

Meeting Report

Preparedness to respond to possible acts of nuclear terrorism: Some strategies and recommendations

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1. Background

The unprecedented terrorist attack on the World Trade Centre, New York, on 11 September 2001 and the turn of events across the globe since then have heightened the perception of the threat to the civilized world. The fear of a repeat of such events with increased intensity and the possible use of weapons of mass destruction in such acts is not an impossible reality. Prompted by such possibilities, the scientific communities of the world have started to address the issue of planning appropriate strategies to minimize loss of life and property. One important workshop, 'Interagency Workshop on the Radiobiology of Nuclear Terrorism', was held at Bethesda, MD, USA in December 2001 (Moulder 2002a) to address the nuclear-related issues in the post-11 September era. Incidentally, about a year earlier, another workshop, 'Modifying Normal Tissue Damage Postirradiation', also addressed issues relevant to radiation damage (Stone *et al.* 2002). Both workshop deliberations have many overlaps, understandably due to common concerns, in the domain of the existing knowledge base of the consequences of human exposure to moderate doses (1–10 Sv) of radiation. The Bethesda workshop, in addition, outlined possible strategies to be adopted over the next 5 years to improve our ability to diagnose, triage, prevent and treat radiation injuries (Moulder 2002b). While the academic contents and recommendations of these meetings are relevant to the nuclear disaster scenario, one has to keep in mind that in a nuclear tragedy situation large segments of population will likely be simultaneously exposed to a range of doses. Therefore, there is a need to look into the biological response to different qualities as well as to variable quantities of radiation. Further, the context of discussion in the two meetings

mentioned above related to situations in developed countries where medical, paramedical and first-response teams are relatively better trained and the awareness level of the population is relatively high. The circumstances in a large number of underdeveloped, Third World countries, including India, are quite different. The response management and medical infrastructures are relatively poor and the awareness level of the population is low. Thus, it is important that other aspects, including the psychological state of the population in distress, are also discussed and evaluated so that the immediate impact of such a disaster could be kept to a minimum. With this in view, the Indian Society for Radiation Biology (ISRB) took the lead in organizing a multinational, multi-agency workshop, 'Radiation Risk in the Age of Nuclear Terrorism', in collaboration with the Research Center, Juelich (Germany), Health Canada, Ottawa (Canada) and the School of Life Sciences, Jawaharlal Nehru University (JNU), New Delhi (India).

2. Issues of discussion at the workshop

The workshop was held on 16 November 2002 at the School of Life Sciences, JNU. The 40 participants formed a multinational team of radiation biologists and allied scientists, including scientists from Japan—the only country with first-hand experience of the management of the aftermath of nuclear bombings (for details, see ISRB Participants 2002). In his opening remarks, Professor R. N. Sharan highlighted the need and urgency of the workshop and discussed its scope in light of the increasing threat perception of nuclear or 'dirty' devices falling into the hands of terrorists. Professor Emeritus P. N. Srivastava (JNU), in his inaugural address, recalled the chronological events of the past where large segments of populations across the globe were exposed to doses of radiation. He impressed upon the participants the need to come up with suitable recommendations that may

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form part of the strategies of various governments to tackle radiation emergencies with dexterity. Professor K. A. Dinshaw (Tata Memorial Center, Mumbai) delivered a lucid thematic talk, ‘“Managing Radiation Emergencies”—a physician’s view’, covering all aspects of medical and health management during and after a nuclear disaster. The next four technical sessions covered in depth various aspects of the consequences of radiation exposure, new approaches to biological dosimetry, biological responses and radioprotection strategies. Dr A. Trivedi (Health Canada) presented new strategies for radiation risk assessment in the dose range 1–10 Sv—doses that may not be lethal but can potentially cause acute effects. Dr K. P. Mishra (Bhabha Atomic Research Center, Mumbai) detailed the need for more extensive research to elucidate the role of free radicals in the induction of membrane and DNA damage that may provide a better understanding of apoptotic death and bystander effects. Professor R. N. Sharan (NEHU, Shillong) presented evidence of the nucleotide sequence determined vulnerability of segments of genomic DNA suggesting that genome instability or inherent radiosensitivity may be, at least in part, determined by the primary sequence of nucleotides. Professor Emeritus M. S. Sasaki (Kyoto University) presented a new model of biological dosimetry. The strategy takes into account the fact that dose distribution is unlikely to be homogeneous in those exposed to radiation in a nuclear disaster. Thus, the score of chromosome aberration recorded in lymphocytes is spread over a mixed Poisson distribution into dose components to get the most probable dose distribution profile and a realistic biological dose assessment. Dr F. H. A. Schneeweiss (Institute of Medicine, Research Center, Juelich) offered an alternative to this approach in which early cellular response could be assessed by analyses of lymphocyte proteins by two-dimensional differential gel electrophoresis and mass-spectrophotometry coupled with COMET-FISH analysis of DNA damage. Professor P. Uma Devi (J.N. Cancer Hospital, Bhopal) presented results of extensive research involving prenatal exposures of mice and cancer incidence. Prenatal exposure was shown to increase genome instability significantly. Professor R. K. Kale (JNU) presented evidence of the xanthine oxidoreductase system producing free radicals in the post-irradiation period suggesting, thereby, that inhibition of the system may reduce radiation damage. Dr B. S. Dwarkanath (Institute of Nuclear Medicine and Allied Sciences, Delhi) discussed the possible use of minor groove binding DNA ligands, such as Hoechst 33258 and 33342, for protection of radiation-induced DNA damage. The Hoechst ligands were shown to scav-

enge free radicals as well as afford stabilization to the DNA superstructure. Dr A. Chatterjee (NEHU, Shillong) elaborated on the use of the endogenous radioprotector, GSH, in reducing post-irradiation damage to proliferating cells.

3. Recommendations

The final session of the workshop was a round-table plenary discussion with panellists Professor P. N. Srivastava (India), Professor M. S. Sasaki (Japan), Dr F. H. A. Schneeweiss (Germany), Dr A. Trivedi (Canada) and Dr Vijaylaxami (USA). The session was initiated by a short presentation on ‘Chemical, Biological, Radiological and Nuclear Research & Technology Initiative’ by Dr Trivedi. All panellists and the participants interacted extensively and freely on various aspects of the proceedings of the day and made recommendations to define a strategy to handle a nuclear disaster scenario. Briefly, the main points of the recommendations were as follows (for details see, ISRB Recommendations 2002):

- International collaborations/partnerships: Closely interactive joint efforts be initiated and strengthened for free exchange of information and collaborative research among scientists and institutions engaged in radiobiological teachings and research across the globe.
- Preparedness: The participants felt strongly that ‘preparedness’ was an essential component of containing the damage of a nuclear disaster. It was felt that special initiatives were needed for school children and public awareness. The ISRB should play a proactive role in the design of such programmes to prevent misinformation and unfounded alarm to children and the public.
- First-response team: First-response teams should be created at various locations. The Fire Brigade, Police and paramilitary personnel should be given training and orientation on the effects of radiations and the handling of radiation accident/disaster situations including decontamination procedures. Preparation of emergency situation ‘manuals’ for different teams was recommended.
- Categorization of hospitals: Hospitals should be categorized and equipped for handling various categories of patients and different degrees of emergencies. Triage centres and teams, emergency centres, definitive care centres and specialized centres could be some of these categories of hospitals.
- Trauma control hospitals: Specialized hospitals with psychotherapists and psychoanalysts should be developed for trauma control.

Diary of events

The *Journal* welcomes announcements of events from conference organizers for inclusion in this diary. Relevant information should be sent to the Editor.

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- June 1-3** **2nd ESTRO Workshop on Biology in Radiation Oncology, Berg en Dal/Nijmegen, Netherlands.** Contact: ESTRO, Avenue E. Mounier 83, Brussels, Belgium 1200; Tel: +32 2 775 93 40; E-mail: info@estro.be
- August 13-15** **5th Auger Symposium, An International Meeting on Physical, Molecular and Cellular Aspects of Auger Processes, Peter MacCallum Cancer Institute, St Andrews Place, East Melbourne, Victoria 3002, Australia.** Contact: Dr Hooshang Nikjoo, MRC Radiation & Genome Stability Unit, Harwell, UK. Tel: +44-(0)1235-834776; Fax: +44-(0)1235-834776. URL: www.ragsu.har.mrc.ac.uk; E-mail: auger5har.mrc.ac.uk
- August 17-22** **12th International Congress of Radiation Research, Brisbane Australia.** Contact: ICMS, PO Box 3496, South Brisbane, Queensland, Australia 4101. Tel: +61 7 3844 1138; E-mail: icrr2003@icms.com.au
- September 10-13** **The Sixth International Symposium on Chromosomal Aberrations, University of Essen, Germany.** The following topics will be discussed: 1) DNA Repair Related to Chromosomal Aberrations, 2) Molecular Cytogenetics, 3) Chromosomal Aberrations: Basic Aspects, 4) Chromosomal Aberrations: Applied Aspects, 5) Chromosomal Alterations and Human Diseases. Contact: Prof. G. Obe, Dept. of Genetics, University of Essen, Universitaetsstrasse 5, 45117 Essen, Germany. Tel: +49 201 183 2688; Fax: +49 201 183 4397; URL: www.uni-essen.de/genetik; E-mail: guenter.obe@uni-essen.de
- September 21-25** **ECCO 12 - The European Cancer Conference, Copenhagen, Denmark.** Contact: ECCO 12 Secretariat, Federation of European Cancer Societies, Avenue E. Mounier 83, Brussels, Belgium B-1200. Tel: +32 2 775 02 01; E-mail: ecco12@fecs.be
- October 19-23** **ASTRO: 45th Annual Meeting, Salt Lake City, UT, USA.** Contact: American Society for Therapeutic Radiology and Oncology, 12500 Fair Lakes Circle, Suite 375, Fairfax, Virginia 22033-3 USA. Tel: +1 (703) 502 1550; E-mail: meetings@astro.org

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