veteran specialists have been appointed as the State Advisory Team for Nuclear Accident Emergency Medical Assistance and a State Expert Team of 17 scientists in this field has been organized. For the coordination among the major relevant institutions of China in perfecting the medical preparedness against nuclear accidents so as to upgrade the technical preparedness of medical handling and the capability of radiation emergency assistance, the State Collaborating Centers of China in Radiation Emergency Medical Preparedness and Assistance was established in 1993.

The State Collaborating Centers of China in Radiation Emergency Medical Preparedness and Assistance consist of the Institute of Radiation Medicine Beijing (IRMB), the North Tai-Ping Road Hospital (NTPH), the Laboratory of Industrial Hygiene affiliated to the Ministry of Public Health (LIH) and the Institute of Radiation Medicine affiliated to Chinese Academy of Medical Sciences (IRM/CAMS).

IRMB and NTPH associated as an integration have been an important center for the treatment of acute radiation sickness since the first major radiation accident in China. They are well staffed with experienced doctors

[1] This paper was not discussed during the meeting but it was kindly presented by the author for including in the Report

and scientists and well equipped for radiobiological/radiation medical researches and clinical study of radiation syndrome and protection, thus being quite professional competent. Their staff members have participated in the treatment of the large majority of radiation sickness patients in Chinese major radiation accidents and conducted active studies on the important problems related to the mechanism of radiation injuries and their repair, the diagnosis/therapy of radiation syndrome and radiation protection.

LIH is responsible for the registration of radiation accidents in China and, with a secondary standard dosimetry laboratory (SSDL) established recently, also responsible for the quality assurance of monitoring techniques. It is another duty of LIH to make supervision of radiation hygienic protection and surveillance of exposure doses to radiation workers and general public. In the national environment radiation monitoring network, LIH is a leading institution. The staff members have conducted a series of relevant research works as well as fruitful epidemiological survey on the inhabitants in high radiation background areas and participated in the treatment of some accidentally overexposed persons.

IRM/CAMS is also a multi-discipline institute. In the institute, the scientists have performed studies in the fields of nuclide labeling, experimental nuclear medicine, early and late effects of low level radiation, hyperthermia and radiosensitizer in tumor therapy, radioprotectors, personal dose estimation, environment radiation monitoring and retrospective dosimetry, radiation protection in X-ray workers, monitoring of radioactivity and decontamination of food, water and internal contamination due to nuclear accident Furthermore, there is a Department for Radiation Disease in IRM/CAMS attached to the Hospital of Hematological Disease of CAMS, and has been assigned jointly with the Hospital as a Clinical Department of the National Center for Medical Emergency in Nuclear Accident in 1992.

Activities of the State Collaborating Centers:

1. Strengthening of the centers

   Further perfect the organization, equipment, respective regulations and standard techniques and the preparation of necessary materials.

2. Dosimetric researches

   - Develop computer software series for describing the dynamic status of nuclear power stations in China and predicting the emergency condition of various nuclear accident

   - Study furthermore the biological dosimeter for radiation exposure; such as CB micronuclei, Fish technique for chromosome aberration study, HPRT and GPA gene point mutation assay technique, etc.; develop, on the basis of previous works, the automatic computer system for the assay of chromosome aberration and respective estimation of radiation dose.

   - Develop technical standards and computer software for pre-dosimetry and estimation of external and internal radiation doses suitable to radiation accident monitoring.

   - Establish dose estimation and evaluation system suitable to the accident with large number of persons overexposed and feasible for dose monitoring in the public population involved.

3. Studies on the environmental monitoring and the detection of radiation contamination

   - Develop quick methods for analysis and measurement of critical nuclides in the water, food and air collected from the area contaminated following nuclear accidents.

   - Establish continuous telecontrolled external radiation dose monitoring technique and monitoring stations around the nuclear power station.

   - Compile manuals of standard techniques of monitoring radiation contamination in the environment and human body.

- Strengthen the environment monitoring work, so that the Environmental Radiation Monitoring Network of the Ministry of Public Health of China could be incorporated into the Global Environmental Radiation Monitoring Network (GERMON).

4. Scientific researches relevant to the medical handling of overexposed persons.

- Study the problems encountered in medical handling of massive overexposed persons, such as early quick triage and diagnosis of radiation injury, on-site rescue, evacuation and treatment by stages.
- Study furthermore the radioprotectors, for example E838, Tremella preparations, etc.
- Investigate the therapeutic effect of hemopoietic factor on the radiation induced injury to hemopoiesis.
- Continue to study bone marrow transplantation clinically and experimentally.
- Start the research on the prophylaxis, diagnosis and treatment of severe complications after heavy exposure, e.g. radiation pneumonitis
- Inspect furthermore the feature and mechanism of radiation injuries and their recovery in the essential organs and tissues.

5. Epidemiological survey and follow-up observation

- Lay down the proper methods for epidemiological survey in the public population surrounding nuclear facilities.
- Continue the follow-up and late effect observation in the surviving overexposed individuals.

6. Data base

- Establish data base for the fundamental information of nuclear facilities and radiation sources, radiation epidemiological and dosimetric data of the population inhabiting near the nuclear power stations, dosimetry and health control of persons overexposed in radiation accident and the information of all radiation accidents occurred in China, as well as the computer software for biological physical and environmental radiation dosimetry.

- Further improve the data base for the information of acute radiation sickness patients and consultation system for the medical treatment of accidentally irradiated persons already established at IRMB.

7 Tasks entrusted by the State Committee on Health Standards and Techniques, relevant authorities or requested by other institutions such as special training course and drills.

New activities of IRMB after the last REMPAN Meeting:

The following new research works have been started in 1955:

1. New dosimetric methods and materials, such as stable chromosome aberration, HPRT and GPA gene mutation, ESR of tooth and bone, watch cover as a dosimeter, etc.;
2. Three dimensional deduction of radiation dose;
3. The repair of DNA radiation injuries,
4. The application of PCR and other advanced techniques in the diagnosis of radiation injury and its complications (e.g. CMV and fungus infection);
5 The therapeutic effect of hematopoietic factors on radiation sickness,
6 The pathogenesis and treatment of radiation interstitial pneumonitis;
7. Gene engineering in radiation medicine: thrombopoietin (TPO), thrombocyte derived growth factor (PDGF), interleukin-9 (IL-9), hepatocyte growth factor (HGF), leukemia inhibitory factor (LIF).

The State Collaborating Centers of China in Radiation Emergency Medical Preparedness and Assistance

I. **Aim**

To coordinate, under the leadership of the Ministry of Public Health, the major relevant institutions of China in perfecting the medical preparedness against radiation accidents, so as to upgrade the technical preparedness of

the medical handling and improve the capability of radiation emergency assistance.

II. Organization

Member institutions:

1. The Institute of Radiation Medicine, Beijing (IRMB) and the North Tai-Ping Road Hospital (NTPH), Beijing;
2. The Laboratory of Industrial Hygiene, the Ministry of Public Health (LIH), Beijing;
3. The Institute of Radiation Medicine, Chinese Academy of Medical Sciences (IRM/CAMS), Tianjin.

The present leading group and officers:

Director: Chu-Tse Wu (Academician of Chinese Academy of Sciences, IRMB)

Associate Directors: Bing-Zhi Mao (Professor, Director of IRMB)
Kai-Bao Li (Professor, Vice-Director of LIH)
Liang-An Zhang (Professor, Vice-Director of IRM/CAMS)

Secretary-General: Qing-Xi Zhang (Professor, IRMB)
Secretary: Sheng-Cai Wu (Associate Professor, LIH)

Expert Group.
Chairman: De-Chang Wu (Professor, IRMB)
Members: Gen-Yao Ye (Professor, NTPH)
Lu-Xin Wei (Professor, LIH)
Yuan-M Shi (Professor, IRMB)
Jing-Yuan Zhang (Professor, IRM/CAMS)
Dao-Pei Lu (Professor, The People's Hospital, Beijing Medical University)
Yu-Shu Hao (Professor, Hospital of Hematological Diseases, CAMS)

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III. Roles

1. To strengthen and perfect the preparedness for radiation accident emergency medical treatment and assistance (including the organization, personnel, technology, rescue equipments traffic facilities, communication, information administration, etc.), in order to ensure that an efficient medical emergency treatment and assistance can be provided quickly once a radiation accident happens in China.

2. To make contact, establish communication, conduct academic exchange and establish bilateral or multilateral inter-relationship or cooperation with relevant institutions or organizations internationally. To send experts or assistance/consultant teams to the site of radiation accident in the neighboring countries especially in the Southeast Asia when requested by relevant organizations or give other types of help such as to admit overexposed persons for medical treatment, etc.

3. To conduct relevant experimental and clinical researches (such as new techniques of radiation dose estimation for overexposed persons, improved and advanced diagnostic methods, therapeutic measures and radioprotectors, basic and applied studies related to the medical treatment of radiation injuries, rapid and accurate methods of diagnosis for triage and appropriate medical handling procedures when large number of persons are involved in the accident, the improvement of environmental radiation monitoring around nuclear facilities under accident and non-accident conditions, monitoring of internal contamination and internal radiation dosimetry, risk evaluation and medical treatment of internal irradiation, related radiation epidemiological survey, and studies on the

medical problems encountered in the radiation protection), so as to upgrade the professional skill in the medical handling of radiation accidents.

4. As entrusted by the Ministry of Public Health, to be responsible for the registration of radiation accidents and collection of information, and to carry out follow-up observations on overexposed persons. To hold special courses and conduct other types of professional training as requested by the Ministry or other relevant authorities.

IV. Proposed works in the coming years

1. Strengthening of the centers:

Perfect the organization and equipment of each center, establish respective regulations and standard procedures of operation, build up the command, communication and liaison system, workout the contingency plan, organize the radiation emergency assistance/consultation teams, prepare necessary materials and equipments for accident handling and assistance, and conduct requisite drills

2. Dosimetric researches:

-- Develop computer software series for describing the dynamic status of nuclear power stations in China and predicting the emergency condition of various nuclear accidents
-- Study furthermore the biological dosimeter for radiation exposures, such as CB micronuclei, Fish technique for chromosome aberration study, HPRT and GPA gene point mutation assay technique, etc.; develop on the basis of previous works the automatic computer system for the assay of chromosome aberration and respective estimation of radiation dose.
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3 Studies on the environmental monitoring and the detection of radiation contamination:

-- Develop quick method for analysis and measurement of critical nuclides in the water, food and air collected from the area contaminated following nuclear accidents.
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-- Compile manuals of standard techniques of monitoring radiation contamination in the environment and human body
-- Strengthen the environment monitoring work, so that the Environmental Radiation Monitoring Network of the Ministry of Public Health of China could be incorporated into the Global Environmental Radiation Monitoring Network (GERMON)

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-- Lay down the proper method for epidemiological survey in the public population surrounding nuclear facilities.
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-- Further improve the data base for the information of acute radiation sickness patients and consultation system for the medical treatment of accidentally irradiated persons already established at IRMB and continue to keep contact with the Data Base of CREMPA at Ulm University, Germany

7. *Accomplish the tasks* entrusted by the State Committee on Health Standards and Techniques or relevant authorities.

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