Chapter 15

TRIAGE OF CHEMICAL CASUALTIES

SHIRLEY D. TUORINSKY, MSN[*]; DUANE C. CANEVA, MD[†]; AND FREDERICK R. SIDELL, MD[‡]

[*] *Lieutenant Colonel, AN, US Army; Executive Officer, Combat Casualty Care Division, US Army Medical Research Institute of Chemical Defense, 3100 Ricketts Point Road, Aberdeen Proving Ground, Maryland 21010-5400*
[†] *Head, Medical Plans and Policy, Navy Medicine Office of Homeland Security, 2300 E Street, NW, Washington, DC 20372*
[‡] *Formerly, Chief, Chemical Casualty Care Division, and Director, Medical Management of Chemical Casualties Course, US Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, Maryland*

INTRODUCTION

The term "triage" has come to have different meanings depending on the situation in which it is used. Derived from the French word *trier,* meaning to sort, categorize, or select, its initial use is thought to have been in reference to the sorting of crops according to quality. Triage soon became used on the battlefield as the sorting of casualties into three groups: (1) those needing immediate care, (2) those who could wait for treatment, and (3) those not expected to survive. Military triage has certain definitions codified in doctrine and policy. The term also refers to the initial screening and prioritization process in emergency departments.

Triage is one of the most important tools in the handling of mass chemical casualties. Triage criteria must be relevant to the available medical units' capabilities, and triage process should be planned in advance and practiced. In general, triage is performed at naturally occurring bottlenecks, where delays in medical care may occur, and when medical requirements exceed capabilities or resources, which may cause a breech in the standard of care. The ultimate goal of triage is to optimize the use of available medical resources to provide the best medical care possible by identifying the correct priority of patients.[1] This chapter will focus on the process of triage in chemical agent mass casualties. Specific chemical warfare agent classes, current triage systems, and classifications of triage will be reviewed, with discussion of issues specific to the battlefield and installation setting.

TRIAGE PRINCIPLES AND PROCESSES

In a mass casualty situation, whether in peacetime or on a battlefield, triage is carried out to provide immediate and appropriate care for casualties with treatable injuries, to delay care for those with less immediate needs, and to set aside those for whom care would be too timely or asset-consuming. Triage ensures the greatest care for the greatest number and the maximal utilization of medical assets: personnel, supplies, and facilities. To effectively triage a given population, a triage officer should know the following essential information:

- The current environment and potential threat, course, and harm. Situational awareness must include current tactical goals and conditions, the potential evolution of hazardous materials or conditions, and the impact these might have on the patients and providers.
- The ongoing medical requirements, including the number and type of current casualties and potential population at risk.
- The medical resources on hand.
- The natural course of a given injury.
- The current and likely casualty flow.
- The medical evacuation capabilities.
- The decontamination requirements in a chemical incident.

According to FM 8-10, *Health Service Support in a Theater of* Operations,[2] the triage officer should be a highly experienced medical provider who can make sound clinical judgments quickly. Ideally, a surgeon experienced with combat trauma would be used in this capacity; however, once casualty flow progresses, surgeons must spend time in the operating suite, and their available time to perform triage will be limited beyond the initial efforts and between operations. Additionally, the expertise of surgical triage applies to traumatic injuries, and may not be as applicable to chemical incidents. Commonly, the most experienced combat medic performs triage; however, other physicians, dentists, or nurses with appropriate training and experience can also accomplish this arduous task.

Part of the triage process is the evaluation of the benefit that immediate assistance will provide. This evaluation is based, in part, on the natural course of the injury or disease. For example, dedicating medical assets to a casualty with an injury that will either heal or prove fatal no matter what immediate care is given would be of little benefit. Another part of the process is considering the overall tactical mission requirements, which may change rapidly in the battlefield setting. The ultimate goal of combat medicine is to return the greatest possible number of soldiers to combat and the preservation of life, limb, and eyesight in those who must be evacuated.[3]

Setting aside casualties who are in need is unpopular among medical care providers, and poses an ethical dilemma on how to provide the ultimate care for each patient. The Hippocratic Oath is not helpful in this sorting process, because the modern interpretation of the Oath states that the duty of physicians and nurses is to protect and promote the welfare of their patients. Furthermore, according to the Oath, caregivers must focus their full attention on that patient until the patient's needs are met, before turning their attention to another patient. Additionally, in peacetime, every patient who enters the hospital emergency room

receives the full attention of all personnel needed to provide optimal care. For these reasons, the thought of setting aside a critically sick or injured patient may well be repugnant to someone who has not been in a mass casualty situation or who has given little thought to such situations.[4]

In addition to knowing the natural course of the disease or injury, the triage officer should also be aware of current medical assets, the current casualty population, the anticipated number and types of incoming casualties, the current status of the evacuation process, and the assets and casualty population at the evacuation site. Committing assets to the stabilization of a seriously injured casualty in anticipation of early evacuation and more definitive care would be pointless if evacuation could not be accomplished within the time needed for the casualty's effective care, or if the assets at the evacuation site were already committed. The officer might also triage differently if, for example, he or she knew that the 10 casualties present would need care in the next 24 hours, or, on the other hand, that those 10 casualties were to be followed by 50 more within an hour.[5] In an unfavorable tactical situation, another consideration may arise: casualties with minor wounds, who otherwise may be classified minimal, might have highest priority for care to enable them to return to duty. The fighting strength thus preserved could save medical personnel and casualties from attack.

Levels of Care

Triage is a dynamic rather than a static process, in which casualties are periodically reevaluated for changes in condition and retriaged at various levels of medical care, ranging from the battlefield to the battalion aid station to the combat support hospital. The first triage is done by the corpsman, medic, or unit combat lifesaver in the field. The medic first evaluates the severity of injury and decides whether anything can be done to save life or limb. If the answer is no, the medic moves on, perhaps after administering an analgesic. More commonly, the medic decides that care is indicated. Can the medic provide that care on the spot to return the service member to duty quickly? Can the care wait until the battle is less intense or an ambulance arrives? Or must the care be given immediately if the casualty is to survive? In the latter case, the medic ensures that the casualty is transferred to the medical facility if possible.

A casualty is triaged once more upon entry into a medical care facility, followed by repeated triage within the facility as circumstances (eg, the casualty's condition and the assets available) change. For example, a casualty set aside as expectant (see Triage Categories for Chemical Casualties, below, for definitions of classification groups) because personnel are occupied with more salvageable casualties might be reclassified as immediate when those personnel become free. On the other hand, a casualty with a serious but not life-threatening wound, initially classified as delayed, could suddenly develop unanticipated bleeding and, if treatment assets were available, might be retriaged as immediate.

Even in the most sophisticated medical setting, a form of triage is usually performed (perhaps not always consciously): separation of those casualties who will benefit from medical intervention from those who will not be helped even by maximal care. However, in most circumstances in a large medical facility, care is administered anyway; for instance, an individual with a devastating head injury might receive life-support measures. The realization that in some settings assets cannot be spent in this manner is an integral part of triage.[6]

Decontamination

At the first level of medical care, the chemical casualty is contaminated, and both the casualty and the triage officer are in protective clothing (mission oriented protective posture [MOPP] level 4 or Occupational Safety and Health Administration level C). Furthermore, the first medical care given to the casualty is in a contaminated area, on the "hot" or dirty side of the "hotline" at the emergency treatment station (see Chapter 14, Field Management of Chemical Casualties). This situation is in contrast to any level of care in which casualties were previously decontaminated, and to a conventional situation with no contamination involved. Examination of the casualty is not as efficient or effective as it might be in a clean (not contaminated) environment, and very little care can be given to a casualty in the emergency treatment section in the contaminated area. In a chemically contaminated environment, in contrast to other triage situations, the most experienced medical staff work in the clean treatment area, where they can provide maximum care.

It is extremely unlikely that immediate decontamination at the first level of medical care will change the fate of the chemical casualty or the outcome of the injury. Various estimates indicate that the casualty usually will not reach the first level of care for 15 to 60 minutes after the injury or onset of effects, except when the medical treatment facility (MTF) is close to the battle line or is under attack and the injury occurs just outside. The casualty is unlikely to seek care until the injury becomes apparent, which is usually long

after exposure. For example, mustard, a vesicant, may be on the skin for many hours before a lesion becomes noticeable. Thus, it is likely that the agent has been completely absorbed or has evaporated from the skin by the time the casualty reaches the MTF, and the small amount unabsorbed, or absorbed during a wait for decontamination, is very unlikely to be significant.

The process of patient decontamination must be factored into the triage decision. (It must be remembered that triage refers to priority for medical or surgical care, not priority for decontamination. All chemical casualties require decontamination. Although a casualty exposed to vapor from a volatile agent such as cyanide, phosgene, or a nerve agent may not appear to need decontamination, verifying that no liquid is present on the casualty is difficult.) In a contaminated environment, emergency care is given by personnel in MOPP 4, the highest level of protective gear, which limits their capabilities. After receiving emergency care, a casualty must go through the decontamination station before receiving more definitive care in a clean environment. Decontamination takes 10 to 20 minutes. As a rule no medical care is provided during this time or during the time spent waiting to begin the decontamination process. Therefore, before leaving the emergency care area, patients must be stabilized to an extent that their condition will not deteriorate during this time. If stabilization cannot be achieved, the triage officer must consider this factor when making the triage judgment. If the casualty has torn clothing or a wound suspected to be the source of contamination, a different type of decontamination—immediate decontamination—must be performed at the triage or emergency treatment station in the dirty or chemically contaminated area.

Casualties exposed to certain chemical agents such as nerve agents may be apneic or nearly apneic; one of the first interventions required is assisted ventilation. Special, air-filtering assisted ventilation equipment, a chemical mask-valve-bag device (called resuscitation device, individual chemical), is available for use in a chemical environment. However, personnel available to provide ventilator assistance in the contaminated environment are likely to be limited. Also, if a brisk wind is present and the medical facility is far upwind from the source of contamination, very little agent vapor will remain in the air. If no air-filtering ventilation equipment is available, medical personnel must decide whether to ventilate with air that is possibly minimally contaminated or let the casualty remain apneic. Once assisted ventilation is begun, the care provider is committed to the process and cannot care for other casualties, so the number of medical personnel available in the contaminated area influences the ventilation decision. However, a walking wounded casualty (in the minimal category) can quickly be taught how to ventilate other casualties.[7]

Treatment, Decontamination, and Transport Linkage

Triage is always linked to treatment; in a mass casualty event, triage and treatment are also linked to transport. In a chemical weapons mass casualty event, decontamination is also linked, and transport is from the contaminated environment. This linked process occurs at the incident site, and is somewhat duplicated at the MTF; however, different statutory codes, policies, and requirements are relevant in each place. As the preparedness and response efforts for homeland security mature, the tactics, techniques, and procedures used in military settings or homeland settings are converging. Likewise, the regulatory statutes, including best practices, certification processes for equipment, training, and competencies, are showing a pattern of convergence. Further alignment should be driven by such initiatives as development of national resource typing systems (discussed in Other Triage Systems, below) in support of national preparedness goals.

During response preparations, the triage and treatment teams are best placed at naturally occurring bottlenecks as patients are processed through the decontamination corridor (Figure 15-1). At least three triage locations should be placed at the incident site. Triage and treatment teams must integrate their work with patient transport teams (litter bearers and ambulance staff). They must also integrate with decontamination teams, which may be comprised of personnel with very limited medical training. Medical oversight of the patients must be clearly defined and understood by all personnel, including recognition of and proper alerts for changes in patient condition, continuation of any supportive measures, and strict adherence to protocol and procedure.

The initial casualty collection point is located near the border of the hot and warm (contamination reduction) zones. This location allows for initial collection of nonambulatory victims from the incident site in the hot zone and provides shorter distances and cycle times for teams retrieving the casualties from the incident site. It also provides a working environment for medical personnel who are initially uncontaminated. Antidote administration and airway management are the mainstays of treatment at this point. The next bottleneck generally occurs on both sides of the decontamination shelter. Current methods for mass casualty decontamination allow for very limited throughput, even by the most experienced of teams with the best technology, leading to a backup of patient flow at the

entrance. These "decon triage" teams provide retriage and basic treatment including airway management, additional administration of antidote, and perhaps more invasive medical intervention.

On the clean side of the decontamination shelter is another typical bottleneck as patients await transport from the incident scene to more definitive treatment facilities. Here, medical personnel are not encumbered with personal protective equipment and are able to evaluate patients in an uncontaminated environment. More invasive medical intervention is possible without concern for further contaminating the patient. A balance among condition, transport times, medical resources, and interventional requirements must be sought in the prioritization and triage of the patients. In incidents conducted in a noncombat situation, such as might occur on an installation during peacetime, first responders adhere to federal statutes for training qualifications.[8]

A somewhat similar scenario occurs at the MTF (see Figure 14–12**).** At the MTF, training requirements are governed by different regulations than those for the incident site. For example, current Occupational Safety and Health Administration guidelines require 8 hours of hazardous waste operations and emergency response (HAZWOPER) first responder operations level training for first receivers who are expected to decontaminate victims or handle victims before they are thoroughly decontaminated at the MTF. The guidelines include additional criteria for the personal protective equipment levels recommended (level C), no more than a 10-minute time period from patient exposure at the incident site to presentation to the MTF, and a thorough hazard vulnerability assessment to identify specific threats or hazards that might drive additional requirements. Additionally, the hazardous zones are recognized as different from those at the decontamination incident site, referred to as the "warm (contamination reduction) zone" and "cold (postdecontamination) zone" (see Figure 14-12). At

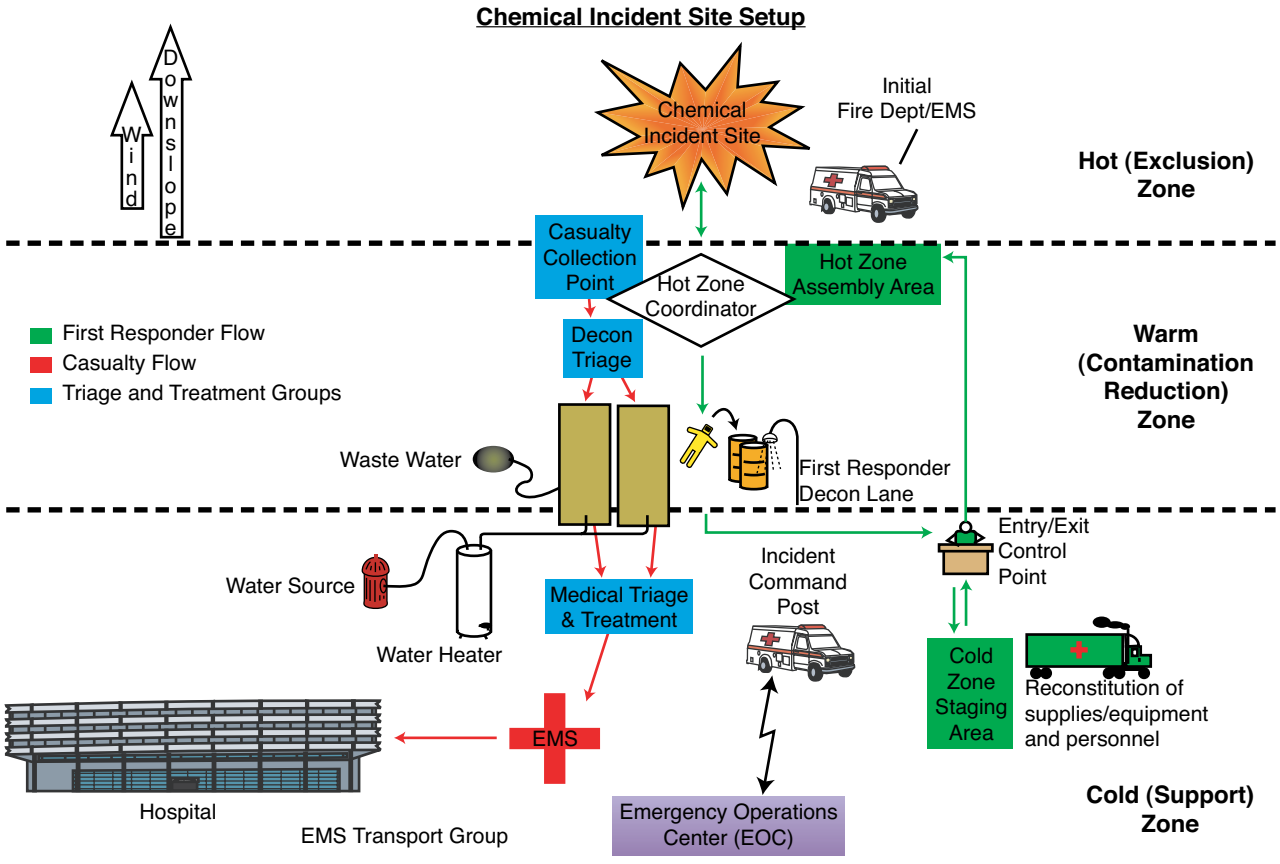

Fig. 15-1. National site setup and control zones for a hazardous materials site. All distances are notional.
EMS: emergency medical service
Diagram: Courtesy of Commander Duane Caneva, US Navy.

the MTF, the casualty receiving and decontamination triage areas are likely to be co-located or simply combined. Additionally, a separate evaluation area may be needed where those who received thorough decontamination at the warm or contamination reduction zone are confirmed clean.[9]

TRIAGE CATEGORIES FOR CHEMICAL CASUALTIES

Chemical casualty triage poses unique challenges beyond the normal triaging of patients with traumatic injuries. Current triage systems are designed for traumatic injuries and, to the degree that they are evidence-based, are based on trauma data. Criteria used, such as respiratory rate and effort, pulse, mental status, and motor function, are specifically affected by many chemical weapons agents; however, correlation with degree of abnormality, course of injury, and survivability is not as well understood as in cases of traumatic injury. Complicating the situation may be the occurrence of combined injury, both poisoning and trauma, if the chemical agent was dispersed through explosive ordnance (see Casualties with Combined Injuries, below). Such a situation requires decisions to be made balancing emergency medical treatments with chemical decontamination: airway management or control of hemorrhage may be equally urgent or more urgent than the treatment for chemical agent poisoning. Emergency medical treatment triage measures may need to be performed simultaneously or in rapid sequence with decontamination procedures.

The simplest form of triage is placing the casualties into treatment priority categories. In a conventional situation (uncontaminated environment), casualties who require immediate intervention to save their lives usually have injuries affecting the airway, breathing, or circulation—the "ABCs"—that can be treated effectively with the assets available within the time available. The second conventional category consists of casualties with injuries that pose no immediate danger of loss of life or limb. Casualties in this group might include someone with a minor injury who merely needs suturing and a bandage before being returned to duty, or someone who has an extensive injury necessitating long-term hospitalization, but who at present is stable. The third conventional category consists of those for whom medical care cannot be provided because of lacking medical assets or time or because the triage officer knows from experience that the casualty will die no matter what care is given. Again, a casualty's classification might change as assets become available or when later reevaluation shows that the casualty's condition was not as serious as first anticipated.

US Military Triage Categories

The triage system commonly used by US military medical departments and by many civilian medical systems, based on the North Atlantic Treaty Organization mass casualty triage standard, contains four categories:

1. Immediate treatment (T1): Casualties who require emergency life-saving treatment. This treatment should not be time consuming or require numerous or highly trained personnel, and the casualty should have a high chance of surviving with the medical treatment.
2. Delayed treatment (T2): Casualties whose condition permits some delay in medical treatment. However some continuing care and pain relief may be required before definitive care is given.
3. Minimal treatment (T3): Casualties with relatively minor signs and symptoms who can care for themselves or who can be helped by untrained personnel.
4. Expectant treatment (T4): Casualties with a low chance for survival whose life-threatening condition requires treatment beyond the capabilities of the medical unit. Placing casualties into this category does not necessarily mean that no treatment will be given; rather, the category determines the priority in which treatment will be given.

These are the categories that will be used in this chapter. This chapter will not cover triage of the conventionally wounded casualty except in the context of combined injury.

Alternative triage categories are emergent (historically subdivided into immediate and urgent), nonemergent (historically subdivided into delayed and minimal), and expectant. Sometimes the term "chemical intermediate" is used for a casualty who requires an immediate life-saving antidote (as in nerve agent or cyanide poisoning).

Triage categories are based on the need for medical care, and they should not be confused with categories for evacuation to a higher-level MTF for definitive care. However, the need for evacuation and, more importantly, the availability of evacuation assets influences the medical triage decision. For example, if a casualty at a battalion aid station is urgently in need of short-term surgery to control bleeding, and evacuation is not possible for several hours, the triage category might be expectant instead of immediate. The evacuation

categories are urgent (life immediately threatened), "urgent-surg" (must receive surgical intervention to save life and stabilize for further evacuation), priority (life or limb in serious jeopardy), routine, and convenience (evacuation is matter of medical convenience).[10] The distinction between the urgent and immediate groups has often been ignored, as has the separation of the chemical immediate and immediate groups.

Other Triage Systems

In an attempt to eliminate subjectivity from the triage process, various systems have been created to identify specific criteria for categorization and to correlate these criteria to data from trauma registries; however, very few systems address the impact of chemical toxidromes. Cone and Koenig provide a comprehensive summary of various systems and propose algorithms for chemical, biological, radiological, and nuclear incident types.[11] The commonly used simple triage and rapid treatment (START) system, based on the respiratory rate, pulse, and motor function (collectively referred to as the "RPMs"), provides an algorithm that allows for a patient to be evaluated, classified by color, and receive minimal lifesaving measures within about 30 to 60 seconds. The START process begins with an initial safety survey, followed by the identification of ambulatory patients considered "green," or having minimal injury, to be moved to a safe gathering place, and the evaluation of the remaining nonambulatory victims. These victims are then triaged as immediate (red), delayed (yellow), minimal (green), or expectant (black).[12] Largely objective, the START algorithm is correlated with a trauma registry that identifies which field-measurable physiological parameters correlate with survival and severity of injury. The RPMs are used to determine the revised trauma score for a predictable outcome.[13]

The Sacco triage method (STM) builds on this concept through a more complex algorithm. Using the criteria developed for START, the RPMs are used to provide a revised trauma score ranging from 0 to 12. STM then considers the available resources (eg, receiving hospital beds), transport times, and scoring distribution of all known patients, and optimizes the order of patients by their revised trauma score. For example, if an incident occurs with long transport times, the model predicts that patients with lower scores will not survive. Higher scored patients are thus prioritized for transport first so as to not use limited resources on patients who are statistically unlikely to survive.

Although STM is more complex than other systems, it has several advantages.[14] Like START, its basic evaluation is fairly objective, using criteria correlated to actual trauma data registry. Unlike other systems, STM accounts for other critical factors such as transport times and receiving hospital resources. It also provides a better stratification of critical patients, with a more practical, realistic spectrum of severity of condition. Furthermore, STM recognizes that patients with more severe injury tend to decompensate faster and sooner and considers differing transport times to separate hospitals, as well as the availability of hospitals to receive patients. Through use of an incident management system, STM links on-scene triage and treatment, transport, and patient reception at the hospital, providing the data for a unified command system to secure transport routes. The system can therefore be customized for specific municipalities or operational scenarios, as well as providing strategies to maximize survivability during preparedness and response phases.

Current military doctrine provides limited insight into specific criteria for mass casualty triage in a chemical environment. Although the triage criteria for casualties exposed to a chemical agent may be similar or even the same as those for traumatic injury, substantial differences in the triage process exist. Additional steps in the process of care for casualties exposed to a chemical agent include, for example, the administration of antidote, if efficacious; extraction from the area of chemical exposure; proper management and removal of any personal protective equipment worn by the patient; and medical management through a decontamination corridor. Medical personnel must carry out these procedures while wearing personal protective equipment.

Furthermore, changes in vital signs of chemical casualties are generally predictable given the severity of exposure, but their correlation with injury is not nearly as well understood as that for traumatic injury and vital signs. No easily measurable, dose-response parameters have been predictably correlated to survivability with a known time course for decompensation. No criteria are available, therefore, to prioritize, for example, the evacuation of an unconscious, nearly apneic casualty versus one who is alert and dyspneic. Applying these criteria to an algorithm is further complicated by differing toxicity levels across the general population.[15]

MEDICAL MANAGEMENT OF CHEMICAL CASUALTIES

The initial management and treatment of contaminated chemical agent casualties varies according to the agent as well as the tactical situation. For this reason, each MTF must have a plan that can be modified as needed for specific situations. Unless the chemical agent is dispensed downwind or at the site of the inci-

dent, casualties will probably take at least 15 minutes after the exposure to reach a medical treatment area. Furthermore, some casualties will not seek medical attention until effects from the agents are apparent, and an appreciable amount of time may elapse before the casualty is seen.

Nerve Agents

In a unit-level MTF, nerve agent casualties might be classified as immediate, minimal, delayed, or expectant. In a full-care MTF, a nerve agent casualty is unlikely to be classified as expectant because treatment should be available. A nerve agent casualty who is walking and talking can generally be treated and returned to duty within a short period (see Chapter 5, Nerve Agents for a more complete discussion of nerve agent effects and treatment). In most cases, rather than reporting to the triage point, military personnel exposed to nerve agents should self-administer the Mark I or antidote treatment nerve agent autoinjector (ATNAA), either of which should reverse the respiratory effects of vapor exposure. Casualties who appear at the triage station should be classified as minimal because they are able to self-administer the antidote (or it can be administered by a medic), evacuation is not anticipated, and they can return to duty shortly.

Casualties who have received the contents of all three Mark I or ATNAA kits and continue to have dyspnea, have increasing dyspnea, or begin to have other systemic symptoms (such as nausea and vomiting, muscular twitching, or weakness) should be classified as immediate. A source of continuing contamination with liquid agent, such as a break in protective clothing or a wound, should be given immediate decontamination and irrigated with water or saline solution (this procedure is not included in the general advice about decontamination in Warrior Task Training[16]; however, the newest version of FM 8-285[5] directs caregivers to provide treatment as described here). If the casualty is conscious, has not convulsed, and is still breathing, prevention of further illness will ensure a quick return to duty. The casualty will survive unless he or she continues to absorb agent. Also, administration of more atropine should help considerably. With these measures, the progression of nerve agent illness can be stopped or reversed with a minimal expenditure of time and effort in the emergency treatment area.

At the other end of the spectrum, casualties who are seriously poisoned will usually not survive long enough to reach an MTF. However, there are exceptions. If the attack is near an MTF, casualties who are unconscious, apneic, and convulsing or postictal might be seen within minutes of exposure. Or, if the casualties have taken soman nerve agent pyridostigmine bromide pretreatment, they might remain unconscious, convulsing, and with some impairment (but not cessation) of respiration for many minutes to hours. These patients, as well as those in a similar condition who have not used the pretreatment, require immediate care. If they receive that care before circulation fails and convulsions have become prolonged (see Chapter 5, Nerve Agents), they will eventually recover and be able to return to duty.

Supporting this view is a report from the Tokyo subway terrorist incident of 1995. One hospital received two casualties who were apneic with no heartbeat. With vigorous cardiopulmonary resuscitation, cardiac activity was established in both. One resumed spontaneous respiration and walked out of the hospital several days later; the other was placed on a ventilator but did not start breathing spontaneously and died days later. These anecdotes suggest that when circumstances permit, resuscitation should be attempted, for recovery by such patients after nerve agent exposure is clearly possible. In a contaminated area where resources, including personnel, are limited, the use of ventilatory support and closed chest cardiac compression must be balanced against other factors (discussed above), but the immediate administration of diazepam and additional atropine requires little effort and can be very helpful in the casualty who still has recoverable cardiopulmonary function.

Cyanide

Symptoms of cyanide poisoning depend upon the agent concentration and the duration of exposure. High concentrations of cyanide gas can cause death within minutes; however, low concentrations may produce symptoms gradually, causing challenges for the triage officer. Generally, a person exposed to a lethal amount of cyanide will die within 5 to 10 minutes and will not reach an MTF. Conversely, a person who does reach the MTF may not require therapy and could possibly be in the minimal group, able to return to duty soon. If the exposure occurs near the treatment area, a severely exposed casualty might appear for treatment. The casualty will be unconscious, convulsing or postictal, and apneic. If circulation is still intact, antidotes will restore the person to a reasonably functional status within a short period of time. The triage officer, however, must keep in mind that it takes 5 to 10 minutes to inject the two antidotes needed. In a unit-level MTF, a cyanide casualty might be immediate, minimal, or expectant; the last classification would apply if the antidote could not be administered or if circulation had failed before the casualty reached medical care.

In a full-care facility, the casualty might be classified as immediate or minimal.

Vesicants

Most casualties from mustard exposure require evacuation to a facility where they can receive care for several days to months. The exceptions are those with small areas of erythema or with only a few small, discrete blisters. However, even these guidelines are not absolute. If the casualty is seen early after exposure, erythema may be the only manifestation, but it may be the precursor of blister formation. Small, discrete blisters may appear innocuous, but on certain areas of the body they can be incapacitating, rendering a soldier unfit for duty (see Chapter 8, Vesicants, for a more complete discussion).

Mustard casualties, especially those with eye involvement, are often classified as immediate for purposes of decontamination. However, immediate decontamination within 2 minutes can decrease the damage of mustard to the tissues. This classification is not helpful unless the casualty presents to the MTF within 2 minutes of exposure, which is very unlikely because of mustard's latent effects. By the time the mustard lesion forms, the agent has been in contact with the skin, eye, or mucous membrane for a number of hours, and irreversible effects have already begun.

Casualties who have liquid mustard burns over 50% or more of body surface area or burns of a lesser extent but with more than minimal pulmonary involvement pose a challenge for the triage officer. The medial lethal dose (LD_{50}) of liquid mustard, estimated at 100 mg/kg, covers 20% to 25% of body surface area. It is unlikely that a casualty will survive twice the LD_{50}, which would cover about 50% of body surface area, because of the tissue damage from the radiomimetic effects of mustard. Casualties with a burn this size or greater from liquid mustard should be considered expectant. They require intensive care (which may include care in an aseptic environment because of leukopenia) for weeks to months, which can be provided only at the far-rear level of care or in the continental United States. Chances of survival are very low in the best of circumstances and are decreased by delays in evacuation. Furthermore, even in a major hospital during wartime, long-term care will require assets that might be needed for casualties more likely to survive.

Under battlefield or other mass casualty conditions, casualties with conventional thermal burns covering greater than 70% of body surface area are usually put in the expectant group when medical facilities are limited. This percentage is subject to downward modification (in increments of 10%) by other factors, including further restriction of healthcare availability, coexisting inhalational injury, and associated traumatic injury. However, differences exist between conventional burns and mustard burns: conventional burns are likely to have a larger component of third-degree burns, whereas mustard burns are mostly second-degree. On the other hand, exposure to mustard causes problems not seen with conventional burns, such as hemopoietic suppression and the ensuing susceptibility to systemic infection, which is greater than that seen with conventional burns.

Mustard casualties are generally classified as delayed for both medical attention and decontamination. Exceptions are casualties with a very small lesion (< 1% of body surface area) in noncritical areas, who are usually classified as minimal and returned to duty, and those with large burn areas from liquid mustard (> 50% of body surface area) and moderate to severe pulmonary involvement, who are usually classified as expectant. In a more favorable medical environment, every effort should be made to provide care for these casualties; at least those in the latter group should be classified as immediate.

In a unit-level MTF, a mustard casualty might be categorized as minimal, delayed, or expectant, but probably not immediate, because required care would not be available. Even if immediate evacuation is possible, the eventual cost in medical care for a casualty needing evacuation must be compared to the probable cost and outcome of care for a casualty of another type. In a large medical facility where optimum care is available and the cost is negligible, a mustard casualty might be classified as minimal, delayed, or immediate.

Lung-Damaging Agents

Casualties exposed to lung-damaging agents (toxic industrial chemicals) may also present a dilemma to the triage officer. A casualty who is in marked distress, severely dyspneic, and productive of frothy sputum might recover in a fully equipped and staffed hospital; however, such a casualty would not survive without ventilatory assistance within minutes to an hour. This assistance is not possible in the forward levels of medical care, nor is it possible to transport the casualty to a hospital within the critical period. Casualties with mild or moderate respiratory distress and physical findings of pulmonary edema must also be evacuated immediately; if evacuation to a full-care MTF is not forthcoming in a reasonably short period, the prognosis becomes bleak. (These casualties would not be triaged as immediate because the required immediate care is probably unavailable at the forward levels of medical care.) Thus, with lung-damaging agent casual-

ties, availability of both evacuation and further medical care is important in the triage decision.

Peripherally acting lung-damaging agents induce pulmonary edema that varies in severity; a casualty might recover with the limited care given at the unit-level MTF. However, a casualty who complains of dyspnea but has no physical signs presents a triage dilemma: to evacuate this casualty might encourage others to come to the MTF with the same complaints, anticipating evacuation from the battle area, but refusing to evacuate might preclude timely care and potentially cause an unnecessary fatality, and observing the individual until signs of illness appear might also delay medical intervention until the damage is irreversible. Knowledge about the following physical manifestations of peripherally acting lung-damaging agent intoxication may be helpful to the triage officer if a reliable history of the time of exposure is available:

- The first physical signs, crackles (rales) or rhonchi, occur at about half the time it takes for the injury to become fully evident. Thus, if crackles are first heard 3 hours after exposure, the lesion will increase in severity for the next 3 hours.
- If no signs of intoxication occur within the first 4 hours, the chance for survival is good, although severe disease may ultimately develop. In contrast, if the first sign occurs within 4 hours of exposure, the prognosis is not good, even with care in a medical center. The sooner after exposure that symptoms develop, the more ominous the outlook.

Casualties with crackles or rhonchi 3 hours after exposure must reach a medical facility that can provide care as soon as possible. Even with optimal care, the chances of survival are not good. It should be emphasized that these guidelines apply only to objective signs, not the casualty's symptoms (such as dyspnea). In a contaminated area, where both medical personnel and casualties are wearing MOPP 4 gear, it will not be easy and may not be possible to elicit these signs.

In a unit-level MTF, casualties from peripherally acting lung-damaging agents might be triaged as minimal or expectant, with a separate evacuation group for those who require immediate care, if timely evacuation to a higher-level facility is possible. In a large, higher-level MTF, these casualties might be classified as minimal or immediate because full care can be provided on-site.

Incapacitating Agents

An incapacitating agent is a chemical warfare agent that produces temporary disabling conditions that can last hours or even days after exposure. Casualties showing the effects of exposure to an incapacitating agent may be confused, incoherent, disoriented, and disruptive. They cannot be held at the unit-level MTF, but they should not be evacuated ahead of casualties who need lifesaving care unless they are completely unmanageable and threatening harm to themselves or others. Casualties who are only mildly confused from exposure to a small amount of agent, or whose history indicates they are improving or near recovery, may be held and reevaluated in 24 hours. In a unit-level MTF, a casualty from exposure to an incapacitating agent might be minimal or delayed, with little need for high priority in evacuation. In a higher-level MTF, these casualties would be cared for on a nonurgent basis.[7]

Riot Control Agents

Riot control agents, which include irritant agents (eg, CN [chloroacetophenone]) and vomiting agents (eg, DA [diphenylchlorarsine]), have been available for many years and are used in uncontrolled disturbances to render people temporarily incapacitated without injury, although use of the agents includes risks of persistent skin effects, eye effects, and allergic reaction after exposure. Decontamination can relieve irritation of symptoms and decrease risk of injury or delay effects of contact dermatitis. Casualties exposed to riot control agents will most likely not be seen at an MTF, but if they do present with complications, triage according to the nature of the injuries.[17]

TRIAGE BY CATEGORY AND AGENT

Immediate

Nerve Agents

A nerve agent casualty in severe distress would be classified as immediate. The casualty may or may not be conscious; may be in severe respiratory distress or may have become apneic minutes before reaching the facility; may not have convulsed or may be convulsing or immediately postictal. Often the contents of three Mark I or ATNAA kits (or more) plus diazepam and, possibly, short-term ventilatory assistance will be all that is required to prevent further deterioration and death. In addition, a casualty with involvement of two or more systems (eg, neuromuscular, gastrointestinal, and respiratory, but excluding effects on the eyes and

nose) should be classified as immediate and administered the contents of three Mark I or ATNAA kits plus diazepam.

Phosgene and Vesicants

Casualties of phosgene (or any peripherally acting lung-damaging agent) or vesicants who have moderate or severe respiratory distress should be placed in the immediate group when intense ventilatory and other required support is immediately available. In a battalion aid station or other unit-level MTF, these support systems may not be available immediately, and would probably not be available during transport to a large medical facility. In general, limited assets would best be used for casualties more likely to benefit from them.

Cyanide

A cyanide casualty who is convulsing or who has become apneic minutes before reaching the medical station and has adequate circulation should be in the immediate group. If circulation remains adequate, the administration of antidote may be all that is required for complete recovery. However, since death may occur within 4 to 5 minutes of exposure to a lethal dose of cyanide unless treatment is immediate, this type of casualty is unlikely to be seen in an MTF.

Incapacitating Agents

Casualties with cardiovascular collapse or severe hyperthermia following the exposure to incapacitating agents such as BZ (3-quinuclidinyl benzilate) should be placed in the immediate category.

Delayed

Nerve Agents

Casualties who require hospitalization but have no immediate threat to life should be placed in the delayed group. This is generally limited to a casualty who has survived a severe nerve agent exposure, is regaining consciousness, and has resumed spontaneous respiration. These casualties will require further medical care but cannot be held in the unit-level MTF for the time necessary for recovery.

Vesicants

Casualties with a vesicant burn between 5% and 50% of body surface area (if by liquid) or with eye involvement require hospitalization but not immediate lifesaving care. These casualties must be observed for pulmonary symptoms and hemopoietic complications. Pulmonary complications generally occur about the same time that dermal injury becomes apparent.

Peripherally Acting Lung-Damaging Agents

Casualties who have been exposed to peripherally acting pulmonary agents such as phosgene with delayed onset of respiratory distress (> 4 hours after exposure) can be placed in the delayed category. For casualties with significant exposure, evacuation should not be delayed because pulmonary edema can rapidly become life threatening. Medical intervention must be initiated quickly for the casualty to survive (as noted above; however, this care may not be available).

Cyanide

Casualties exposed to cyanide vapor who have survived for 15 minutes can be categorized as minimal or delayed.

Incapacitating Agents

Casualties showing signs of exposure to an incapacitating agent (such as BZ; see Chapter 12, Incapacitating Agents) usually does not have a life-threatening injury, but must be evacuated because of long recovery times. A casualty who has had a very large exposure, however, and is convulsing or has cardiac arrhythmias requires immediate attention if it can be made available.

Minimal

Nerve Agents

A nerve agent casualty who is walking and talking and has only mild effects from the agent vapor (such as miosis, rhinorrhea, or mild-to-moderate respiratory distress) should be categorized as minimal. If any treatment is indicated, the contents of one or more Mark I or ATNAA kits will suffice. A casualty who has administered self-aid for these effects may need no further therapy and can often be returned to duty in 24 hours or sooner, if the degree of miosis does not interfere with performance of duty.

Vesicants

A vesicant casualty with a small area of burn—generally less than 5% of body surface area in a noncritical site (but the critical size depends on the site [see Chapter 8, Vesicants])—or minor eye irritation can be placed in the minimal category and possibly returned to duty after treatment. Lesions covering

larger areas or evidence suggesting more than minimal pulmonary involvement would place this casualty in another triage group.

Peripherally Acting Lung-Damaging Agents

A casualty exposed to phosgene or other peripherally acting lung-damaging agents rarely belongs in the minimal group. If development of pulmonary edema is suspected, the casualty is placed in a different triage group. On the other hand, if a casualty gives a reliable history of exposure several days before, reports mild dyspnea in the intervening time, and is now improving, the triage officer should consider holding the casualty for 24 hours for reevaluation and determination of return-to-duty status.

Cyanide

A casualty who has been exposed to cyanide but has not required therapy will recover quickly.

Incapacitating Agents

Casualties exposed to an incapacitating agent should be evaluated in a similar manner as those exposed to peripherally acting lung-damaging agents. If the casualty's condition is worsening, evacuation is necessary. On the other hand, if there is a reliable history of exposure with an intervening period of mild symptoms and evidence of recovery, the casualty may be observed for 24 hours on-site and returned to duty.

Expectant

Nerve Agents

Any nerve agent casualty who is pulseless or apneic (duration unknown) should be categorized as expectant. (However, as noted above, some of these casualties may survive if prolonged, aggressive care is possible.)

Vesicants

A vesicant casualty who has burns covering more than 50% of body surface area from liquid exposure, or who has signs of more than minimal pulmonary involvement, can survive only with extensive medical care. This care may be available at rear levels of medical care, but advanced treatment should be initiated for those with the greatest chance of survival.[7]

Peripherally Acting Lung-Damaging Agents

A casualty with moderate or severe dyspnea and signs of advanced pulmonary edema from exposure to phosgene or other peripherally acting lung-damaging agents requires a major expenditure of rear-area medical assets.[7]

Cyanide

A cyanide casualty who is pulseless belongs in the expectant group.

CASUALTIES WITH COMBINED INJURIES

Combined injury casualties have wounds caused by conventional weapons and have been exposed to a chemical agent. The conventional wounds may or may not be contaminated with chemical agent. Limited experimental data on this topic exists, and little has been written about the treatment for combined injury chemical casualties in World War I or the Iran–Iraq War. Uncontaminated wounds should be dressed and treated in the usual way. The wound should be covered with agent-proof (nonporous) material (for additional information, see Chapter 16, Decontamination of Chemical Casualties), and if a pressure bandage is needed, it should be applied after the protective covering. These safety measures may prevent the patient from becoming a combined chemical and conventional casualty. This section will consider the effects of chemical agent poisoning on conventional wounds, the results of treatment for such poisoning, and possible drug interactions of the treatments.

Nonpersistent Nerve Agents

Nerve agents interact with anesthetic drugs, causing increased respiratory depression and reduced cholinesterase activity, which affects metabolism. Blood loss complicates respiratory failure, so casualties may require supplemental oxygen or resuscitation with positive pressure ventilation. Need for replacement of blood lost through conventional injury is increased in the presence of respiratory depression. The action of anticholinesterase (including pyridostigmine pretreatment, to a lesser extent) may potentiate or prolong the action of depolarizing relaxants (eg, succinylcholine).

With nondepolarizing relaxants (eg, vecuronium), the actions are opposed, leading to a higher effective dose. Opiates and similar drugs reduce respiratory drive and should be used with caution in cases of nerve agent poisoning.

Persistent Nerve Agents

When a conventional injury is contaminated by a persistent nerve agent, the danger of absorbing a lethal dose is great and the prognosis is poor. The skin surface surrounding the wound must be decontaminated, followed by application of a surface dressing with a protective cover to prevent further contamination. In a superficial wound the entire skin surface would be decontaminated. Surgery on contaminated wounds poses minimal danger to medical staff when butyl rubber gloves are worn. If these gloves are not available, two pair of latex rubber gloves, washed at short intervals in hypochlorite solution and changed frequently, should suffice. These casualties require careful observation during evacuation to the surgical unit. If signs of poisoning persist or worsen, Mark I or ATNAA treatment should be continued (for further information see Chapter 5, Nerve Agents).

If the wound is not directly contaminated by liquid agent on the skin but the surrounding skin is affected, the casualty should be decontaminated and given the appropriate agent therapy. If the injury is not directly contaminated but skin absorption is thought to have occurred, the skin must be decontaminated. Because liquid nerve agent can penetrate the skin within 2 minutes but the effects from agent absorption into the bloodstream may be delayed up to 18 hours after exposure, the casualty should be kept under close observation during this period and given an autoinjector when indicated.

Vesicants

Vesicant agents weaken those exposed, and the agent's systemic effects could lead to serious delay in the healing of any wound because of depression of the immune system (see Chapter 8, Vesicants, for more information) even if the wound is not directly contaminated. Casualties with a Lewisite-contaminated wound will feel immediate pain disproportionate to the severity of the wound. Early treatment with dimercaprol (BAL) is required. The first responder (medic or buddy) should decontaminate the area around the wound and dress it with a protective material to prevent further contamination.

Thickened vesicant agent may be carried into conventional wounds on fragments and debris. These wounds need to be carefully explored using the no-touch technique. Wounds should be irrigated using a solution containing 3,000 to 5,000 ppm free chlorine for approximately 2 minutes, followed by irrigation with saline (this can be done by squeezing the fluid from intravenous bags into the wound). This technique should not be used in the abdominal or thoracic cavities, or in casualties with intracranial head injuries.

Lung-Damaging Agents

A conventional wound in a casualty exposed to a lung-damaging agent is compounded by development of pulmonary edema. The latent period between exposure and the onset of pulmonary edema may be short. The resultant pulmonary edema may be servere. Casualties exposed to lung-damaging agents should be kept at rest. When indicated, steroid treatment should be started early. The use of opiates and other systemic analgesics to treat pain or shock from the conventional injury is not contraindicated. Oxygen therapy is required; however, fluid replacement should be used with caution to avoid precipitating or increasing pulmonary edema.

Cyanide

Contamination of conventional injuries with cyanide can result in respiratory depression and reduction of oxygen-carrying capacity of the blood. Urgent use of cyanide poisoning antidote is required (see Chapter 11, Cyanide Poisoning). Oxygen therapy combined with positive pressure resuscitation may be required sooner in the presence of marked hemorrhage from the conventional injury. Opiates and other drugs that reduce respiratory drive must be used with extreme caution.

Incapacitating Agents

A casualty presenting with a major wound and intoxication by an incapacitating compound might be delirious and unmanageable. If the compound is a cholinergic-blocking agent such as BZ, the administration of physostigmine may temporarily calm the patient (the effects diminish in 45–60 min) so that care can be given. However, physostigmine may have a limited effect on muscle relaxants used during anesthesia. At various stages the incapacitating compounds cause tachycardia, suggesting that heart rate may not be a reliable indication of cardiovascular status. Otherwise, review of these compounds indicates that they do not interfere with wound healing or further care.[7]

SUMMARY

Triage of chemical agent casualties is a dynamic process based on the same principles as the triage of conventional casualties, with the same goal of maximizing survival. The triage officer must provide immediate care to those who need it to survive; however, the officer is also faced with the task of deferring treatment for some casualties or delaying the treatment of those with minor injuries or who do not need immediate medical intervention. The triage officer should judiciously use valuable resources on casualties who are certain to die or those who will survive without medical care. At the first level of medical care on a battlefield, medical capabilities are very limited. When chemical agents are present or suspected, medical capabilities are further diminished because early care is given by the medical care provider and to the casualty in protective clothing. Decontamination, a time-consuming process, must be carried out before the casualty receives more definitive care, even at this initial level. At the rear level of care, or at a hospital in peacetime, medical capabilities are much greater, and decontamination is anticipated to have been accomplished prior to casualty arrival.

Triage should be based on knowledge of medical assets, the casualty load, and, at least at unit-level MTFs, the evacuation process. Most importantly, the triage officer must have full knowledge of the natural course of an injury and its potential complications.

REFERENCES

1. Rund DA. *Triage*. St. Louis, Mo: Mosby Company; 1981: 310.
2. US Department of the Army. *Health Service Support in a Theater of Operations*. Washington, DC: DA; 1991. FM 8-10.
3. US Department of the Army. *Force Health Protection in a Global Environment*. Washington, DC: DA; 2003. FM 4-02.
4. Veatch RM. Disaster preparedness and triage: justice and the common good. *Mt Sinai J Med.* 2005; 72(4):236-241.
5. Medical management and treatment in chemical operations. In: US Departments of the Army, Navy, Air Force, and Marine Corps. *Treatment of Chemical Agent Casualties and Conventional Military Chemical Injuries*. Washington, DC: DoD; 1995: Appendix C. FM 8-285, NAVMED P-5041, AFJMAN 44-149, FMFM 11-11.
6. Triage. In: Burris DG, FitzHarris JB, Holcomb JB, et al, eds. *Emergency War Surgery*. 3rd rev ed. Washington, DC: Department of the Army, Office of The Surgeon General, Borden Institute; 2004: Chap 3.
7. US Departments of the Army, Navy, and Air Force. *NATO Handbook on the Medical Aspects of NBC Defensive Operations*. Washington, DC: DoD; 1996: Chap 11. AMedP-6(B), FM 8-9, NAVMED P-5059, AFJMAN 44-151. Available at: http://www.fas.org/nuke/guide/usa/doctrine/dod/fm8-9/toc.htm. Accessed on October 18, 2007.
8. 29 CFR, Part 1910.120.
9. Occupational Safety and Health Agency. *OSHA Best Practices for Hospital-Based First Receivers of Victims from Mass Casualty Incidents Involving the Release of Hazardous Substances*. Washington, DC: OSHA; 2005. Available at: http://www.osha.gov/dts/osta/bestpractices/html/hospital_firstreceivers.html. Accessed September 10, 2007.
10. US Department of the Army. *Medical Evacuation in a Theater of Operations: Tactics, Techniques, and Procedures*. Washington, DC: DA; 2000. FM 8-10-6.
11. Cone DC, Koenig KL. Mass casualty triage in the chemical, biological, radiological, or nuclear environment. *Eur J Emerg Med*. 2005;12:287-302.
12. START triage plan for disaster scenarios. *ED Manag*. 1996;8:103-104.
13. Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A revision of the trauma score. *J Trauma*. 1989;29:623-629.

14. Sacco WJ, Navin DM, Fiedler KE, Waddell RK 2nd, Long WB, Buckman RF Jr. Precise formulation and eEvidence-based application of resource-constrained triage. *Acad Emerg Med*. 2005;12:759-770.

15. Sommerville DR, Reutter SA, Crosier RB, Shockley EE, Bray JJ. *Chemical Warfare Agent Toxicity Estimates for the General Population***.** Aberdeen Proving Ground, Md: US Army Edgewood Chemical Biological Center; 2005. AD B311889.

16. US Department of the Army. *Soldier's Manual of Common Tasks, Warrior Skills, Level 1*. Washington, DC: DA; 2006. STP 21-1-SMCT.

17. Liudvika J, Erdman, DP. CBRNE—evaluation of a chemical warfare victim. *Emedicine* [serial online]. Available at: www.emedicine.com/emerg/topic892.htm. Accessed September 15, 2004.