

NATO-Committee on Challenges of Modern Society

Pilot Study

**HEALTH AND MEDICAL ISSUES ASSOCIATED
WITH THE RELEASE OF HAZARDOUS SUBSTANCES**

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PREFACE

Markku Murtomaa, M.D., M.Sc.

The manufacture and use of potentially hazardous chemical materials has become a major concern to the European Community. While several international programs and guidelines have been prepared, there are areas for continued improvement and expansion of international cooperative activities.

The Code of Practice in the prevention of major industrial accidents of Major Hazards control, the Seveso Directive, the European Community (EC) Major Hazards Directive and the International Program on Chemical Safety recognize that chemical safety requires international collaboration. Planning and implementation of control measures, harmonization of new and existing programs, readily accessible common data and information systems, and even international disaster response programs need to be furthered by all nations working in concert.

Health care providers respond to animal and human toxic exposures. Contaminated air, water, food, soil and other components of the physical environment are recognized as the source(s) of disease, disability and even death. Public health and environmental and preventive medicine professionals place their emphasis on preventing, rather than treating, unavoidable and unnecessary exposure to toxic chemicals and their byproducts. Chemical safety programs must concentrate on the source material - monitoring the handling, use and disposal. However, chemical safety programs must also appreciate the reality that the use of chemicals, in the public and private sectors, is big business, and therefore technical issues must be dealt with in both political and legislative forums.

In the past, relatively little attention has been paid to the management of the public health and medical consequences of exposure to toxic substances. Immediate intervention is generally required, and long term assessment mandated, to mitigate possible long-term health effects. Health effects need to be defined as physical health, psychological health (individual mental health), and social health (community mental health). The psychosocial effects of a chemical incident often may exceed the actual physical harm from the toxic exposure.

CCMS and PILOT STUDY HISTORY

M. Lynn Schoolfield

The Council of the North Atlantic Treaty Organization (NATO) established the Committee on the Challenges of Modern Society (CCMS) in 1969. This Committee was charged with developing meaningful programs to provide mechanisms to share information among countries on environmental and societal issues that complement international initiatives. Additionally, individual countries were asked to provide leadership and expertise in solving specific problems of the human environment. A fundamental concept of NATO/CCMS involves the transfer of technological and scientific solutions among nations with similar environmental challenges.

Since the establishment of NATO/CCMS in 1969, several studies concerning human health and environmental well-being have been completed. These studies are summarized as follows:

- ♦ 1970 - "Disaster Assistance" study. Participating countries directed their activities toward improving their state of readiness by reviewing necessary emergency measures taken during disasters, and post-disaster construction and rehabilitation.
- ♦ 1971-1976 - "Advanced Health Care." This study directed international cooperation to provide quality health care to patients by systematic assessment of health services, organizing ambulatory services, emergency medical services, and the automation of clinical laboratories.
- ♦ 1978-1991 - "Improvement of Emergency Medical Services." Several NATO and non-NATO countries, and the World Health Organization (WHO) participated in workshops and studies to plan, organize and manage emergency medical services (EMS) systems in their respective countries. Specific procedures and protocols included adequate emergency transportation, EMS communications, training and education of EMS personnel, and an overview of disaster planning and emergency preparedness.
- ♦ 1983 - "Risk Management of Chemicals in the Environment." Study participants recommended that countries be encouraged to reduce emissions of harmful chemicals and that information about the harmful effects of chemicals on human health and the environment be provided to the general public.
- ♦ 1984-1988 - "Health and Medical Aspects of Disaster Preparedness." The primary focus of this study was the importance of disaster planning and the necessary roles and responsibilities of individuals concerned with both natural and man-made disasters. Study results included suggested components of a

model disaster plan.

This pilot study provided a forum for international disaster planners and associated health and response personnel to meet and deliberate on ideas and recommendations on how cities and countries can address emergent community and public health and response issues. Meetings and workshops were held in key cities in NATO countries where participants discussed common problems and explored possible solutions.

- ♦ July 12-13, 1989. Pilot study leaders met in Baltimore, Maryland, to plan the study.
- ♦ June 14-16, 1990. First pilot study meeting, Brussels, Belgium. A visit was also made to St. Jan's Hospital in Brugge to review and discuss a case study involving the ferry boat disaster in Zeebrugge.
- ♦ April 22-26, 1991. Second pilot study meeting in Atlanta, Georgia, and Louisville, Kentucky. In Atlanta, briefings were received on the mission and structure of the Centers for Disease Control and Prevention (CDC), and the Agency for Toxic Substances and Disease Registry (ATSDR). In Louisville, the Louisville/Jefferson County Health Department provided an orientation of the health concepts and components of an integrated response plan for hazardous material releases on the local level.
- ♦ October 21-14, 1991. Third pilot study meeting, Brugge, Belgium.
- ♦ May 20, 1992. Fourth pilot study meeting, Apeldoorn, The Netherlands.
- ♦ October 19-22, 1992. Fifth pilot study meeting, Rockville, Maryland. Participants joined the Disaster Medical System Exercise (NDMS '92) held in Memphis, Tennessee and Cape Girardeau, Missouri.
- ♦ May 17-18, 1993. Sixth pilot study meeting, Eupen, Belgium.
- ♦ September 27-29, 1993. Final pilot study meeting, Louisville, Kentucky. Pilot study leaders and the working group prepared the summary, conclusions and recommendations for the study's final report.
- ♦ April 26-28, 1995 - The final report of the pilot study was presented to the CCMS Plenary and the CCMS/North Atlantic Cooperation Council (NACC) Plenary.
- ♦ April 29, 1995 -Follow-up meeting of pilot study group in Brugge, Belgium.

INTRODUCTION

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The effects and consequences of chemical incidents depend, to a great degree, on where and when the accident takes place. Adverse consequences, that is personal injury and property damage, will normally be greater in a densely populated area. Regardless of the actual degree of exposure, strong rational coherent response measures are necessary since such disturbances to the life of the community can be immense.

Although there are innumerable chemicals, most can be classified according to their effects. Based on the significance of adverse effects from uncontrolled exposures, we can concentrate on the most dangerous and most widely used ones. A limited number of chemicals, maybe less than one hundred, pose really significant health threats. Yet, little attention has been addressed to the role of health care providers in the control of potentially dangerous situations caused by chemicals; and, only recently has emphasis been put on the psychosocial sequelae of chemical incidents.

Comprehensive public health and therapeutic intervention plans for the management of chemical accidents do not, in general, exist. The study participants have become aware of the need to assess and describe the general principles of medical preparedness in the overall national response plan for disasters. However, as the preparedness of health care organizations, varies by nation, only general principles, rather than specifics, can currently be addressed.

The self-imposed isolation of health care delivery systems from medical care problems beyond the walls of medical offices and hospitals has removed many health care providers from emergency response situations. In contrast, the military, police, fire brigades, and rescue services are organized to respond to events beyond their facilities. In many locations, communication problems exist between the traditional medical care establishment and emergency service workers. Medical administrators and managers often lack the formal education and the practical experience in operational or crisis management to make rapid decisions based on all available, but often incomplete, data. A concerted and coordinated response plan, involving all aspects of general rescue services, needs to be developed to deal with the consequences of chemical incidents.

GOALS

This report is designed to increase the awareness and national and international preparedness to control hazardous material incidents and threats to the health and well-being of the population. There is a need for health care workers, general service workers, industry representatives, and governmental entities to recognize the

hazards involved in handling and using chemical substances. These groups must work together in the development and implementation (when needed) of a response activity.

A special feature of chemical accidents is their internationality; a chemical accident can easily extend across borders. A rapid and reliable exchange of information requires an uniform terminology and recognized principles of action so that cooperation will be both feasible and successful. Cooperation must exist early and must begin in the planning stages of any activity.

OBJECTIVES

Preparedness programs are designed to minimize the hazards associated with chemical accidents and prepare the community to response to and recover from an incident of a hazardous materials release. The health sector response (medical and psychological), admittedly is an important response, but it is one component of a preparedness program. Social welfare and physical recovery programs are as important as medical and psychological recovery efforts. This report informs the authorities responsible for preparedness about the potential and role of health care in the prevention of chemical accidents and, when necessary, the treatment of chemical injuries, and assigns health care authorities their tasks and responsibilities in both prevention and intervention activities.

EXPECTATIONS

This report provides a common framework for a stronger influence of the health care system on the preparedness for, and response to, hazardous material releases.

The general tasks of the health care system include:

- prevention of health threats
- risk analysis concerning physical, mental and social health
- diagnosis and treatment of those actually exposed and those potentially or thought to be exposed
- minimize the acute consequences -- the pain and distress to the patients, their families and their community
- implement rehabilitation activities to minimize morbidity and mortality to the patients, their families and their community
- interpreted effects, to the patient, the family, and the community, to permit a reintegration of social cohesiveness and function

Whereas the aim of rescue organizations is primarily to minimize the immediate adverse consequences to the affected individuals, the additional focus of the health care system, in chemical incidents, is to prevent the development of chronic medical (and psychological and social) effects from the long-term exposure of the chemical on the population. This epidemiological approach is very different from the first response, and requires a different set of public health and preventive medicine providers with specific knowledge and training about the long-term effects of chemical agents.

Decontamination of the air, water, food, soil and other components of the physical environment is a necessary function of public health personnel and their associated governmental agencies. Special treatment of effected patients, and prevention and mitigation of the psychosocial disturbances also require specially trained health care providers. These health care providers must also be accessible to the media. They must be able to clearly, comprehensibly, and concisely explain what has happened, what is being accomplished to mitigate the damages, and what reparative or ameliorative actions are being undertaken. Fear and panic must be addressed before they become significant issues and create an additional layer of complexity to the ongoing difficulties associated with managing a chemical incident.

TRANSBOUNDARY

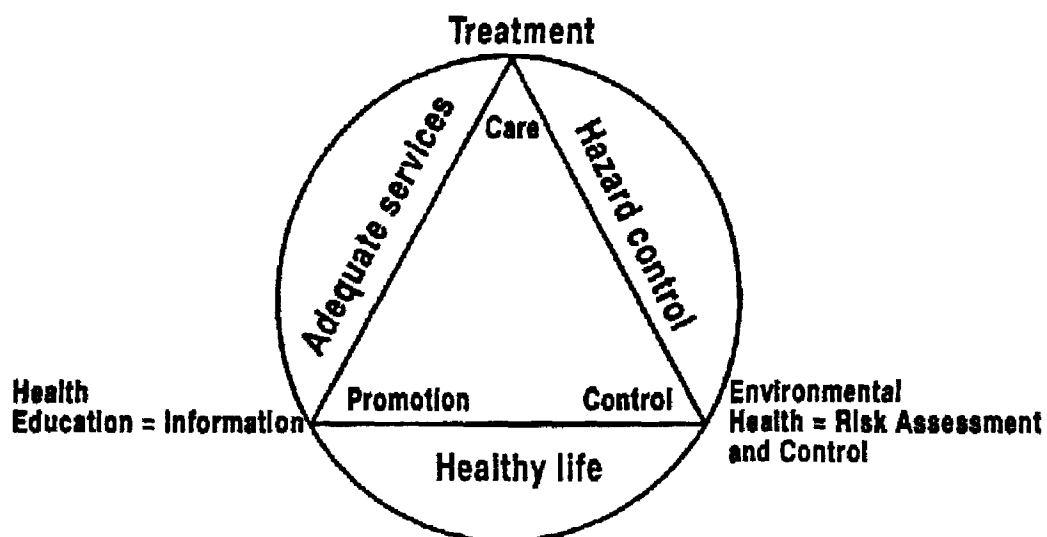
There is a need to encourage countries to establish mutual planning and preparedness activities to be able to respond to large hazardous material incidents. Rapid notification of chemical incidents and the development and implementation of common information systems are the first steps which must be initiated in the evolution of an international response.

HARMONIZATION OF HEALTH/MEDICAL RESPONSIBILITIES

To make international cooperation and aid possible, we need to create mutually acceptable principles concerning preparedness and response for chemical incidents. We have to find common ground for risk assessment, defining response levels and establishing guidelines for prevention, intervention and recovery activities. If neighboring countries have different grounds for their actions, both populations will have great difficulty in accepting the immediate intervention and long-term recovery decisions which are made. International aid also requires coordination of the equipment and response methods used, and if possible, standardized terminology. The cooperating parties should have frequent meetings, so that personal trust and confidence can be developed. This Pilot Study provided a forum for this type of exchange.

Hazardous materials releases cause a complicated community-, national-, and international-based problem that requires extensive cooperation. The issues involved transcend technical matters and individual expertise. Community and national values, attitudes and beliefs need to be addressed in developing chemical hazardous

Cornerstones of Health Care



material programs.

Awareness about the hazards in our chemical environment is a basis for preventing accidents, and retaining our living environment as healthy and safe. The community has a right to expect sufficient preparedness to minimize the risks associated with the benefits of hazardous chemicals being present in their communities.

TECHNICAL DISASTER

EXPOSURE:

- CHEMICAL
- PHYSICAL
- BIOLOGICAL
- PSYCHO-SOCIAL

SEQUELAE

1. IMMEDIATE (PROMPT) DOSE-EFFECT RELEASE
2. LONGSTANDING: DURING THE WHOLE LIFE
 - SUMMATION OF EXPOSURES (DELAYED)
 - SYNERGISM

TARGET:

1. INDIVIDUALS
2. POPULATION, GROUP OF POPULATION.

CONSEQUENCES

TARGET	IMMEDIATE	LONGSTANDING
INDIVIDUALS	X	
POPULATION		X

COMMITTEE ON CHALLENGES OF MODERN SOCIETY

HEALTH AND MEDICAL RESPONSE PREPAREDNESS FOR CHEMICAL RELEASES

Background:

The Committee on Challenges of Modern Society (CCMS) established and chartered the pilot study on Health and Medical Issues Associated with the Release of Hazardous Substances in 1988 and announced the first organizational meeting would be held in 1990. These meetings continued on a semi-annual basis through 1993. This pilot study was in response to the recommendations found in the Summary Report of the Pilot Study on Health and Medical Aspects of Disaster Preparedness (AC/274-D/246) . The project goal was the review of current activities associated with the release of hazardous substances and identification of the health and medical issues to be addressed in chemical emergency preparedness and response activities in each country.

Methodology:

With the leadership provided by the Co-Chairs from Belgium and the United States and the executive secretary, and following several coordinative consultations, invitations were extended to the NATO membership and others to participate in this fact finding study. During the deliberations representatives from the countries of Belgium, Turkey, United Kingdom, United States, France, Luxembourg, Netherlands, Canada, Russia, Finland, Norway, Germany, Sweden, attended sponsored workshops, presented papers, conducted briefings, and hosted meetings. Elected officials and employees of national, state, and local governments attended along with multinational corporations, academia, and organizations such as World Health Organization, Pan American Health Organization, and NATO. Over 65 individuals contributed. Toxicology, epidemiology, public health, risk analysis, emergency medical services, fire command, emergency planning, disaster medicine, military, information management, chemical engineering, environmental protection, hospital administration, rescue services, poison control, public affairs, nursing, statistics, and law are some of the major specialties that were represented. Detailed briefings from the national and local perspective were presented in three countries and several multinational symposia were attended by the participants. Workshops focusing on specific issues were conducted. In the later phases of the study, specific papers designed to summarize the consensus of the study were presented for review and comment.

Findings:

The study findings were predictable in many areas and surprising in others. It was apparent to all that we live in a relative small world that is becoming increasingly dependent upon chemicals in our everyday lives. More than 14 million substances have been developed and the number is increasing dramatically. When used properly, chemicals represent a low risk to our health and well being. However, they can and do represent a threat to our safety when they are used inappropriately or released in an uncontrolled manner. As the toxicity and volume of the material released and the number of the exposed population increases, the chance for harmful health effects increases. The potential impact on the environment and the economy are also major concerns associated with the release of hazardous substances.

The health impact to workers and the public from exposure to hazardous chemicals can range from death to mild symptoms such as irritation of the eyes and throat. Long term health problems can also occur. Medical treatment for chemical exposures is limited, with antidotes available for few substances. Psychological impact of chemical releases must not be underestimated. The exact relationship between exposure to hazardous substances and health insult is unknown. However, preventive actions can limit the risk of exposure to the public and workers.

Prevention is the key to success. Prevention of releases through proper engineering practices, containment, training of workers, and proper maintenance are critical. Prevention, or minimization, of chemical exposure can be enhanced through proper transportation, land use planning, and response training. This must involve preparedness, training, communication, cooperation, and general awareness of all organizations and individuals in our population who may be at risk. It will require harmonization of reporting systems, response activities, terminology, equipment, and most of all cooperation between all who may be involved in response to a release at the international, national and local level. This will require change and the assignment of priority on the national, regional, and community level.

Specifically, there is a general lack of involvement of health professionals in addressing preparedness and response activities associated with chemical incidents. The medical community may not be aware of their role in response planning, response, mediation of environmental threats, and communication with the public. Often, emergency rescue is not planned appropriately and responders are ill trained and equipped to respond to chemical releases. Hospitals are routinely not prepared to decontaminate chemical casualties, administer appropriate treatment, or collect information needed for proper documentation of the event. Public health authorities are not prepared, trained or equipped to address health issues at the scene of a release. Long term follow up of exposed individuals is rarely initiated due to the lack of proper documentation, training, and resources.

Several factors contribute to the lack of preparedness of the health community. Reporting and documentation of chemical releases understates the magnitude of the problem. Thus, the argument goes, why prepare to address a health problem which

does not exist or is insignificant in magnitude. Research and epidemiological investigations into the health impact are incomplete and severely lacking. Society is more successful in developing new chemicals than in defining the health threat from exposure and in developing patient management procedures. Other health priorities and the belief that the response personnel will call if they need information tend to keep the health professionals within their own organizational environment. This lack of health involvement results in planning and response organizations other than health professionals making decisions which are clearly health related and which can have a significant impact on the health and well being of those exposed.

There is a general expectation among the public, responders, and governmental officials that the medical and health profession is prepared to handle the health issues which occur on a daily basis. This is not the case when dealing with chemical exposures. The study found that health and medical professionals were not prepared since they are seldom involved in response. At the same time, they are rarely requested to become involved in preparedness activities since it is believed that they are prepared. This circular situation is self defeating and contra productive. The lack of health professional involvement in the preparedness and response for chemical releases will be difficult to correct. It will require a considerable effort by national, regional, and local organizations.

Conclusions:

Following receipt of the presentations and papers, the study group has arrived at the following conclusions relative to the assigned mission:

1. National governments should view chemical releases as a national problem requiring appropriate resource allocation for all organizations which should become involved. It cannot be assumed chemical incidents are rare. Therefore, while a national priority may exist to address medical and environmental issues associated with hazardous substance releases of an extraordinary nature, priority should also be assigned for preparation for response to releases which are smaller in scope and which occur on a daily basis.
2. A centralized information and scientific reporting system does not exist for the chemical incidents. There is no standard international definition of a chemical incident. Current reporting thresholds can give the impression that the frequency and impact of releases are low. The reporting systems which do exist are incomplete, lack information to adequately describe the magnitude of the health threat, and generally preclude detailed analysis necessary for programmatic decisions involving health. In essence, the extent of the problem is unknown. An international effort is needed to encourage standardized reporting, information exchange, data collection, and transboundary communication.

3. Planning and legislation generally excludes small events, small quantities and small manufacturing facilities. These factors may account for a significant number of events. Planners at all levels of government must focus on "releases" not just "major disasters" to protect the public.
4. Although the data are not sufficient, it is the opinion of the group that chemical incidents are increasing in frequency. What data that are available indicate that a large percentage of releases involve a small number of different chemicals (less than 100 chemicals).
5. National governments should be encouraged to support local efforts in the prevention of releases and the development of response teams. This will necessitate the provision of resources, technical and programmatic support. It is also agreed that planning should start at the local level and subsequent planning on the Regional and National level should focus on addressing those issues which can not be handled locally (bottom up rather than top down).
6. Risk assessment plays a vital role in planning for chemical releases. It is the belief of the group that such assessments should be based on human rather than animal data and should not use lethality as the sole action level when dealing with civilian populations. It is also noted the risk assessment methodologies are not harmonized and vary considerably. A concerted effort is required to develop methodologies which are well tested and accepted world wide.
7. Promotion of formal mutual aid agreements between countries, regions, and communities should be encouraged to enhance the resources available to address a release. This requires national priority.
8. Planning for response to a release must include the individuals and organizations which will be involved in the response. Beside the obvious participants, the planning group should include: political leaders, media, and representatives of the community.
9. There is a lack of involvement of health (public health, private health) professionals in activities associated with chemical incidents. While it is readily agreed that a release of hazardous materials can constitute a public health threat, the full involvement of health is generally not routine. In many cases non-health individuals are deciding medical issues. The same holds true in planning for response to a release. Due to the advanced training of health personnel it is assumed that medical personnel are prepared to handle the health issues which will be presented. This assumption is false. Without full participation, the health community can not, and will not, be prepared.

10. There is a lack of recognition by response organizations of the value and utility of the involvement of the health professional in chemical incidents.
11. Health organizations do not understand their role in chemical incidents nor do they understand the response process and the role of other organizations. This is generally driven by the lack of resources or training. There is a belief by many health professionals that response organizations will involve them if a health issue arises. This leads to health decisions by non health personnel and can preclude appropriate preventive actions and the collection of data necessary to resolve the public concerns which arise following a chemical release.
12. Specialized medical teams may need to go "on-scene" to address casualties and response team health and safety problems. The health and medical teams must be trained to operate as members of the overall response team, work in a hostile environment, use personal protective equipment, and address the complex medical situations which will be presented. There are variations in the indicators for deployment of such teams. Operational investigations have not been performed to define the composition of the teams (Emergency Medical Technicians, Paramedics, Registered Nurses, Medical Doctorate, etc.), decision logic, equipment and supplies, etc. which could be used for the types of situations faced within the community. Additional investigations are also required for triage systems and assessment of their validity.
13. Legislative mandate for response to chemical incidents is often based on the type, or location, of the release without regard to other organizations and their concerns which would be impinged upon (i.e. health, commerce, etc.) In addition, resources to support involvement of health organizations are not adequate. This is due to a lower health priorities for preparedness activities related to chemical releases and the perceived low level of need.
14. The health and medical community is, for the most part, ill prepared to participate in response to chemical incidents. The use of antidotes, appropriate triage, decontamination, and the need for exposure documentation are not routinely understood. The role of health in advising the population and the media is also ill defined. These issues can be addressed through proper planning for response to an incident. The health and medical personnel must fully interact with the other organizations in the response and planning community.
15. Non health planners must be aware that there may be no physical injuries (in the traditional sense) following a chemical incident and that

the impact of a chemical release on health may only be exhibited after the event in the form of subtle symptoms or disease manifestations. The lack of a definition of "health impact" hampers action and planning. This difficulty is directly related to the lack of full involvement by health professionals and failure to obtain full documentation of chemical releases.

16. Psychological issues may override actual physical casualties. It must be anticipated that psychological stress will occur. This must be accounted for in planning activities.
17. Planning measures currently in place should be considered deficient if they do not include active participation of health. The scientific data regarding the health impact of exposure to chemicals are incomplete. This necessitates interpretation of the data and informed input into the decisions regarding the potential health threat posed by a substance. This is particularly true in the use of models for prediction of health threat, since they are only tested against a very limited number of actual observations. The models may be unreliable in real incidents due to the topography, release scenario, demographics, and health indicators chosen. Without health input as well as input from environmental dispersion experts, the planning groups may be making uninformed decisions that could be contraproductive.
18. There are inadequate resources for epidemiological and environmental studies to define the etiology of the events and document the health consequences. The problem is compounded by the lack of organizational structure to accomplish epidemiological and environmental studies in many communities. A chemical release presents many unique problems which complicate environmental and biological sampling, control of the release, management of health consequences, etc. This results in limited or even flawed studies which are of marginal use in the medical community. There is an absence of definite information on which type of epidemiological study to perform.
19. Appropriate remediation to return sites and individuals to desirable post incident state is required. However, the scientific basis is not available to support the decisions necessary to accomplish the objective and there is little chance that it will evolve in the near future without concerted action. Remediation is a topic which should also be included in the planning efforts of the community. This issue should be addressed prior to a release.
20. There is a major need to increase community awareness of chemicals found in, and transported through, the community. This awareness effort should include background information on the substance, its use,

potential health threats, and the actions which should be taken by the resident if the substance is released. Health personnel should take an active role in correcting this deficiency.

21. A resource for information on medical effects and treatment advice needs to be available on a 24 hour a day basis. A Poison Center (or other information center) may be used to fulfill the need. A list of other resources should be developed and verified periodically.
22. The study was briefed on several models/systems to predict the dispersion of contaminants. It is apparent that the results produced by models are not in harmony, and could result in confusion and different actions by the response teams depending upon which models are used. This is a critical concern particularly when addressing evacuation, dose reconstruction, and risk assessment. The models should be verified to the extent possible and harmonized.
23. Prevention of a release should be stressed in all planning efforts. Prevention strategies to preclude or minimize the health insult should be the basis for all activities including land use and other community planning.
24. One uniform plan for response in all countries should not be prepared since the national and local resources and situations could not be represented.

Recommendations:

The following recommendations are submitted for consideration:

1. NATO
 - A. NATO should initiate a program of international coordination and cooperation in the following areas of hazardous substance preparedness: mutual aid, response, evaluation, health responsibilities, resources, and use of risk assessment methodologies. Such a program should be conducted in concert with other organizations such as WHO, IPCS, UNEP, OECD, APELL etc.
 - B. There should be a NATO-sponsored follow-up health and medical workshop or symposium with CCMS participants and invitations should be extended to appropriate officials in the North Atlantic Cooperation Council (NACC), and other international organizations. The workshop should take place in one of the eastern European capitals.
 - C. A study should be initiated to develop a harmonized international form

for the reporting chemical releases.

2. National policy recommendations:

- A. National governments should develop national policies to integrate preparedness and response plans for chemical releases at the local, provincial and federal levels and incorporate these into a single system.**
- B. Mutual aid agreements should be made between and among countries, regions and communities to enable resources to be utilized effectively to meet the safety and health concerns of catastrophic releases.**
- C. Nations should prioritize preparedness and response plans to meet safety, health and environmental hazards through the involvement of the relevant professionals.**
- D. A group of national and international experts regarding health and environmental effects of chemical incidents and disasters should be established in order to 1) collect health related data of chemical incidents and disaster to draw up the lessons learned; 2) propose standardized education and training guidelines for population, rescue agencies, medical and paramedical personnel, planners and education personnel; 3) start research on epidemiological methodology, definition of the ideal response models, factors for evacuation of population, triage solidation, and biological markers in casualties.**
- E. National governments should strengthen and support by regulatory and economic means comprehensive research, planning and creation of response forces for prevention and control of hazardous material releases.**

3. Research recommendations:

- A. Studies of chemical releases should be undertaken to:**
 - obtain the scientific data required to validate health and safety impact models.**
 - anticipate health and safety consequences in major releases.**
 - determine and develop appropriate chemical and bio-markers as indicators of chemical hazards.**
 - develop interactive data bases to document chemical releases, validate models and provide vital information for immediate**

response to toxic chemicals.

- B. Research should be directed at developing an inventory of the available epidemiological and experimental toxicological information. This would increase the insight into health impact of exposure to toxic chemicals. From this information, quantitative dose response models should be derived to serve and increase the accuracy of prediction of the consequences of chemical releases including lethal as well as other (short and long term) health effects.
 - C. Research efforts should be directed towards the calculation of lethal and non-lethal health effects and further development of risk assessment models, especially in the field of dispersion modeling.
4. Training recommendations:
- A. Health professionals should be recruited to form "on-scene" specialized teams to operate as a component of the overall response team, work in hostile environments and to analyze appropriate protective equipment and medicines.
 - B. Health professionals should be trained in the recognition of psychological as well as physical health problems and to manage post incident stress debriefings in both survivors and health workers.