



**Advances in  
Consequence  
Management for  
Radiological  
Terrorism Events**

**PROGRAM**

**Fortieth  
Annual Meeting**

**April 14–15, 2004**

**Crystal Forum  
Crystal City Marriott  
1999 Jefferson Davis Highway  
Arlington, Virginia**

**National Council on  
Radiation Protection  
and Measurements**



## Advances in Consequence Management for Radiological Terrorism Events

***A unique series of presentations on recent advances in managing the immediate and long-term consequences of terrorism involving radiation exposure and the release of radioactive materials.***

The 2004 Annual Meeting of the National Council on Radiation Protection and Measurements is focused on advances in counteracting the threat to human life created by acts of radiological terrorism. International experts involved in planning for this form of terrorism will discuss the current threat and state of preparedness in both the United States and worldwide. Major advances in several aspects of preparing for acts of radiological terrorism will be described, including new radiation detection technologies, current and future biological dosimetry, recent advances in the development of chemical protectants and therapeutic agents for mitigating radiation health effects, and strategies for identifying and managing the psychological impacts of a radiological terrorism event. Other presentations will focus on practical and scientifically-based approaches for efficiently cleaning up and restoring sites contaminated as a result of terrorist actions involving the release of radioactive materials.





## Program Summary

Wednesday, April 14, 2004

### Opening Session

8:15 a.m.

#### **Welcome**

Thomas S. Tenforde, *President*  
National Council on Radiation Protection and  
Measurements

### **First Annual Warren K. Sinclair Keynote Address**

8:30 a.m.

Introduction of the Lecturer  
Thomas S. Tenforde

#### **Current Challenges in Countering Radiological Terrorism**

John W. Poston, Sr.  
Texas A&M University

### **Radiological Terrorism— Introduction and Preparedness**

Cheri Abdelnour, *Session Chair*

9:15 a.m.

#### **Radiological Threat Assessment and Federal Response Plan—Gap Analysis**

Philip L. Liotta  
Armed Forces Medical Intelligence Command  
W. Craig Conklin  
U.S. Department of Homeland Security

9:45 a.m.

#### **The U.S. National Response to Radiological Incidents**

Alan L. Remick  
U.S. Department of Energy

10:15 a.m.

Break

10:45 a.m.

#### **Advances in Radiation Detection Technologies for Responders**

Michael P. Unterweger  
National Institute of Standards and Technology

## Medical Management of Radiological Terrorism Events

Jill A. Lipoti, *Session Chair*

- 11:15 a.m. **Medical Resources and Requirements**  
Fred A. Mettler, Jr.  
University of New Mexico
- 11:45 a.m. **Current and Future Biological Dosimetry**  
William F. Blakely  
Armed Forces Radiobiology Research Institute
- 12:15 p.m. Lunch
- 1:30 p.m. **Medical Treatment for Radiological Casualties**  
Ronald E. Goans  
Tulane University and MJW Corporation  
Jamie K. Waselenko  
Walter Reed Army Medical Center
- 2:00 p.m. **Hospital Management of Mass Radiological Casualties**  
James M. Smith  
Center for Disease Control and Prevention
- 2:30 p.m. **Psychological and Communication Issues in Radiological Terrorism Situations**  
Steven M. Becker  
University of Alabama at Birmingham
- 3:00 p.m. Break

## Research Advances in Radiation Prophylactic and Therapeutic Strategies

Terry C. Pellmar, *Session Chair*

- 3:30 p.m. **Radiation Protectants: Current Status and Future Prospects**  
Thomas M. Seed  
Catholic University of America
- 4:00 p.m. **Defining the Full Potential of Supportive Care and Cytokine Therapy in the Post-Radiation Accident Environment**  
Thomas MacVittie and Ann M. Farese  
University of Maryland  
William Jackson, III  
Armed Forces Radiobiology Research Institute
- 4:30 p.m. Break



## Twenty-Eighth Lauriston S. Taylor Lecture on Radiation Protection and Measurements

- 5:00 p.m. **Introduction of the Lecturer**  
Brian Dodd  
BD Consulting
- Radiation Protection in the Aftermath of a Terrorist  
Attack Involving Exposure to Ionizing Radiation**  
Abel J. Gonzalez  
International Atomic Energy Agency
- 6:00 p.m. **Reception in Honor of the Lecturer**

### Thursday, April 15, 2004

- 8:30 a.m. **Business Session**  
**Consequence Management Strategies**  
Robert C. Ricks, *Session Chair*
- 10:00 a.m. **International Efforts in Countering Radiological  
Terrorism— International Atomic Energy Agency and  
World Health Organization**  
Brian Dodd  
BD Consulting
- 10:30 a.m. **International Knowledge Base for Cleanup and Site  
Restoration**  
Friedrich Steinhausler  
University of Salzburg
- 11:00 a.m. **National Policy for Cleanup and Site Restoration**  
W. Craig Conklin  
U.S. Department of Homeland Security
- 11:30 a.m. **Practical and Scientifically-Based Approaches for  
Cleanup and Site Restoration**  
Debra McBaugh  
State of Washington Department of Health  
John E. Till  
Risk Management Corporation
- 12:00 noon **Questions and Discussion**
- 12:15 p.m. **Closing Remarks**  
Thomas S. Tenforde, *President*  
National Council on Radiation Protection and  
Measurements





## Abstracts of Presentations

Wednesday, April 14, 2004

### Opening Session

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National Council on Radiation Protection and  
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#### **First Annual Warren K. Sinclair Keynote Address**

8:30 a.m.

Introduction of the Lecturer  
Thomas S. Tenforde

#### **Current Challenges in Countering Radiological Terrorism**

John W. Poston, Sr.  
Texas A&M University

Terrorism, although perhaps known by other names, is not a new phenomenon. It dates back to Roman times and perhaps even further in world history. The Romans used terrorism quite effectively as they conquered large portions of the known world—although they called it a “punitive war” or a “destructive war.” Caleb Carr in his little book entitled “*The Lessons of War*” summarizes terrorism by stating, “Terrorism, in other words, is simply the contemporary name given to, and the modern permutation of, warfare deliberately waged against civilians with the purpose of destroying their will to support either leaders or policies that the agents of such violence find objectionable.” It also is hard for the general public to remember or recognize that terrorism against U.S. citizens is not new. Certainly the terrorist events leading up to the Civil War, such as the events in “bloody Kansas” and John Brown’s

raid on Harper's Ferry, illustrate that this country has not been immune.

In modern times, there have been isolated acts of citizens against each other, although these acts usually were directed toward symbols of the federal government. In the Middle East and other parts of the world, random acts of violence against U.S. citizens and military personnel date back into the early 1960s. But, these events occurred in distant lands of sometimes-uncertain location and the American public soon forgot them and their important message. Even though there had been at least one other attempt on the World Trade Center, it was not until September 11, 2001 that successful, large-scale acts of terrorism came to our shores.

In 1998, the NCRP formed a Scientific Committee and charged the committee with the task of providing a report on the state of preparation and the potential use by terrorists of radiation and radioactivity. The draft report of the committee was produced a year in advance of the events of September 11th and was published in its final form about a month after these terrible events. The report brought together in one place information that existed in a number of areas, not all of which were easily accessible. However, there were a number of gaps in the information and in the planning and preparation for such events. These were reflected in a series of recommendations for organization, planning and training, as well as for research and development in a number of areas. One of the highest barriers to preparation and response to such events was the fragmented structure within the federal government and the huge number of agencies with some mandated responsibility to play a role in the response. In addition, the report helped planners, trainers and responders recognize the often-neglected aspect of the "worried well" and their potential impact of the health delivery infrastructure during a large-scale emergency.

Now, nearly three years later, the NCRP has chosen to focus on the progress we have made in several of these areas. The title of the 40th Annual Meeting begins with the word "advances" and we will spend the next two days considering what has been accomplished and what needs to be done so we can be better prepared for terrorist acts involving radiation and radioactivity.



## **Radiological Terrorism— Introduction and Preparedness**

Cheri E. Abdelnour, *Session Chair*

9:15 a.m.

### **Radiological Threat Assessment and Federal Response Plan—Gap Analysis**

Philip L. Liotta

Armed Forces Medical Intelligence Command

W. Craig Conklin

U.S. Department of Homeland Security

The ability of the federal government to effectively and efficiently respond to nuclear or radiological terrorist incidents has been the subject of intense discussion and analysis for many years. Because of recent terrorist activities and intelligence information, there is strong sentiment that it is not a question of if, but when, a radiological terrorist incident will occur. As a result, there is considerable concern that the federal government may not be adequately prepared to respond to an incident involving a radiological dispersal device (RDD) or improvised nuclear device (IND). In response to these concerns, federal departments and agencies have initiated steps to develop a better understanding of the magnitude of the threat and to improve the ability of the federal government to support state and local response efforts. This paper will provide an unclassified assessment of the RDD/IND threat facing the United States. In addition, the paper will describe federal efforts to improve the nation's ability to plan for, respond to, and recover from such terrorist incidents. In an era of limited fiscal growth and competing priorities, the federal government will have to work collaboratively with state and local governments, the private sector, and academia to ensure that the nation is capable of responding to a nuclear/radiological terrorist incident.

9:45 a.m.

### **The U.S. National Response to Radiological Incidents**

Alan L. Remick

U.S. Department of Energy

The Federal Radiological Emergency Response Plan (FRERP) establishes an organized and integrated capability for timely, coordinated response by federal agencies to peacetime radiological emergencies. The FRERP provides

the federal government's concept of operations, outlines federal policies and planning considerations, and specifies authorities and responsibilities of the federal agencies that have a significant role in responding to radiological emergencies. Each of the participating federal agencies has responsibilities and capabilities that pertain to various types of radiological emergencies.

The U.S. Department of Energy's (DOE) National Nuclear Security Administration (NNSA) has the world's leading scientists, engineers and technicians from over 50 years of managing the nation's nuclear weapons programs. Throughout these many years of training and experience, NNSA has perfected a system of emergency response including triage, initial notification, monitoring and assessment of the situation, and working with other agencies to resolve the emergency. When the need arises, NNSA is prepared to respond immediately to any type of radiological accident or incident anywhere in the world with seven radiological emergency response assets. NNSA's radiological emergency response assets include the Aerial Measuring System, the Atmospheric Release Advisory Capability, the Accident Response Group, the Federal Radiological Monitoring and Assessment Center, the Nuclear Emergency Support Team, the Radiological Assistance Program, and the Radiation Emergency Assistance Center/Training Site. Each asset handles certain aspects of the radiological response and all are designed for rapid response.

This presentation will be a comprehensive overview of both NNSA's emergency response system, and the national response assets provided by other federal agencies (*i.e.*, Department of Defense, Veterans Administration, Health and Human Services) that are available for response to radiological incidents in the United States. Specific areas of focus will include the capabilities of the various response organizations, and how the assets of multiple national agencies integrate with state and local first responders through verification of initial information, crisis and consequence management, and ultimately remediation.

10:15 a.m.

**Break**



10:45 a.m. **Advances in Radiation Detection Technologies for Responders**

Michael P. Unterweger  
National Institute of Standards and Technology

Since the events of September 11th, 2001 the technical capabilities available to emergency responders, particularly in regard to terrorist use of weapons of mass destruction, have come under great scrutiny from experts. Subsequently the development and marketing of new technologies for the detection of radiation has been dynamic. Radiation detection instruments have long been used to determine the presence and magnitude of radioactive material in many medical and industrial applications. Likewise, their proper selection, use and application are critical in the response to incidents involving the release of radiation. Specific methods and devices are then also needed by the first-responder community to detect the presence of radioactive sources that may be illegally transported, deliberately placed, or purposely dispersed with the intent of causing harm. These instruments are required to alert the user to the presence of a radiation source that is distinctly above the level of background radiation, and may also be carried to evaluate the potential for harmful biological effects.

These methods and devices include: (1) alarming personal radiation detectors, (2) hand-held instrument for detection and identification of radionuclides, (3) radiation detection portal monitors, and (4) portable radiation detection instrumentation.

The aim of this presentation will be to provide an overview of the latest advances in technology for emergency responders in the detection and prevention of a radioactive or nuclear terrorist incident. Additionally, the advances made by the U.S. Department of Homeland Security and National Institute of Standards and Technology in establishing the requirements for equipment to be used to prevent and respond to a terrorist attack, the eventual deployment of these instruments, and the related training will be examined and future needs will be discussed. The status and review of proposed and existing standards pertaining to radiological equipment used by emergency responders will be presented, and the projected consequences of these requirements will be discussed. An overview of current instrumentation being used, and the

direction of developing instrumentation pertaining to the areas of four American National Standards Institute standards (corresponding to the equipment categories listed above) will be given, along with a discussion of the effectiveness of present instrumentation.

## Medical Management of Radiological Terrorism Events

Jill A. Lipoti, *Session Chair*

11:15 a.m.

### Medical Resources and Requirements

Fred A. Mettler, Jr.  
University of New Mexico

Medical planning and response to radiological terrorism is different than planning or response to an event such as a nuclear power plant accident. The major differences are that now we must plan for multiple simultaneous events, suicide scenarios, and the possibility of biological, chemical and radiological agents being used at the same time. This demands an “all-hazards” approach not just radiological response.

While there are very few physicians who have actual experience in the management of radiation injuries, the medical radiological aspects will be helped by the staff and resources available in hospitals as well as in many professional societies and organizations. For example, there is a slide set prepared by the Health Physics Society and the American College of Radiology has a primer on radiological terrorism available at their web site. The Centers for Disease Control and Prevention web site now includes documents on management in the emergency room and other aspects (such as radiation and pregnancy).

Currently the Departments of Health and Human Services and Homeland Security are examining the issue of having a team of medical experts on call for radiological terrorist events. While a small or medium radiological terrorist event can be handled locally or with state and federal resources the use of a relatively low-yield nuclear weapon in an urban area may even require foreign medical assistance. It has been estimated that for a one kiloton detonation there may be more than 7,000 prompt casualties, and about 20,000 persons who will require intensive care treatment. For radiological events there are coordinating assistance centers at Radiation Emergency Assistance Center/



Training Site in Oak Ridge and internationally at the International Atomic Energy Agency and the World Health Organization.

Recent advances include the assessment and prioritization of current and research needs as well as issues related to availability and utility of dosimetry and drugs and stockpiling issues. The U.S. Food and Drug Administration has recently fast-tracked a number of drugs (such as Prussian Blue) to allow them to be used without the requirements associated with investigational drugs. The Homeland Security Department Radiological/Nuclear Threat Countermeasures Group has produced a number of documents that are available to the public. A committee of the National Academy of Sciences is currently addressing aspects of the use of potassium iodide.

There are a number of currently available resources that should be known. The Armed Forces Radiobiology Research Institute has a number of resources available online. These include a handbook on the *Medical Management of Radiation Casualties* as well as the BAT (Biological Assessment Tool) program which allows clinical data to be input and provides an estimate of the likely absorbed dose. There are a number of textbooks and reports (such as NCRP Report No. 138) that are currently available and a number in production. In addition, the International Commission on Radiological Protection is working on a new document on radiological protection in the event of a terrorist event.

11:45 a.m.

### **Current and Future Biological Dosimetry**

William F. Blakely

Armed Forces Radiobiology Research Institute

Effective medical management of a suspected radiation overexposure incident necessitates the recording of dynamic medical data and the measurement of appropriate radiation bioassays in order to provide diagnostic information to the treating physician and dose assessment for personnel radiation protection records. The accepted generic multiparameter approach includes (1) radioactivity measurements and monitoring of the exposed individual; (2) observation and recording of prodromal signs/symptoms and erythema; (3) obtaining complete blood counts (CBCs) with white blood cell differential; (4) blood sampling for the chromosome-aberration cytogenetic bioassay, using the “gold standard” dicentric assay for dose

assessment; (5) bioassay sampling, if appropriate, to determine radioactivity contamination; and (6) use of other available dosimetry approaches. The Biological Assessment Tool (BAT), a radiation casualty management software application available at the AFRRRI website ([www.afrrri.usuhs.mil](http://www.afrrri.usuhs.mil)), was developed to facilitate medical recording and bioassay dose prediction features of this function. Prodromal signs and symptoms as well as body location and degree of transitory radiation-induced erythema should be recorded. Ronald Goans and colleagues recently published prodromal symptom dose prediction models based on the time for onset of vomiting following photon and criticality accident exposures. A CBC with white cell differential should be obtained immediately after exposure, then three times a day for the next two to three days, and then twice a day for the next three to six days. Lymphocyte cell counts and lymphocyte depletion kinetics provide dose assessment prediction between a 1 and 10 Gy photon equivalent dose range. Following coordination with a qualified radiation cytogenetic biodosimetry laboratory and typically at 24 hours after exposure, a blood sample should also be taken for dose assessment using the “gold standard” lymphocyte-dicentric radiation bioassay. Several cytogenetic biodosimetry laboratories now also use the premature chromosome condensation bioassay, which permits dose assessment at higher doses (>5 Gy photon equivalent and acute high-dose rate exposures). Other opportunistic dosimetry approaches should be considered.

Current national resources need to be enhanced to provide suitable dose assessment and medical triage and diagnoses in the event of a large-scale radiological casualty incident. Establishment of this capability should be broadly based and include (1) stockpiling of reagents and devices; (2) establishment of deployable hematology and reference cytogenetic biodosimetry laboratories; (3) networking of qualified radioactivity-counting bioassay, cytogenetic biodosimetry, and deployable hematology laboratories with the medical responder community and national radiation protection program; and (4) research efforts to identify novel radiation biomarkers and develop applied biological dosimetry assays monitored with clinical, deployable and hand-held analytical systems.

Automated instrumentation to accomplish sample preparation and analysis for the conventional and cytogenetic-



based bioassays needs to be integrated into reference cytogenetic biodosimetry laboratories and beta tested. Complementary novel interphase-based cytological bioassays that detect cells with chromosomal aberrations and radiation-responsive molecular biomarkers (*i.e.*, gene expression, protein) need to be validated and optimized for rapid radiation exposure assessment applications. These research and applied science efforts should ultimately contribute towards approved, regulated biodosimetry devices or diagnostic tests.

12:15 p.m. **Lunch**

1:30 p.m. **Medical Treatment for Radiological Casualties**

Ronald E. Goans  
Tulane University and MJW Corporation  
Jamie K. Waselenko  
Walter Reed Army Medical Center

Victims of radiation terrorism require prompt diagnosis and treatment of medical and surgical conditions as well as conditions related to radiation exposure. Hospital emergency personnel should triage victims using traditional medical and trauma criteria. Patients should be stabilized and then assessed for radiation injury on the basis of dose, isotope, and whether there is internal contamination. Resource limitations may necessitate some differences in care in the event of mass casualties.

Radiation dose can be estimated using rapid-sort, automated biodosimetry, and clinical parameters such as the time to emesis (TE) and lymphocyte depletion kinetics. TE, measured from the irradiating event, decreases monotonically with increasing dose. For TE < 4 hours, the effective whole-body dose is likely at least 3.5 Gy. If TE < 1 hour, the whole-body dose exceeds 6.5 Gy. Lymphocyte depletion follows dose-dependent first order kinetics after high-level gamma and criticality incidents. Patient radiation dose can be estimated very effectively from the medical history, serial lymphocyte counts, and TE using the AFRRI Biological Assessment Tool (BAT).

Medical management of patients with moderate to severe radiation exposure (effective whole-body dose >3 Gy)

should emphasize treatment of radiation-induced neutropenia and prevention of infection. Initial care should reduce pathogen acquisition through reverse isolation, low-microbial-content food and water, selective use of gastrointestinal decontamination, and prophylaxis for opportunistic viral and fungal infections. Established or suspected infection in the neutropenic patient is managed in the same manner as for chemotherapy patients. Antibiotic prophylaxis should be considered in severely neutropenic patients and in patients who do not have a fever but are at the highest risk of infection. Wound closure should be also effected within 24 to 36 hours.

Cytokines increase the functional capacity of the neutrophil and thereby contribute to the prevention of infection. Hematopoietic growth factors, such as Neupogen® (G-CSF), Leukine® (GM-CSF), and the long-acting cytokine Neulasta®, stimulate hematopoiesis and shorten the period of neutropenia. For maximum clinical response, growth factors should be started 24 to 72 hours subsequent to the exposure. Moreover, irradiated preclinical models have also demonstrated a survival advantage in animals treated with early cytokines (<24 hours) as compared to those receiving delayed therapy or no treatment.

If internal contamination is suspected, the medically stabilized patient should be evaluated for internal contamination through a history of the event, 24 hours urine/fecal bioassay, and/or *in vivo* counting. Suspected isotopes should be identified, if possible. If there is evidence for significant intake, the most appropriate means for minimizing its impact is determined on the basis of the isotope's chemical properties. For <sup>137</sup>Cs, the most effective decorporation therapy is oral administration of Prussian Blue (PB), which enhances excretion of cesium by means of ion exchange and reduces the biological half-life to approximately one-third of its normal value. PB now has new drug status with the FDA and is to be included in the National Strategic Stockpile. With uranium exposure, the kidney is the first organ to show chemical damage. Oral doses or infusions of sodium bicarbonate help alkalinize urine, thereby promoting excretion of the nontoxic uranium carbonate complex. For inhalation of actinides, the treatment of choice is chelation therapy using Ca-DTPA and Zn-DTPA, preferably within six hours of exposure.



2:00 p.m. **Hospital Management of Mass Radiological Casualties**

James M. Smith  
Center for Disease Control and Prevention

Local hospitals and medical systems are a critical infrastructure for providing the early response necessary to treat injuries and reduce deaths from a terrorist event, including one that may be nuclear or radiological in nature. Hospitals and health care personnel could be called upon to manage extraordinary numbers of casualties amidst the chaos that accompanies terrorism, especially when the event involves an obscure agent such as radiation. Massive numbers of patients including both the injured and those concerned about potential exposure may seek medical attention, with a corresponding need for medical supplies, diagnostic and laboratory tests, hospital beds, information, and reassurance.

Rapid medical and public health response to terrorism is crucial. Hospitals should prepare for the unique features of radiological terrorism, such as mass casualties with blast injuries combined with burns, radioactive contamination, and acute radiation syndrome. Local medical services might become quickly disabled if provider facilities and equipment become significantly contaminated. One of the most important needs for hospitals and emergency departments is competency-based training for physicians, nurses, and allied health care workers. Training should include such basic principles as radiation protection, practical strategies for treating contaminated patients, and clear definition of roles and responsibilities of all staff. Basic radiation training, combined with realistic emergency response exercises, should help reduce stress and thereby increase the quality of care in a radiological mass casualty incident.

Finally, although providing the highest quality health care and patient treatment day-to-day is the hospital's primary goal, hospitals should work with community emergency planners as well as their local and state health departments on community planning for mass casualty incidents of all types. An important benefit of the overall planning process is developing new partnerships and reaffirming longstanding ones. In times of crises, these established relationships may prove invaluable.

2:30 p.m.

## **Psychological and Communication Issues in Radiological Terrorism Situations**

Steven M. Becker

University of Alabama at Birmingham

In many ways, NCRP Report No. 138 (*Management of Terrorist Incidents Involving Radioactive Materials*, October 2001) was a groundbreaking document. Using an integrated, multidisciplinary approach, the report provided the first comprehensive examination of crisis and consequence management concerns related to radiological/nuclear terrorism.

One of the most innovative aspects of NCRP Report No. 138 was the high priority it accorded to psychosocial issues. While previous discussions of radiological/nuclear terrorism had occasionally referred to these topics, NCRP Report No. 138 was the first report of its kind to emphasize that social, psychological and behavioral issues are *central* to the success or failure of crisis and consequence management efforts. A major terrorist incident involving radioactive materials could have tremendous psychosocial consequences, said NCRP Report No. 138, affecting communities, regions and even the nation as a whole. In light of this, concluded the report, psychosocial issues, and efforts to prevent adverse impacts, urgently need more attention in preparedness and response efforts.

In the two and a half years since the release of NCRP Report No. 138, a host of important developments have taken place in relation to psychosocial issues. It is these developments and their implications that are the focus of this presentation. Among the areas to be discussed are the results of federally-sponsored roundtables that have explored psychosocial and communication issues related to radiological terrorism; training exercises, where new efforts are being made to increase realism by incorporating psychosocial considerations; and new survey work that improves our understanding of both public and professional views of the radiological terrorism threat.

The largest part of the discussion, however, focuses on advances in the area of communication. Since 2002, a major project involving federal agencies and four universities has been under way to research and prepare clear, scientifically accurate, audience-tested "pre-event messages" that can be used when an unconventional terrorist incident occurs. Such messages are seen as a crucial



component of efforts to prevent or mitigate social, psychological and behavioral consequences. Key communication findings related to nuclear/radiological terrorism are highlighted, including issues related to the perceptions, information needs, self-protection concerns, and preferred information sources for a range of population groups. The presentation concludes by identifying some of the continuing psychosocial and communication challenges facing the nation as it moves to meet the threat of terrorism involving radioactive materials.

3:00 p.m. **Break**

## **Research Advances in Radiation Prophylactic and Therapeutic Strategies**

Terry C. Pellmar, *Session Chair*

3:30 p.m. **Radiation Protectants: Current Status and Future Prospects**

Thomas M. Seed  
Catholic University of America

In today's new heightened nuclear-biological-chemical threat environment, there is an increased need to have safe and effective means to protect not only special high-risk service groups but also the general population at large from the health hazards of untended ionizing radiation exposures. An unfulfilled dream of civil and military officials concerned with this issue has been to have a globally effective pharmacologic, *i.e.*, the magic radioprotective pill, that could be easily taken orally without any undue side effects prior to an suspected or impending nuclear/radiological event in order to provide the individual full bodily protection not only against early arising acute injury, but against late arising pathologies. As we all are acutely aware, such an ideal radioprotective agent has yet to be identified, let alone fully developed and approved for human use. No one would argue that this deficit is problematic and needs to be corrected, but where might the ultimate solution to this difficult problem be found? Without question, representative species within the aminothiols family [*e.g.*, amifostine (WR2721) and phosphonol (WR3689)] have proven to be potent cytoprotectants for normal tissues subjected to ionizing irradiation or to radiomimetic chemicals. These protectants operate largely

through free radical scavenging but other mechanisms of protection have been demonstrated as well (e.g., modulating genes tied to intracellular antioxidants, cell cycle checkpoints, cytokine mimicry, etc.). Although amifostine is currently used clinically for alleviation of xerostomia in cancer patients undergoing intense radiotherapy for head and neck tumors, inherent drug toxicity, limited time window of drug-induced protection, and administration of drug by intravenous infusion, all serve to limit the drug's utility in nonclinical settings. Based on the unfortunate lessons learned from the amifostine story, concerns over drug toxicity and associated performance-decrementing effects, still remain the principal drivers in the research and development of virtually all radioprotectants of interest for nonclinical purposes. Nevertheless, new insights into basic molecular and cellular pathways of radiation-induced cell death and in turn tissue dysfunction are providing researchers with a host of brand new targets upon which to develop new classes of naturally occurring isolates or *de novo* synthesized radioprotective agents.

Currently a full range of research and development strategies are being employed in the hunt for new safe and effective radioprotectants including:

1. large scale screening of newly identified chemical classes or natural products;
2. reformulating or restructuring of older protectants with proven efficacies but unwanted toxicities;
3. using nutraceuticals that are only moderately protective but that are essentially nontoxic and exceedingly well tolerated;
4. using low dose combinations of potentially toxic (at high drug doses) but efficacious agents that cytoprotect through different routes in hopes of fostering radioprotective synergy; and
5. accepting lower levels of drug efficacy in lieu of reduced toxicity, banking on the premise that any/all of the protection afforded by the drug can be leveraged by effective post-exposure therapies.

Although it is difficult to predict which of these strategies will ultimately prove to be successful in yielding the desired product, *i.e.*, safe and effective radioprotectants for nonclinical applications, it is a certainty that the probability of a useful protectant being fielded is increased significantly. This is due to the resurgence of interest in the



radiation protection field, increased resources being expended by both federal agencies and private concerns alike in order to address the problem, and finally by FDA's willingness to innovate relative to new approval guidance (e.g., design and implementation of the "New Animal Rule").

4:00 p.m.

**Defining the Full Potential of Supportive Care and Cytokine Therapy in the Post-Radiation Accident Environment**

Thomas MacVittie and Ann M. Farese

University of Maryland

William Jackson, III

Armed Forces Radiobiology Research Institute

Several prevailing themes are present throughout the radiation accident scenario. Namely, the radiation environment is likely to be ill-defined and uncontrolled. Also, the exposure may be nonuniform, partial-body, and of variable dose rate and exposure time. The time interval between exposure and treatment is usually less than optimal and it is difficult to establish an accurate absorbed dose. The only reasonable aspect of the radiation exposure is that its uncontrolled and ill-defined nature will forecast a variable dose distribution and possible sparing of hematopoietic stem cells.

The definition of an effective treatment strategy for radiation-induced myelosuppression will depend on the aforementioned conditions. We propose that there is only one treatment strategy available for irradiated personnel. It is available now and focuses on the prevention of radiation-induced neutropenia and infection. Its two components are aggressive supportive care and administration of recombinant cytokines as soon as possible after radiation exposure and triage.

We support our proposal with a consistent and substantial data base in preclinical, large animal (canine and rhesus monkey) models of severe radiation-induced myelosuppression. The data base underscores the efficacy of supportive care and recombinant cytokines in enhancing the recovery of myelopoiesis, as well as increasing survival after lethal doses of acute, total-body irradiation.

This data base is concordant with requirements under the Food and Drug Administration's rule for approval of new

drugs and biological products when efficacy studies in humans are not ethically feasible. In this regard, there is a reasonably well understood mechanism of radiation effects and prevention. The treatment effects are substantiated in two relevant species and the response is predictive for humans. New directions in growth factor therapies will also be discussed.

4:30 p.m. **Break**

### **Twenty-Eighth Lauriston S. Taylor Lecture on Radiation Protection and Measurements**

5:00 p.m. **Introduction of the Lecturer**

Brian Dodd  
BD Consulting

### **Radiation Protection in the Aftermath of a Terrorist Attack Involving Exposure to Ionizing Radiation**

Abel J. Gonzalez  
International Atomic Energy Agency

6:00 p.m. **Reception in Honor of the Lecturer**



**Thursday, April 15, 2004**

8:30 a.m. **Business Session**

9:30 a.m. **Break**

## **Consequence Management Strategies**

Robert C. Ricks, *Session Chair*

10:00 a.m. **International Efforts in Countering Radiological Terrorism—International Atomic Energy Agency and World Health Organization**

Brian Dodd  
BD Consulting

An analysis of the possible goals of terrorists and the means of achieving them leads to an assessment of the most likely target materials and facilities for radiological terrorism. Countering this has two main objectives. The first is to prevent, detect and respond to *acquisition* of the target radioactive materials, or *access* to the target facilities. This has to be done throughout the life-cycle for radioactive sources. The second objective is to prevent, detect and respond to the *use* (or threat of use) of these materials, or *sabotage* of the facilities, and to minimize the consequences of such use or sabotage. The number of international bodies, groups, agencies and organizations contributing to these goals is very large and almost impossible to catalogue. However, this paper groups the types of efforts that are being undertaken, identifies the key agencies involved, and provides some specific examples of their work.

10:30 a.m. **International Knowledge Base for Cleanup and Site Restoration**

Friedrich Steinhausler  
University of Salzburg

Based on detailed Al Qaeda plans for an advanced version of a *dirty bomb* uncovered in Afghanistan, and the arrest of the American sympathizer Jose Padilla on May 8, 2002 on suspicion of intending to deploy a radiological dispersal device (RDD) in the United States, there is concern among members of the U.S. intelligence community about a terror

attack resulting in the uncontrolled release of radioactivity. Besides the human toll due to the explosive yield of the device, this would result in an additional challenge, *i.e.*, the radiological impact on man and the environment. This presentation reviews the issues considered critical for selecting a scientifically sound and cost-effective approach to cleanup and site restoration (CSR) of the site affected by such a terror attack.

The current knowledge base concerning CSR of areas contaminated due to the deployment of an RDD is derived from a significant amount of scientific data derived from military tests or civil defense exercises (*e.g.*, *Project 57, Roller Coaster, Igloo tests, Kismet, TOPOFF2, DACIA 2003*), as well as field data resulting from accidents [Pacific Islands (1962), Chernobyl (1986), Goiania (1987)] assembled over the past 50 years. This presentation will focus *inter alia* on the extensive experience in CSR gained in the aftermath of the Chernobyl reactor accident in 1986, and in the management of the incident in the Brazilian city of Goiania in 1987.

The decision on the optimum CSR strategy after the deployment of an RDD is a complex issue and needs to consider the following issues: the activity/amount of material released, isotopic properties and the physical/chemical status of the radioactive material used in the RDD (prime candidates:  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$ ,  $^{60}\text{Co}$ ); details of the explosive device that distributed the radioactive material, thereby determining the size of the particles released (*e.g.*, use of TNT, C4, or ANFO); meteorological conditions at the time of the detonation of the RDD (direction and speed of wind, precipitation, stability class, season); location and size of buildings near the site of deployment of the RDD (detonation indoors or outdoors); type of area designated for cleanup (urban, rural); category of material to be decontaminated (soil, grass, concrete, plaster, asphalt, steel, glass, marble, limestone).

Extensive experience in CSR has been gained in the aftermath of the Chernobyl reactor accident in 1986 concerning the  $^{137}\text{Cs}$ ,  $^{90}\text{Sr}$  and plutonium contamination in the 30 km zone, and during the management of the incident in the modern metropolis of Goiania involving a stolen  $^{137}\text{Cs}$  source. A review of the different stages of the intervention policy in the former USSR reveals that risk-benefit-cost analysis was not used for the decision-making process



during the later stages of the post-accident situation. Originally the exposure-based 350 mSv concept was conceived during 1988 to 1990 to limit late health effects. This concept accounted for the lifetime dose (external and internal exposures, excluding the exposure to the natural radiation environment). However, as a result of public pressure on decision makers this led to a situation where radiological considerations were dominated by sociopolitical factors. Subsequently a CSR policy was adopted that resulted in continuously escalating costs. Ultimately, the level reached for the protection of one person from the hypothetical post-accident radiation exposure equalled the cost for the average medical health care of 10,000 persons from other health hazards. It can be safely assumed that the situation is likely to be worse in a country with more favorable socioeconomic conditions. This reflects the controversy between the conceptual basis of radiological emergency response and the practice of decision making under the inevitable pressures of sociopolitical factors, combined with inadequate public perception of radiation-related risk.

The incident in Goiânia, resulting in large-scale contamination of a city with over one million inhabitants caused without any criminal intention, demonstrated the inherent difficulties of implementing a sound CSR based on a balanced judgment of all relevant factors, such as public safety and environmental issues. Although the contamination was due to losing control inadvertently over just one hospital  $^{137}\text{Cs}$  source, the cleanup operation took six months and produced more than 5,000 m<sup>3</sup> of waste. Due to the tropical climate, a dedicated waste storage site had to be constructed for the material resulting from the demolished buildings, contaminated furnishings and vegetation, etc. Despite all these efforts, the change of lifestyle and land use due to the CSR was widely perceived by the citizens as a symbol of a hazard in everyday life. This shows clearly that the ultimate effectiveness of countermeasures depends also on the psychological acceptance of the CSR by the affected population.

With regard to the deployment of an RDD it is probable that in many cases the resulting radiation exposure of the targeted population will be insufficient to cause a severe radiation detriment. Nevertheless, due to atmospheric dispersion of the radioactive material an urban area equaling several city blocks could be affected, resulting in the

contamination of buildings, roads, sidewalks and recreational areas such as parks. It cannot be excluded that the radioactive contamination may be extensive in the near-zone of the site of deployment of the RDD. However, many areas in the far-zone are likely to be contaminated to a largely varying degree, down to a level of a resulting hypothetical radiation risk considered trivial. In any case, there will be many reasons for the contaminated property to return to a normal or unregulated state. For this purpose the international community has developed different approaches to CSR, ranging from a multiplicity of guidance levels (unconditional clearance, authorized release, authorized disposal, specific clearance, exemption, etc.), to the recommendation of individual and collective dose constraints to be fulfilled before such a site can be released for unrestricted use, or otherwise released for restricted use.

The CSR approach taken by the European Union and Japan, together with the recommendations by the International Atomic Energy Agency, will be discussed in terms of its applicability to managing the aftermath of an RDD terror attack. Thereby, this presentation aims to assist in the development of common views on CSR *prior* to the deployment of an RDD. This proactive approach should ultimately contribute to a better protection of the population and the environment, lead to a more standardized technological practice for reducing the generation of waste, and make regulatory decisions and the whole CSR process more transparent and thereby more readily acceptable to the public.

11:00 a.m. **National Policy for Cleanup and Site Restoration**

W. Craig Conklin

U.S. Department of Homeland Security

Cleanup following a radiological dispersal device (RDD) or improvised nuclear device (IND) is likely to be technologically challenging, costly, and politically charged. Lessons learned from the Top Officials 2 (TOPOFF2) exercise and the increased threat of terrorist use of an RDD or IND have driven federal officials to push for an agreed-upon process for determining appropriate cleanup levels.

State and local authorities generally have the ultimate responsibility for final public health decisions in their jurisdictions. In terrorist attacks, certainly of national significance, local authorities are likely to request federal



assistance in assessing risk and establishing appropriate cleanup levels. It is realistic to expect local and state requests for significant federal assistance in planning and implementing recovery operations. State and local authorities may desire “shared accountability” with the federal government in setting the appropriate cleanup levels. Government officials at all levels will face pressure to say how clean is clean enough and how quickly people can re-enter the affected areas. Issues arising include: (1) the nature of the relationship between the federal, state, and local leadership involved in the recovery efforts and (2) where the funding for recovery comes from. Many agencies, including the U.S. Environmental Protection Agency (EPA), the U.S. Nuclear Regulatory Commission (NRC) and the U.S. Department of Energy (DOE) have long been involved in cleanup activities involving radioactive materials. These agencies have recognized the need for a participatory process and realize the need to remain flexible when faced with possibly unprecedented environmental challenges following a terrorist attack. Currently, the U.S. Department of Homeland Security has a committee process underway, with participation of EPA, NRC, DOE, and other federal agencies, to try to resolve these issues and to begin engaging state, local and tribal governments, and others as appropriate.

11:30 a.m.

**Practical and Scientifically-Based Approaches for Cleanup and Site Restoration**

Debra McBaugh  
State of Washington Department of Health  
John E. Till  
Risk Management Corporation

This paper presents practical and scientific approaches for cleanup and site restoration following terrorist events. Both approaches are required in real emergency situations and the two are complementary. The practical examples are taken from the May 2003 second biannual national emergency exercise, Top Officials 2, that occurred in Chicago and Seattle. Scientific examples are taken from the Department of Energy sites at Rocky Flats, Fernald, and Los Alamos where cleanup initiatives are underway that are based on scientific approaches and include community input. Three examples are provided to explain from a practical standpoint how decisions during the exercise

had to be made quickly, even though the alternatives were not always clear. These examples are used to illustrate how scientific approaches can be integrated into the resolution of these dilemmas. The examples used are:

1. The use of water to wash city roads and freeways contaminated with plutonium,  $^{241}\text{Am}$  and  $^{137}\text{Cs}$ ;
2. Decontamination of large public ferries that passed through a radioactive plume;
3. Handling of wastewater following decontamination within a city.

Each of these situations posed the need for an immediate decision by authorities in charge, without the benefit of community input or time for an analysis of the important pathways of exposure. It is evident there is a need to merge the practical knowledge gained in emergency response with scientific knowledge learned from cleanup and site restoration. The development of some basic scientific approaches ahead of time in the form of easy-to-use tools will allow practical decisions to be made more quickly and effectively should an actual event occur.

12:00 noon      **Questions and Discussion**

12:15 p.m.      **Closing Remarks**

Thomas S. Tenforde, *President*  
National Council on Radiation Protection and  
Measurements



## **The Program Committee**

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## **Registration**

Wednesday, April 14, 2004  
7:30 a.m. – 5:00 p.m.

Thursday, April 15, 2004  
8:00 a.m. – 12:00 noon

There is no registration fee.

## **2005 Annual Meeting**

March 30–31, 2005 in Arlington, Virginia

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