

Chapter 17

HEALTHCARE AND THE CHEMICAL SURETY MISSION

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INTRODUCTION

Medical officers with assignments to U.S. Army depots or other installations storing chemical warfare agents face a number of unique challenges. Not only will newly assigned general medical officers provide patient care to both military and civilian workers, they will also have a myriad of additional duties unique to chemical weapons storage sites.

The depot may be physically isolated and a considerable distance away from the Medical Center (MEDCEN) or Medical Department Activity (MEDDAC) responsible for providing medical support and consultation. The preventive/occupational medicine physicians are usually responsible for providing this support and are a source of information and guidance. Other governmental agencies have also been identified to assist medical personnel in acquiring solutions to unfamiliar medical problems related to chemical exposure (Exhibit 17-1).

Physicians assigned to installations with a chemical *surety* mission (the term encompasses safety, security, and reliability) must be able to recognize and treat a wide variety of chemically related diseases and injuries. Time or assets are seldom available, however, to train a general medical officer in the unique occupational setting of depot operations. At the present time, newly assigned general medical officers are required to complete the Medical Management of Chemical Casualties Course given at Aberdeen Proving Ground, Maryland. This

course provides the basic concepts needed to recognize the clinical signs and symptoms of a chemical agent exposure and the appropriate therapeutic interventions used in treating and managing chemical agent casualties. In addition, the Office of The Surgeon General sponsors the Toxic Chemical Training for Medical Support Personnel Course, which is conducted at the Chemical Demilitarization Training Facility at the Edgewood Area of Aberdeen Proving Ground. This training course has incorporated presentations on medical diagnosis and treatment that are essential to managing the health-related concerns of the chemical surety mission. These orientation courses provide essential information to the medical officer beginning his atypical assignment.

As used in this chapter, a *chemical agent* is defined as a chemical substance intended for use in military operations to kill, seriously injure, or incapacitate a person through its physiological effects. Riot control agents, chemical herbicides, smoke, and flame are not officially defined as chemical agents.

Although the chemical agents discussed are unique to the military, the hazards to the workers are common to many industries. Examples include pesticide workers who are exposed to acetylcholinesterase inhibitors (the operative mechanism of nerve agents) and carbonyl chloride (phosgene),

EXHIBIT 17-1

ADVISING AGENCIES FOR TREATMENT OF CHEMICAL AGENT INJURY

The Preventive or Occupational Medicine department
of the supporting Medical Department Activity or
Medical Center

U.S. Army Center for Health Promotion and
Preventive Medicine
ATTN: HSHB-MO
Aberdeen Proving Ground, Maryland 21010-5422

Office of The Surgeon General
Chemical Surety Consultant
ATTN: SFIL-CMS
Aberdeen Proving Ground, Maryland 21010-5401

U.S. Army Medical Research Institute of Chemical
Defense
ATTN: SGRD-UV-ZM
Aberdeen Proving Ground, Maryland 21010-5425

U.S. Army Materiel Command
ATTN: AMCSG
5001 Eisenhower Avenue
Alexandria, Virginia 22333-0001

U.S. Army Depot System Command
ATTN: AMSDS-SU
Chambersburg, Pennsylvania 17201-4170

which is used in the production of foams and plastics. Both are transported daily on the nation's highways. In addition to these chemical threats, many physical hazards found in the chemical storage depot are shared by other types of operations. The operation of forklifts, the presence of excessive noise, heat stress, lifting, and other chemical exposures (in addition to chemical warfare agents) are only a few of the more common hazards.

The intended use, packaging, and storage of chemical munitions, however, present different hazards and therefore require different controls. The system of controls, procedures, and actions that contribute to the safety, security, and reliability of chemical agents and their associated weapon systems throughout their life cycle without degrading operational performance is known as chemical surety.

An integral part of a physician's practice is addressing the occupational healthcare needs of the patients. This responsibility includes identification of occupational and environmental health risks, treatment of disease and injury, and patient counseling concerning preventive behavior. This task by itself is time-consuming and presents demands that, in part, can be performed by the occupational health

nurse, the industrial hygienist, and other clinic staff members.

Although industrial hygienists are often not assigned to the health clinic, they are an integral part of the healthcare team. The industrial hygienist maintains a hazard inventory that contains conventional hazards as well as a list of chemical agents located at the installation. He routinely designs primary prevention strategies and frequently oversees hearing conservation, respiratory protection, and occupational vision programs. The information he provides is necessary to evaluate the work environment and to determine the appropriate frequency of periodic medical examinations. Close and frequent coordination with this individual is imperative for developing a knowledge of the worksite and the subsequent development of a medical surveillance program.

Just as it is imperative to work closely with industrial hygiene and safety personnel, medical personnel must also work in accord with the command, supervisors, personnel officers, and the workers. Maintaining these relationships is frequently difficult, but by identifying and addressing concerns of both the management and the individual workers, medical personnel can establish a basis for formulating appropriate preventive medical measures.

CHEMICAL PERSONNEL RELIABILITY PROGRAM

The Chemical Personnel Reliability Program (CPRP) is a management tool used within the army to identify chemical surety duty positions and to manage the persons assigned to these positions. It also provides a way to assess the reliability and acceptability of personnel being considered for and assigned to chemical duty positions. Chemical surety material is defined in Army Regulation 50-6, *Chemical Surety*, as "chemical agents and their associated weapon system, or storage and shipping containers, that are either adopted or being considered for military use."^{1(p43)}

The program was established to ensure that the personnel assigned to positions involving access to or responsibility for the security of chemical surety material are emotionally stable, loyal to the United States, trustworthy, and physically fit to perform assigned duties. The certifying official is the commander's representative for the CPRP and ultimately responsible for its administration. The decision to qualify or disqualify personnel for CPRP duties is made by the certifying official, with input from the personnel officer and medical personnel. The certifying official must also determine the ap-

propriate medical surveillance category for each worker (see below for a discussion of the four categories) based on the worker's potential for exposure.

The CPRP requires both preassignment screening and continuing evaluation. This screening and evaluation is performed when an individual is assigned initial CPRP duties, when a new assignment is being considered by the certifying official, and once every 5 years thereafter. The CPRP screening/evaluation consists of an initial interview with the certifying official, personnel records screen, medical evaluation, and a final evaluation and briefing by the certifying official.

During each portion of the screening process, evaluators look for any evidence of potentially disqualifying factors that may affect personnel reliability or suitability for CPRP duties. The potential disqualifying factors of medical relevance include: alcohol abuse, drug abuse, inability to wear protective clothing and equipment required by the assigned position, or any significant physical or mental condition that in the judgment of the certifying official may be prejudicial to the reliable perfor-

EXHIBIT 17-2

ADMINISTRATIVE DOCUMENTATION TO SUPPORT A CHEMICAL SURETY INSPECTION

Army Regulations

AR 11-34, 15 Feb 90	<i>The Army Respiratory Protection Program</i>
AR 40-2, 15 Mar 83	<i>Army Medical Treatment Facilities</i>
AR 40-3, 15 Feb 85	<i>Medical, Dental and Veterinary Care</i>
AR 40-5, 15 Oct 90	<i>Preventive Medicine</i>
AR 40-13, 1 Feb 85	<i>Medical Support: Nuclear/Chemical Accidents and Incidents</i>
AR 40-63, 1 Jan 86	<i>Ophthalmic Services</i>
AR 40-66, 20 Jul 92	<i>Medical Record Administration</i>
AR 40-68, 20 Dec 89	<i>Quality Assurance Administration</i>
AR 40-400, 1 Oct 83	<i>Patient Administration</i>
AR 50-6, 12 Nov 86	<i>Chemical Surety</i>
AR 385-10, 23 May 88	<i>Army Safety Program</i>
AR 385-32, 1 May 84	<i>Protective Clothing and Equipment</i>
AR 385-40, 1 Apr 87	<i>Accident Reporting and Records</i>
AR 385-64, 22 May 87	<i>Ammunition and Explosives Safety Standards</i>
AR 600-85, 21 Oct 88	<i>Alcohol and Drug Abuse Prevention and Control Program</i>
HSC-R 10-1, 25 Sep 91	<i>Organization and Functions Policy</i>
HSC-R 40-5, 1 Sep 87	<i>Ambulatory Primary Care</i>
HSC Supplement 1 to AR 40-2, 3 Jun 91	<i>Army Medical Treatment Facilities</i>
HSC Supplement 1 to AR 40-3, 1 May 92	<i>Medical, Dental and Veterinary Care</i>
HSC Supplement 1 to AR 50-6, 10 Feb 88	<i>Chemical Surety</i>
AMC-R 385-131, 9 Oct 87	<i>Safety Regulation for Chemical Agents H, HD, HT, GB, and VX</i>
7th MEDCOM-R 40-8, 24 Apr 87	<i>Medical and Dental Management of the Personnel Reliability Program</i>

Department of the Army Pamphlets and Technical Bulletins Medical

DA PAM 40-8, 4 Dec 90	<i>Occupational Health Guidelines for the Evaluation and Control of Occupational Exposures to Nerve Agents GA, GB, GD, and VX</i>
DA PAM 40-173, 30 Aug 91	<i>Occupational Health Guidelines for the Evaluation and Control of Occupational Exposures to Mustard Agents H, HD, and HT</i>
DA PAM 40-501, 27 Aug 91	<i>Hearing Conservation</i>
DA PAM 50-6, 17 May 9	<i>Chemical Accident or Incident Response and Assistance (CAIRA) Operations</i>
HSC PAM 40-2, June 83	<i>Occupational Health Program</i>
TB MED 502, 15 Mar 82	<i>Respiratory Protection Program</i>
TB MED 503, 1 Feb 85	<i>Industrial Hygiene Program</i>
TB MED 506, 15 Dec 81	<i>Occupational Vision</i>
TB MED 507, 25 Jul 80	<i>Prevention, Treatment, and Control of Heat Injury</i>
TB MED 509, 24 Dec 86	<i>Spirometry in Occupational Health Surveillance</i>

Field Manuals

FM 3-5, 24 Jun 85	<i>NBC Decontamination</i>
FM 8-285, 28 Feb 90	<i>Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries</i>

Exhibit 17-2 (continued)

Personnel Documents

- Table of Distribution and Allowances with mission statement for medical treatment facility or activity
- Intraservice Support Agreement between tenant health clinic and the host installation
- Job descriptions with performance standards (or support forms for active duty)
- Scopes of practices
- Individual or categorical credentials for health care practitioners
- Current certificates of licensure for physicians and nurses
- Advanced Trauma Life Support/Advanced Cardiac Life Support certification for physicians (nurses optional)
- Basic Life Support certification for all personnel with patient care responsibilities
- Certificate of completion of Medical Management of Chemical and Biological Casualties Course for physicians

Memorandums of Understanding and Mutual Aid Agreements

- With local civilian hospitals or ambulance services
- With the supporting medical center or medical department activity
- Between Health Services Command and Army Materiel Command (or other major army commands, if appropriate)

Standing Operating Procedures

- Spirometry
- Audiometry
- Vision screening
- Optical insert program for protective masks
- Medical surveillance examination (agent-specific)
- Pregnancy surveillance/reproductive hazards
- Medical screening of Personnel Reliability Program records
- Illness absence monitoring vis-à-vis Personnel Reliability Program records
- Incorporation of air monitoring results into the medical record
- Interface with Alcohol and Drug Abuse Prevention and Control officer
- Ambulance operation and stockage
- Preparation and review of first aid briefings
- Chemical accident and incident response
- Handling of contaminated casualties at the clinic

Medical Directives

- Administration of nerve agent antidotes in the clinic
- Administration of intravenous solutions
- First aid for minor illnesses or injuries

Other

- *Medical Management of Chemical Casualties Handbook*, September 1994

Available from Chemical Casualty Care Office, U.S. Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, Maryland 21010

AMC: Army Materiel Command; HSC: Health Services Command; MEDCOM: Medical Command; NBC: nuclear, biological, and chemical

mance of CPRP duties. Factors that restrict the wearing of protective clothing include: (a) the inability to obtain a seal with the protective mask, (b) an allergy to protective clothing and equipment, (c) any medical condition that precludes correct wear and use of protective clothing, and (d) poor visual acuity that requires the use of glasses unless mask optical inserts are used. Contact lenses are not permitted to be worn with the protective mask because they can concentrate agent beneath the lens, or, more commonly, a foreign body will become lodged beneath a contact lens, necessitating immediate removal. This cannot be done in a chemical environment!

Any medical conditions, including the use of any prescribed medications, that may detract from an individual's ability to perform assigned chemical surety duties must be communicated to the certifying official by oral notification and confirmed *in writing*. In addition, the physician must provide a recommendation as to the suitability of the worker to continue CPRP duties. Documentation of these communications should be included on the Standard Form 600. As in all healthcare, documentation is extremely important and, in this case, subject to examination during a Chemical Surety Inspection (CSI). Exhibit 17-2 lists the administrative documentation necessary to support a CSI.

HEALTH SURVEILLANCE FOR CHEMICAL WORKERS

Medical surveillance is the systematic collection, analysis, and dissemination of disease data on groups of workers. It is designed to detect early signs of work-related illness.³ A chemical work site medical program should provide the following surveillance: preplacement screening, periodic medical examinations (with follow-up examinations, when appropriate), and termination examinations. Additional follow-up examinations are required if an individual has been exposed or if a potential exposure has occurred. An efficient medical surveillance program will assist in detecting a relationship between exposure to a hazard and a disease. In addition, the medical surveillance system will assist in identifying an occupational disease at an early stage, when medical intervention can be beneficial.

Since the purpose of medical surveillance is to identify work-related disease at an early stage, it may be considered a type of screening. *Screening* is the search for a previously unrecognized disease or pathophysiological condition at a stage when intervention can slow, halt, or reverse the progression of the disorder.³ Screening for the CPRP must be

While the medical officer does not decide the suitability of a candidate for CPRP duties, the certifying official makes a decision based on the medical information and recommendations he provides. The recommendation should state: (a) no restriction, (b) restrictions or limitations on duties, (c) temporary disqualification, or (d) permanent disqualification. Potentially disqualifying information is provided in a sealed envelope marked "EXCLUSIVE FOR" the certifying official. Temporarily disqualified personnel remain in the CPRP; therefore, their medical records must be treated in the same manner as the medical records of other personnel in the program.

A chemical-duty position roster lists all individuals assigned to chemical-duty positions in the CPRP by name, social security number, and job title. This roster also contains the name of the certifying official, the organization, and the medical surveillance exposure category of each worker. The roster must be periodically reviewed to verify that a change in duty position that requires a change in category is incorporated into the medical record, and that periodic surveillance is changed to match. Medical records for personnel in the CPRP are required to be identified in accordance with Army Regulation 40-66, *Medical Record Administration*.² These medical records are required to be segregated from records of personnel not in the CPRP.

performed by a physician or other qualified medical staff member (physician's assistant, dentist, or dental assistant) who has been officially designated to perform this function.

Additional examinations that are independent of medical surveillance will be required. These include fitness evaluations for personal protective equipment and evaluation of a potential worker's ability to meet the functional requirements of the job.

Engineering and individual protective measures are the primary disease prevention methods; medical screening is a tertiary measure. The importance of engineering and individual protective measures must continually be stressed. An individual that shows signs or complains of symptoms of occupationally related illness should be identified as a possible sentinel case. Not only must the individual be treated, but the cause must also be investigated thoroughly by the Installation Medical Authority (IMA), the industrial hygienist, and the safety personnel. The cause may be related to improper work practices of the affected individual or it may be related to a failure of engineering devices or personal

protective measures. In the latter case, further morbidity can be avoided if identification of the problem is prompt.

The IMA, or contract physician, is responsible for establishing and supervising the medical surveillance system. Not all individuals working at the installation, or even in a particular work area, need to be on the same surveillance program. The type of work, work area, and required personal protective equipment are factors in determining the type and frequency of surveillance.

For additional information and direction concerning the development of an occupational medicine program, the installation medical officer is encouraged to seek advice from the regional MEDCEN or MEDDAC. In addition, the Occupational and Environmental Medicine Division of the U. S. Army Center for Health Promotion and Preventive Medicine may be of assistance.

Preplacement Examination

Prior to evaluating a patient history and completing a physical examination, the physician should acquire an accurate and *current* job description listing the specific tasks the worker will be required to accomplish. The type of respiratory protection and protective clothing required must also be ascertained, because these will affect an individual's ability to perform his job.

Not all individuals are required to wear protective clothing all the time; the frequency of use, the exertion level associated with the personal protective clothing, and the environmental conditions in which they are worn will have a dramatic influence on how well an individual will perform. Changing environmental conditions must be considered; a worker at Tooele, Utah, may be very comfortable in the winter in protective clothing and unable to tolerate the same level of protection in the heat of the summer. Work-rest cycles become very important.

Preplacement examination has two major functions: (1) determination of an individual's fitness for duty, including the ability to work while wearing protective equipment, and (2) provision of baseline medical surveillance for comparison with future medical data.⁴ The chemical agent worker must be evaluated to ensure that he is not predisposed to physical, mental, or emotional impairment, which may result in an increased vulnerability to chemical warfare agent exposure. This examination is performed at no cost to the applicant. Abnormalities identified during the course of the

preplacement examination, however, need to be followed up by the applicant, at his expense, with a private physician.

An occupational and medical history questionnaire is the first step in acquiring necessary information from the prospective worker. A thorough review, by the medical officer, is required to identify past illnesses and diseases that may prevent the individual from satisfactory performance of job requirements. It is particularly important to inquire about atopic dermatitis, pulmonary disease, and cardiovascular disease.

A review of symptoms will enable the medical officer to evaluate the ability of an individual to work in protective ensemble. Questions concerning shortness of breath or labored breathing on exertion, asthma, other respiratory symptoms, chest pain, high blood pressure, and heat intolerance will provide helpful information. Questions about allergic reactions to rubber products and cold-induced bronchospasm should be asked and a brief psychiatric history directed toward the individual's ability to be encapsulated in personal protective equipment should be taken. Questions about panic attacks, syncopal episodes, or hyperventilation will also offer valuable information.

For those who are not clearly disqualified by their medical history and physical examination, it is necessary for the medical officer to determine their ability to function while wearing respiratory protective equipment. This can be done by either pulmonary function testing or a "use" test. The former is effective, although costly; the latter provides necessary information and can be performed safely by the majority of applicants. Caution must be exercised, however, in requiring an individual to perform a use test. A worker with a questionable history (eg, angina or previous myocardial infarction) should not be required to complete a use test prior to pulmonary function testing. Input from the industrial hygienists concerning the required tasks will produce more useful results than a generic use test. The outcome of either test must be documented in the individual's medical record.

Contact lenses must be replaced by optical inserts whenever a full-face respirator is worn. Personnel who require glasses must also have optical inserts. Permitting a worker to begin work in a chemical environment without appropriate optical inserts, or while wearing contact lenses, places both the worker and the coworkers at an unacceptable risk for accidents.

The physical examination should be comprehensive and focus on the skin, cardiovascular, pulmo-

nary, and musculoskeletal systems. Obesity, lack of physical strength, and poor muscle tone are indicators of increased susceptibility to heat injury, a condition which will be amplified by working in chemical protective clothing. Factors such as facial hair, scarring, dentures, and arthritic hands or fingers can affect a worker's ability to wear or don a respirator and protective clothing.

Baseline Data for Future Exposures

Baseline data acquired during the preplacement screening can be used following a subsequent exposure event to determine the extent of the exposure. It can also be used to verify the engineering controls in effect. Additionally, baseline data may be used to determine if the worker has been adversely affected by the exposures. Red blood cell cholinesterase (RBC-ChE) baseline levels are essential for workers assigned in areas in which nerve agent munitions are stored. Workers are categorized by the area they are assigned to and the frequency with which they are in a chemical environment. The frequency of follow-up examinations are determined by the category in which prospective workers are placed. These categories are discussed in the following section.

Periodic Medical Examinations

Periodic medical examinations should be developed and used in conjunction with preplacement screening examinations.⁴ Comparing the data obtained through periodic monitoring with the preplacement baseline data is essential for identifying early signs of occupationally induced diseases. The primary purpose of the periodic medical examination is to identify conditions for which early interventions can be initiated, so that progression of the adverse effects can be curtailed prior to significant injury or disease.

The interval medical history and physical should focus on changes in health status, illness, and possible work-related signs and symptoms. The examining physician must be aware of the work environment and potentially hazardous exposures in order to identify work-related conditions or disease. Unlike patients seen in a private office, chemical surety workers who show a change in health status in the periodic evaluation make an evaluation of the work site necessary. Additional workers may require examination on the basis of conditions identified. At a minimum, coordination must be made with industrial hygiene personnel to determine if

there has been a change in the work environment that could be causally related.

The frequency and extent of the periodic medical examination will be determined by the toxicity of the potential or actual exposures, frequency and duration of contact, and the information obtained in the preplacement history and physical examination. The data obtained from these periodic examinations can serve as a guide to the future frequency of physical examinations or tests. Data consistently within acceptable limits for several months may indicate that the frequency can be safely decreased, provided that the work situation remains constant.

Biological monitoring for nerve agent exposure consists of RBC-ChE measurement. Determining who will be monitored, and the frequency, is the responsibility of the IMA. The certifying official is responsible for supplying information concerning the duties the worker performs; an accurate job description is essential. The surety officer and the safety officer may provide advisory input to the monitoring strategy for nerve agent exposures.

In accordance with Department of the Army Pamphlet 40-8, *Occupational Health Guidelines for the Evaluation and Control of Occupational Exposure to Nerve Agents GA, GB, GD, and VX*, the following four categories of personnel are required to have their RBC-ChE measured⁵:

1. Category A: personnel with a high risk of potential exposure due to the nature of the agent operations being conducted. Examples of such operations might include (but are not limited to) storage monitoring inspections of M55 rockets, periodic inspections, toxic chemical munitions maintenance operations that involve movement of munitions from storage locations, work in known contaminated environments, and first-entry monitoring. Category A personnel may be routinely required to work for prolonged periods in areas with high levels of nerve agents where the use of either of the following are required:
 - toxicological agent protective (TAP) ensembles, or
 - protective ensembles with a self-contained or supplied-air breathing apparatus.
2. Category B: personnel with both
 - a low risk or infrequent potential exposure to nerve agents in routine industrial, laboratory, or security operations (examples of such operations might include

- but are not limited to daily site security checks and accident/incident response by initial response force members), and
- job requirements involving the prolonged wearing of protective ensembles during training and emergency responses.
3. Category C: personnel with minimal probability of exposure to nerve agents, even under accident conditions, but whose activities may place them in close proximity to agent areas.
 4. Category D: transient visitors to agent areas where a potential for exposure exists and who are not included in the medical surveillance program for nerve agents at the visited installation.

An individual in category A must have a monthly determination of the RBC-ChE level; an individual in category B will have an annual RBC-ChE determination. Inaccurate categorization of workers will

either fail to provide adequate surveillance or cause exorbitant cost and effort without benefits.

Termination Examination

At the termination of employment or at the termination of duty in a chemical surety position, a worker should have a medical examination. Unless otherwise specified by a local regulation, this examination may be done within 30 days before or after termination of employment. In the event the worker is exposed after his termination examination, it will be necessary to evaluate for and thoroughly document that specific exposure. In most cases, exposure is not expected to occur, and completing the termination examination within the 30 days before the worker departs is advisable. Medical personnel must be aware that although it is in the worker's best interest to have a termination examination, it can be difficult for him return to his former place of employment to complete a medical examination once employment is terminated.

HEAT STRESS

Heat stress is a constant and potentially severe health threat to the worker in toxicological protective clothing. The combination of exposure to solar radiant energy or enclosed areas with high temperatures, metabolic heat production, and the use of impermeable clothing (which prevents evaporative cooling) place the chemical worker at high risk for heat injury.

Encapsulating uniforms increase the heat strain associated with most environments and work rates by creating a microenvironment of small volume around the worker. The impermeability to vapor of the suit (which is, after all, the characteristic that makes it protective) creates high local humidity, restricting evaporative cooling and conductive/convection cooling. In effect, the suit creates an environment at the body surface hotter and wetter under almost any circumstances than the environment outside the suit. Moderating the heat strain associated with an encapsulating ensemble is accomplished in the following ways:

- microclimate cooling: direct removal of heat, water vapor, or both from the worker's microenvironment;
- heat sinks in the suit: ice vests;
- increasing the temperature gradient across the suit: shielding workers from radiant heat sources, cooling the work space or, in

dry environments, wetting the surface of the suit; and

- work-rest cycles to permit cooling and rehydration.

Heat-induced occupational injury or illness occurs when the total heat load from the environment and metabolism exceeds the cooling ability of the body. The resultant inability to maintain normal body temperature results in heat strain (the body's responses to total heat stress).⁶

The reduction of adverse health effects can be accomplished by the proper application of engineering and work-practice controls, worker training and acclimatization, measurements and assessment of heat stress, medical supervision, and proper use of heat-protective clothing and equipment.⁶ Worker training and adequate supervision are basic requirements that need constant reinforcement. The occurrence of heat-induced illness or injury is an indication that (a) the worker has engaged in a careless act that should have been avoided and detected by adequate training and supervision, (b) the individual's medical status has changed and requires further or more frequent evaluation, or (c) supervisory enforcement of work-rest cycles or of adequate rehydration is lacking. In all cases, the healthcare provider must investigate the cause. If the individual's health status has changed, further medi-

cal evaluation is indicated. The worker may require temporary duties commensurate with his present health status or a permanent change of duties if his medical condition warrants. Should the injury appear to be a result of carelessness or lack of attention to changing environmental conditions, further training is indicated. Eliciting the worker's support may be necessary to acquire the appropriate support of intermediate supervisors.

Numerous textbooks and other sources discuss thermoregulation and physiological responses to heat; healthcare providers may benefit from a review of these subjects. This chapter will address the evaluation of heat stress and preventive measures.

The preplacement physical examination is designed for workers who have not been employed in areas exposed to heat extremes. It should be assumed that such individuals are not acclimatized to work in hot climates. The physician should obtain the following information⁶:

- A medical history that addresses the cardiovascular, respiratory, neurological, renal, hematological, gastrointestinal, and reproductive systems and includes information on specific dermatological, endocrine, connective tissue, and metabolic conditions that might affect heat acclimatization or the ability to eliminate heat.
- A complete occupational history, including years of work in each job, the physical and chemical hazards encountered, the physical demands of these jobs, intensity and duration of heat exposure, and nonoccupational exposures to heat and strenuous activities. The history should identify episodes of heat-related disorders and evidence of successful adaptation to work in heat environments as part of previous jobs or in nonoccupational activities.
- A list of all prescribed and over-the-counter medications used by the worker. In particular, the physician should consider the possible impact of medications that potentially can affect cardiac output, electrolyte balance, renal function, sweating capacity, or autonomic nervous system function. Examples of such medications include diuretics, antihypertensive drugs, sedatives, antispasmodics, anticoagulants, psychotropic medications, anticholinergics, and drugs that alter the thirst (haloperidol) or sweating mechanism (phenothiazines, antihistamines, and anticholinergics).

- Information about personal habits, including the use of alcohol and other social drugs.
- Data on height, weight, gender, and age.

The direct evaluation of the worker should include the following⁶:

- Physical examination, with special attention to the skin and cardiovascular, respiratory, musculoskeletal, and nervous systems.
- Clinical chemistry values needed for clinical assessment, such as fasting blood glucose, blood urea nitrogen, serum creatinine, serum electrolytes (sodium, potassium, chloride, bicarbonate), hemoglobin, and urinary sugar and protein.
- Blood pressure evaluation.
- Assessment of the ability of the worker to understand the health and safety hazards of the job, understand the required preventive measures, communicate with fellow workers, and have mobility and orientation capacities to respond properly to emergency situations.

A more detailed medical evaluation may be required. Communication between the physician performing the preplacement evaluation and the worker's private physician may be appropriate and is encouraged.

Follow-up evaluations may be warranted during the acclimatization period for selected workers. The phenomenon of heat acclimatization is well established, but for an individual worker, it can be documented only by demonstrating that after completion of an acclimatization regimen, the worker can work without excessive physiological heat strain in an environment that an unacclimatized worker could not withstand. The IMA needs to be intimately involved in developing the acclimatization program for the installation.

Annual or periodic examinations should monitor individuals for changes in health that might affect heat tolerance and for evidence suggesting failure to maintain a safe working environment. Education of the workers and supervisors, however, is the single most important preventive measure in avoiding heat casualties.

Personnel required to wear toxic-agent protective clothing are also at high risk for dehydration, which is a contributing factor for developing heat injury. The thirst mechanism is not adequate to

stimulate a worker to consume as much as a liter of water per hour that may be lost in sweat. If weight loss exceeds 1.5% to 2.0% of body weight, heart rate and body temperature increase, and work capacity (physical and psychological) decreases.⁷ Workers should be required to consume at least 8 oz of cool water at each break period; for moderate work in greater than 80°F wet bulb globe temperature (WBGT), the average male should plan on 1 qt of fluid per hour; more water may be required depending on the ambient temperature and humidity.

HEALTH EDUCATION FOR CHEMICAL WORKERS

All personnel entering an area where chemical munitions are stored must recognize and understand the potential hazards to their health and safety associated with chemical agents. Workers must be required to recognize signs and symptoms of exposure to these agents. They must be totally familiar with the procedures to assist a coworker and to summon assistance in the event of an accident. Visitors must be briefed on basic procedures that will permit them to complete their visit safely. Visitors must also be evaluated to ensure they can wear a mask appropriately should escape become necessary.

The objectives of training programs for chemical workers are to provide awareness of the potential hazards they may encounter and to provide the knowledge and skills necessary to perform the work with minimal risk. Additional requirements are to make workers aware of the purpose and limitations of safety equipment and to ensure that they can safely avoid or escape during an emergency situation.

Although the IMA may be requested to present a discussion of medical topics, he is responsible for reviewing the training program's lesson plans and the SOPs to ensure the correctness and comprehensiveness of the medical aspects. The level of training should be commensurate with the workers' job function and responsibilities, which will necessitate a modification of training material and techniques to accommodate the audience. The training programs should consist of both classroom didactic instruction and hands-on practice, when feasible.

Although this chapter primarily addresses the principles of occupational medicine as they apply to working in a chemical environment, it should be recognized that other workplace hazards exist. Training programs may focus on chemical warfare agents, but they should also address any additional physical and chemical hazards. A number of these hazards may be obvious and directly related to the

The average diet in the United States provides adequate salt intake for the acclimatized worker. The unacclimatized worker may excrete large amounts of salt: another reason that he will need close monitoring while adjusting to the evaluated temperatures and decreased evaporative cooling. Individuals on medications that further deplete sodium (ie, diuretics) will need even closer monitoring and medical follow-up. The judicious use of sodium replacement may be required during the acclimatization period.

primary mission; for example, the heat stress associated with wearing chemical protective clothing. Additionally, certain occupational medical hazards are common to all industrial operations (eg, low-back strain), which may produce excessive absenteeism and disability. By working closely with management, medical officers can minimize the impact of these additional safety and industrial hazards.

Special consideration should be given to training workers in the recognition of signs of exposure in a coworker wearing chemical agent protective clothing. Describing fasciculations and localized diaphoresis will be of limited value because the coworker will be wearing full protective clothing. Alerting the workers to watch for lack of coordination, inappropriate activity, and pinpoint pupils would be of far greater value. Moreover, discussions of the early symptomatology will give the workers the capability of recognizing chemical agent exposure early enough to permit evaluation prior to the onset of serious injury. These signs and symptoms are discussed at length in other chapters of this text.

Each employee should be thoroughly familiar with the requirements for providing effective self-aid and buddy-aid. The first rule of protection—to protect oneself from injury—must be emphasized. There are numerous case reports of individuals or groups attempting to assist someone exposed to toxic compounds only themselves to become casualties. Workers will require training in proper lifts and carries, both with and without a litter.

All workers should know the procedure for requesting medical assistance. Many installations have one "hotline" for medical, technical escort unit, and security support. Workers should be aware of any set format for reporting emergencies that will expedite the report and response time. Once assistance has arrived, the support personnel should be given accurate and complete information about the accident or incident. Teaching the worker

a logical format in which to present this information is extremely helpful. Their reports should include the nature of the accident or incident (ie, the agent involved and number of casualties), what has been done for the victims to that point (eg, the number of MARK I injectors administered), and whether personnel are missing. Support personnel can ask for additional information as the situation progresses.

Decontamination procedures must be well known to all chemical workers. The training class should present the M258 and M291 kits and their contents and make clear the use of household bleach in the decontamination process. Current doctrine specifies that in a tactical environment 0.5% bleach be used for skin decontamination. In depot operations, however, 5% bleach is used. This stronger concentration may be used because workers exposed at the depot will be decontaminated and then thoroughly rinsed in a fixed facility in a relatively short time. Soldiers in the field, however, may be decontaminated several times and not be rinsed thoroughly for several hours. Repeated applications of 5% bleach without a complete and thorough rinse will cause skin injury.

The bleach used for decontamination should be stored in airtight containers and dated. Bleach deteriorates and may not be as effective after several months.

Decontamination includes removal of contaminated clothing and the decontamination of skin using the bleach solution. Care must be used to avoid putting bleach in open wounds and the eyes. These areas must be rinsed with copious quantities of water. The bleach requires a contact time of approximately 15 minutes to be fully effective. Small areas can be decontaminated by removing the contaminated section of clothing and following the directions on the M258 or M291 kits. Medical evaluation, treatment, or both is always required.

Several additional decontaminants are used at the depot. They are generally very caustic and are not to be used on the skin. They include super tropical bleach (STB), high-test hypochlorite (HTH), 10% sodium carbonate, and 10% sodium hypochlorite. Healthcare personnel must be aware what decontaminants are stocked and what they are used for in case they are used inappropriately and a worker develops a medical problem. The industrial hygienist should be able to furnish this information.

Outergarments should never leave the installation, even for laundering. If the clothing is contaminated, it will pose a chemical agent exposure hazard to the launderer. The use of disposable outer garments or decontamination prior to washing will generally solve this problem; however, a change in contractor or new personnel involved in the transportation or laundering process must be addressed.

MANAGEMENT OF THE CONTAMINATED PATIENT

Clinics located at depots with a chemical surety mission should have an area designated for the decontamination of exposed patients. Generally the treatment area for these patients is separate from the normal patient treatment areas. These facilities are rarely used for an actual chemically contaminated patient, however. A conscious effort must be made to keep these rooms at 100% operational capability. To maintain this capability, the medical staff must develop standing operating procedures (SOPs) that are comprehensive and detailed.

The planning phase is essential to a successful operation, but the plan is useless if the personnel involved are not totally familiar with their responsibilities. Planning is an ongoing process that must be kept current in an ever-changing world. If the planning and updating process stops, the resulting document loses its usefulness. Unfortunately, many SOPs are written, only to be placed in a file for months without being reviewed by assigned personnel, only a few of whom may have been involved in initially producing the document. A routinely

scheduled review and update of the clinic's SOPs not only keeps the document current but, more importantly, requires that the healthcare personnel think about the plan and refamiliarize themselves with the operating procedures.

In addition to producing viable internal SOPs, external coordination dictates Memorandums of Agreement (MOAs) with local agencies. The nature of the chemical agents being stored or demilitarized requires that preparations be made for receiving and treating casualties beyond the capability of the installation clinic. While stabilization may be done at the clinic, hospitalization will require outside facilities. The specter of chemical casualties may make local hospitals needlessly reluctant to accept chemical casualties even after decontamination. Existing MOAs will make the transfer much smoother and will stimulate the local hospital to do preaccident planning and training themselves.

Much of the coordination required for outside agreements will be handled through command channels. The medical officer and medical admin-

istrator can accomplish much, however, by interpersonal contact with the medical facilities and the emergency medical personnel who will respond to an installation emergency. Coordination and interaction between civilian and military medical resources should be a continuous process. The IMA must take the lead to ensure the limited post resources are adequately augmented by off-post medical facilities.

Staffing and treatment capabilities of off-site emergency medical facilities should be verified to ensure appropriate resources are available. Training of civilian resources is coordinated through the Chemical Stockpile Emergency Preparedness Program (CSEPP); the Program Director for CSEPP is located at the Edgewood Area of Aberdeen Proving Ground, Maryland. Unfortunately, the many demands placed on the IMA limits the amount of time he can devote to coordinating with local

healthcare providers and administrators. Communicating with local supporting agencies, however, will be extremely valuable should an incident occur.

The physician assigned as the IMA should have attended the Toxic Agent Training Course and the Medical Management of Chemical Casualties Course prior to reporting for duty. Enlisted personnel and civilian healthcare providers will require training by the medical officer. Evacuation plans, coordination with off-post civilian medical facilities, MOAs, and periodic inventories (with restocking of supplies and equipment) are the responsibility of the IMA. As individual training continues, collective training in the form of drills should become a routine part of the clinic schedule. Only the successful completion of all of the above will ensure readiness for proper management of a chemically contaminated patient.

CHEMICAL ACCIDENT OR INCIDENT RESPONSE AND ASSISTANCE

Each installation with a chemical surety mission is required to develop detailed plans and procedures to be implemented by the emergency actions community in response to a Chemical (Surety Material) Accident or Incident (CAI). Health services support during Chemical Accident or Incident Response and Assistance (CAIRA) operations involves personnel with a wide range of medical expertise who will be involved in providing emergency care.

A decontamination area must be a part of the early medical care to limit the degree of exposure to the casualty. Emergency medical care will, initially, be provided by nonmedical workers who are responsible for removing the casualties from the site of injury through a personnel decontamination station and to the waiting medical team. Further evacuation may be required for one or more victims, either to the Installation Medical Facility (IMF) or to an off-post medical treatment facility (MTF). Civilian medical facilities may be required to receive the injured personnel, and they also will need their own supplies, equipment, and training appropriate for treating these casualties.

The fundamental pathophysiological threats to life (namely, airway compromise, breathing difficulties, and circulatory derangement [the ABCs]) are the same for chemical casualties as they are for casualties of any other type. Because these are chemical agent casualties, all personnel involved must be provided additional training. The IMA, whether military or civilian, must be very proactive in developing medical teams, medical training programs, and strong community relations.

A list of chemical agents, the number of personnel involved, the location of the work area, a summary of work procedures, and the duration of the operation is necessary to develop appropriate emergency medical plans. This information is available through the installation commander or the certifying official. In addition, the most probable event (MPE) and maximum credible event (MCE) must be defined to determine the anticipated casualty loads in either situation. An MPE is the worst potential event likely to occur during routine handling, storage, maintenance, or demilitarization operations that results in the release of agent and exposure of personnel. An MCE is the worst single event that could reasonably occur at any time, with maximal release of agent from munitions, bulk container, or work process as a result of an accidental occurrence. The Office of The Surgeon General will develop guidance for use by installations in estimating the chemical agent casualties expected from an MPE or an MCE.

For planning purposes, medical staffing requirements are based on the MPE for the installation. Because an MCE is expected to exceed the capabilities of the Installation Medical Facility, medical contingency plans and coordination with local, state, and federal emergency medical authorities is essential. The IMA is responsible for developing and periodically updating MOAs with local civilian hospitals and supporting military MTFs to augment the installation medical treatment capabilities.

The IMA must actively participate in training both medical and nonmedical personnel. Nonmedical workers require training in self-aid and buddy

aid as a minimum. The Installation Response Force (IRF) is responsible for providing the immediate safety, security, rescue, and control at the chemical accident or incident site to save lives and reduce exposure to hazards. The IMA must approve the training program for both workers and the IRF and must review their lesson plans for accuracy and completeness. The essentials of this training include recognizing signs and symptoms of agent exposure, first aid, self-aid, buddy aid, individual protection, personnel decontamination (including decontamination of a litter patient), and evacuation of casualties. Active participation in the training by the IMA will ensure that the personnel understand their role, and that the medical care given by people who are not healthcare professionals meets acceptable standards.

Healthcare providers, as well as local officials, are concerned about the spread of contamination. The procedure for decontamination of litter patients can be found in Appendix E of U.S. Army Field Manual 8-10-4, *Medical Platoon Leaders' Handbook: Tactics, Techniques and Procedures*.⁸ The IRF will decontaminate patients and pass them across a hotline to the Medical Response Team (MRT). At that point the casualty should be completely clean. Civilian officials may require a casualty "certified clean" before moving the patient off the military installation. This requirement may be avoided through adequate coordination and training prior to an exercise or an actual chemical accident or incident. Building confidence in the civilian sector through education and communication is essential in providing a rapid and adequate medical response.

Chemical Accident or Incident Response and Assistance encompasses actions taken to save life and preserve health and safety. This support involves a continuum of medical care, ranging from self-aid/buddy-aid in the field to treatment at a tertiary care facility. Due to the nature of some chemical warfare agents, proper care and adequate decontamination must be provided early in the care to avoid serious injury or death. The levels of medical care include the following:

- Level I: composed of IRF nonmedical installation personnel. The local commander appoints the IRF members and ensures they are provided initial and ongoing training as described in Department of the Army Pamphlet 50-6, *Chemical Accident or Incident Response and Assistance (CAIRA) Operations*.⁹ The Office of The Surgeon General and the U.S. Army Medical Department Center and

School are developing a list of essential medical tasks for this group. Additional tasks may be added at the discretion of the IMA or the local commander.

- Level II: the MRT, composed of on-post medical personnel. The leader of the MRT is a physician and is responsible for training the team in triage, treatment, stabilization, and evacuation of casualties from the accident site to the appropriate MTF. The MRT must have adequate personnel, supplies, and equipment to provide healthcare to casualties generated by a MPE. The specific tasks for the MRT leader and members are specified in DA PAM 50-6, Tables 6-3 and 6-4.⁹ One member of the MRT should be issued toxicological agent protective gear so he may cross the hotline and provide emergency medical care to casualties as required. The remaining members of the MRT should be available on the clean side of the hotline to perform triage and provide immediate care.
- Level III: the Medical Augmentation Team (MAT), provided by the MEDDAC or MEDCEN to an installation having chemical surety missions. This team must have the capability to augment the MRT in the event of an MCE. The MAT leader's responsibilities are also delineated in DA PAM 50-6, Table 6-5.⁹
- Level IV: The Chemical Casualty Site Team (CCST) is provided by the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) located at Aberdeen Proving Ground, Maryland. This team provides clinical consultation and subject-matter experts in chemical casualty care. In addition, a veterinarian may be a designated member of this team. During the initial phases of an exercise, concern is primarily for casualties. In previous service response force exercises, however, many questions have also been asked about the safety of livestock, pets, and wildlife. The veterinarian has proven to be an extremely valuable source of information and an asset to this team.

The installation commander looks initially to the IMA for medical support and advice. If the chemical accident or incident exceeds the capability of the installation, a Service Response Force (SRF) is provided to assume control of the situation. The SRF surgeon assumes operational control of the MRT,

the MAT, and the Medical Chemical Advisory Team (MCAT) at the accident site.

MOAs are required with local MTFs, local emergency medical services, ambulance services, and regional or state emergency medical services officials. The MOAs and frequent coordination with these agencies are necessary to ensure that appropriate off-post resources will be available for support during a chemical accident or incident.

Because of the unique nature of chemical agents, training, as defined in an MOA, must be provided

to the supporting civilian agencies. A proactive stance in giving and sustaining education will enhance the relationship with the civilian community. Many civilian medical personnel and officials are very supportive and willing to play an active role in Chemical Accident or Incident Response and Assistance exercises. Assisting them in training and providing them with appropriate supplies and equipment will go far in enlisting their future support and allaying some of their fears of the unknown.

DEMILITARIZATION OF CHEMICAL WARFARE AGENTS

The U.S. has produced and stored a stockpile of chemical warfare agents since World War I. These projectiles, rockets, mines, and ton containers have been maintained at eight depots in eight states: Aberdeen Proving Ground, Maryland; Anniston Army Depot, Alabama; Blue Grass Army Depot, Kentucky; Newport Army Ammunition Plant, Indiana; Pine Bluff Arsenal, Arkansas; Pueblo Army Depot Activity, Colorado; Tooele Army Depot, Utah; and Umatilla Army Depot, Oregon. In addition, two additional states could possibly be affected should there be a large release of agents: Washington and Illinois. The majority of chemical agents are stored in bulk containers that do not have explosive components.

Leaking chemical agents have not presented a health threat to areas surrounding these depots. However, continuing to store the aging munitions may present a risk of chemical agent exposure. The M55 rocket is the most hazardous of the chemical munitions. The rocket contains propellant and a stabilizer that could degrade and form reaction products that might cause ignition.

In 1985, the U.S. Congress initiated a program to dispose of our entire stockpile of lethal chemical agents. There are multiple reasons for destroying these chemical warfare agents:

- Congress has required that the U.S. Army destroy the chemical stockpile by the year 2004,
- ratification of a multilateral chemical arms control treaty requires the destruction of the weapons,
- the need for the stockpile no longer exists, and
- the stockpile is slowly deteriorating with age; although the risk of continued storage is small, it will increase with time.

The prototype destruction plant for lethal agents was erected on Johnston Island: the Johnston Atoll

Chemical Agent Destruction System (JACADS). A second destruction facility was built at Tooele Army Depot, Tooele, Utah, as a pilot plant for other facilities to be located at the remaining depots.

Incineration has been determined to be the process that will safely treat all components of the weapons. The destruction facilities were built with back-up systems to prevent environmental release of agent. The U.S. Public Health Service reviews plans and monitors operations of these chemical destruction plants. The appropriate state environmental authorities must issue permits prior to beginning the incineration process.

Despite the extensive precautions in building the destruction plants, the U.S. Army and the Federal Emergency Management Agency (FEMA) are working with local emergency responders to enhance their capabilities. Training in the medical management of chemical agent casualties specific to the installation is provided frequently to first responders and emergency management officials through CSEPP.

Critics of the army's high-temperature incineration on Johnston Island have found the method to be very controversial and undesirable. The disagreement among scientific experts concerning the incineration process and the emotional concerns of populations surrounding the eight U.S. depots have created numerous debates over the chemical agent destruction program. This controversy has presented the army with numerous challenges in risk communication and preparation to complete the destruction mission.

Extensive security and safety measures have been adopted to ensure that an accident or incident involving the chemical warfare agents and chemical surety material is avoided. The containers are typically stored in an igloo (ie, a storage building topped with 3–4 ft of earth and concrete) and transported in large overpack containers (ie, a container within a heavy container) designed to withstand an explosion.

The agent is destroyed at 2,700°F. Metal parts are also incinerated. Exhaust gases are passed through extensive pollution-control systems. Munitions are destroyed in small quantities in thick-walled rooms that are designed to withstand detonation. The likelihood of an accident that results in exposure of surrounding off-post areas is extremely remote in day-to-day operations.

The solid residue remaining from ash, fiberglass, and wooden dunnage are evaluated for contamination and are transported to approved landfills. Brine (a by-product waste) is packaged and also sent to approved landfills. There is no water discharge resulting from the incineration process.

Stack effluent must meet all requirements of the Clean Air Act,¹⁰ especially the amendments that

were passed in 1970,¹¹ 1977,¹² and 1990¹³; (these last three versions were codified in the United States Code in 1990¹⁴). In addition to carbon dioxide and oxygen, small quantities of sulfur dioxide, oxides of nitrogen, carbon monoxide, and particulate are discharged. Special precautions have been taken to reduce and eliminate the formation of furans and dioxans from the incineration process. Discharges from the stack are continuously monitored to ensure that the requirements of the Clean Air Act are met. Even though the possibility of an event leading to the contamination of an area surrounding a community is remote, extensive planning and preparation have been accomplished. The U.S. Army and FEMA have jointly enhanced the emergency preparedness of these communities.

SUMMARY

The unique challenges of chemical warfare agents, aging munitions, and protecting worker health in a chemical environment can prove a rewarding experience for healthcare providers. The personnel reliability program places numerous safety and administrative demands that require that the physician acquire knowledge in occupational medicine that many physicians never experience. Unlike many clinicians, the IMA is thrust into an environment that requires interaction with multiple professional groups. Coordination with industrial hygienists and safety officers will result in an awareness of the workplace and the work conditions that is seldom appreciated by other physicians.

Designing a medical surveillance program to prevent illness and injury is seldom attempted by most physicians in clinical practice. This secondary preventive measure will augment and re-

inforce the primary preventive efforts of safety and industrial hygiene measures. Appropriate surveillance requires a thorough knowledge of the chemical agents. Requisite information is available through mandatory courses and on-the-job training.

The chemical demilitarization process places additional demands on U.S. Army Medical Department personnel. In addition to the many responsibilities inherent to the chemical surety mission, the IMA may be challenged with risk communication. Many of the civilians living near depot storage facilities do not approve of the plan to incinerate the 30,000 tons of agents stored at these sites. Healthcare providers can play an important role in providing information and building confidence in the U.S. Army's ability to safely destroy these agents through incineration.

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