ters expose many people to toxic substances have special features.

Initially, in such disasters, it is not clear which substances people may have been exposed to, and to what extent. And, even in cases when it is known which agents are involved, it may be difficult to know if pyrolysis or combustion products are formed with toxicological properties that are different from those of the original agents. When a rescue operation starts at the site of an accident, several questions will arise immediately and must be solved before rescue workers can enter the site. These questions concern the possibility of ongoing exposure, definition of the area of exposure (often also dependent on expected weather conditions), and the need for protective clothes and airway protection.

Possible contamination of victims is another feature that needs attention. In acute exposure—for example, in transport accidents or in cases of leakage of stored chemicals due to a crash or explosion—the route of exposure will be dermal, by inhalation, or through the eyes. Especially with inhalation (depending on the nature and concentration of the agents involved), vital functions may be impaired acutely or may be delayed. Low-grade exposure can arise in cases of chemical spills over longer periods of time with contamination of the environment and possible entrance into the food chain. In the latter case, exposure will occur in a low-grade fashion, and may have a chronic intermittent character over an extended period of time. Data collection with reference to possible exposure, contamination of environment, animals and humans, body burden, and the effects of exposed people, is important not only for the immediate actions to be taken, but also to evaluate the accident after some time, and to take actions to avoid future accidents of the same sort.

Reliable information, not only to the public, but also to medical professionals who will supply their patients with answers, has to be disseminated as soon as possible, with regular updates as the situation of the accident develops.

III.2
Triage of Victims in Chemical Disasters

T.J.F. Savelkoul, MD, PhD
University Hospital, Utrecht, Netherlands

Triage is a continuous process of evaluation of the trauma severity of victims of mass accidents, and is aimed at prioritizing transport and medical facilities in the face of limited resources. Often a classification will be used producing four categories of patients:

1) Victims with *life-threatening* injuries who are in immediate need of transport and/or treatment;
2) Victims with *moderate* and *severe* injuries who need treatment, but can wait for transport or treatment;
3) Patients with *mild* or *no* injuries who are not in need of any substantial treatment; and
4) Severely injured victims with poor chances of survival even with adequate treatment, and primarily in need of *palliative support.*

In chemical accidents, a fifth category of victims is needed:

5) Those people who may have been exposed, and who do not experience any symptoms, but in whom delayed symptoms are to be expected. They are in need of observation, possible immediate treatment, and transport to treatment facilities.

Exposure to toxic substances can result in local and/or systemic effects. In the triage process, it is important to be aware of the possibility that certain substances may interact with cells and tissues with the development of severe symptoms as a sign of vital organ disturbances that need immediate treatment. The inhalation of certain gases, e.g., phosgene and nitrogen oxides, are especially notorious for producing such disturbances.

Information about the results of measurements of the substances in the environment have to be interpreted in connection with the symptoms of victims. For each individual, the time between onset of exposure and development of symptoms has to be recorded. The symptoms expected from this exposure data then can be compared with the symptoms encountered. In the hospital classification of certain special types of injuries, e.g., corrosive burns, irritant gases can be added.

III.3
Preparation for HAZMAT Incidents in Israel

J. Adler, MD
United Nations, New York City, New York, USA

Foreword: The development of chemical industries and the increasing amount of hazardous materials (HAZMAT) transported in densely populated areas pose an increasing risk to the population and environment. Most developed countries presently enforce strict control on the handling of dangerous substances, but, in many countries, the readiness of the emergency medical system still is deficient. The Gulf War lessons have had a strong impact on planning and preparations for chemical warfare incidents and disasters in Israel. During the last eight years, a standing interministerial committee has been actively developing policies and priorities for the establishment of a comprehensive HAZMAT response system in the country. The traffic law has been amended to prohibit transportation of HAZMAT through urban areas. The control and supervision of the chemical industry is much stricter, and a committee for developing a doctrine for hospital organization and treatment of HAZMAT casualties has been formed.

Lessons learned from the Gulf War: Preparations of the medical services in Israel before and during the days of the Gulf War in early 1991 have taught us some important lessons: 1) The threat of unconventional weapons and its implications have to be well-defined; 2) The establishment of a well-trained and equipped response system is not a simple matter and requires resources, budgets, and time; 3) The medical response system has to be ready constantly, as a warning period may be short; and 4) The extensive training effort of all components of the health system, during the months of preparation, made policy-makers aware of these facts. They established an infrastructure that may serve as a model for the HAZMAT Medical Response System.

The HAZMAT Medical Response System: This system is being implemented at two levels: 1) the prehospital EMS, operated mainly by MDA in Israel (the National Red Cross Organization), reinforced by army or civil-defense medical units, and 2) The hospital level, which includes the 24 general hospitals in the country.

The Prehospital Level: The doctrine, Standing Operating Procedures (SOP), training and equipment at the prehospital level, has been finalized and joint exercises are being conducted regularly with MDA ambulance teams, police forces, and fire services.

MDA HAZMAT Response Teams: These teams are based on MDA's regular ambulance teams (MICU and regular ambulances) in 10 out of 40 MDA stations throughout the country. These HAZMAT response stations were chosen in locations in which the main chemical industry or storage and shipment facilities are located. The stations have been equipped with two sets of personal protective suits each, of the "RESPONDER 0011" type. We are now in the process of replacing these suits with the more heavy "BUTYLIC" suit, produced by the TRALLEBORG Company. Each suit includes a SCUBA respirator, BD-88. In addition, five light, disposable suits are available in each station for decontamination teams, with gas masks and filters. The medical equipment contained in a first-aid kit includes an "Ambu" manual respirator with filter, an aspirator (foot-pump type), dressing material, a rubber tourniquet, and a cervical collar. All MDA personnel in the HAZMAT stations, including paramedics, ambulance drivers, and adult volunteers, undergo an annual refresher course and an exercise with police and fire services.

Hospitalization: All HAZMAT victims will be hospitalized for observation and medical treatment. Depending on the distance from the incident site to the hospital, the number of casualties and available means for evacuations, an undefined number of victims may bypass the decontamination station and MDA's first-aid points on the scene, and reach the hospitals without decontamination or receiving first aid on-site. Hospitals have to be prepared (as they were during the Gulf War) to receive HAZMAT casualties on very short notice, or without any advance warning. This is a very demanding situation for any hospital and emergency department, even in conventional mass-casualty situations. It requires planning, preparation of a decontamination facility at the entrance to the emergency department, specific medical equipment, drugs, and trained medical teams.

III.4
Decontamination of Victims

Sven-Åke Persson
Research Director, National Defense Research Establishment
Department of NBC Defense, Sweden

Individuals exposed to liquid toxic chemicals must be decontaminated as soon as possible to: 1) save the life of the exposed victim; 2) make transportation and treatment possible; 3) avoid secondary contamination of rescue services and medical personnel; and 4) avoid secondary contamination of transportation vehicles and hospital.

It is extremely important to stop the exposure of the victims to the toxic chemicals and to undress the victim. Decontamination then can be performed by means of: a) dry methods, or b) wet methods.

In peacetime chemical disasters, where resources and supplies are plentiful enough to meet the requirements, the situation is more favorable than in wartime chemical disasters. Mass casualties, lack of resources, use of chemical warfare agents, combined chemical lesions and trauma, and the need for specific decontaminating agents are some of the problems in war. Rapid and accurate detection of chemical exposure has yet to be developed.

Therefore, safe and effective routines for decontamination and treatment have to be developed to save the patient without contaminating medical personnel or the hospital.

III.5
Chemical Disasters: Lung Injuries

Goran Hedenstierna, MD
Department of Clinical Physiology,
University Hospital, Sweden

Inhalation or aspiration of various chemical compounds can cause severe lung damage—either acute and fullminant or more protracted—sometimes characterized by a biphasic progress with a period of apparent recovery. The distribution of the damage within the lung is dependent on the solubility in water of the compound; the more water soluble it is (e.g., formaldehyde, ammonia), the higher up in the airway tree (larynx, trachea) the damage will be located. If the compound is less soluble in water (e.g., chlorine, isocyanates), small airways and alveoli may be damaged.

In upper-airway involvement, the major findings are burns, edema, coughs, bronchospasms, and breathlessness. With severe exposure, laryngeal and epiglottic edema may develop, and, in the worse cases, laryngospasm. Respiratory and circulatory collapse may occur by reflex mechanisms.

Damage to the peripheral airways and the alveoli causes capillary leakage and pulmonary edema. The chemical irritation also may cause a pneumonitis with leaking airways and activation of inflammatory cells. Finally, many inhaled gases and other compounds can cause systemic effects with little direct damage to the lung tissue (e.g., carbon monoxide, alcohol).

III.6
Ventilatory Support in Acute Severe Lung Injury

Ulf Ludwigs, MD
Medical Intensive Care Unit, Department of Medicine-
Södersjukhuset, Stockholm, Sweden

The acute pathological response of the respiratory tract to chemical irritants is characterized by inflammatory changes in the airway and by alveolar edema. The pathophysiologic correlate is an imbalance of ventilation to perfusion (V_A/Q mismatch). Clinically, cough, stridor, hypoxemia, and respiratory distress are common symptoms.

Treatment should be directed against the airway inflammatory response with endothelial injury and airway obstruction through the administration of appropriate pharmacological agents. Mild to moderate hypoxemia may be counteracted with supplemental oxygen administered via nasal prongs or by face mask. More pronounced hypoxemia usually requires measures that counteract