MILITARY PREVENTIVE MEDICINE: MOBILIZATION AND DEPLOYMENT
Volume 1

Section 2: National Mobilization and Training

Louis H. Freund *Entering Camp*

National mobilization requires turning large numbers of civilians into fit-to-fight military personnel and doing it quickly. The problems in disease control and injury prevention are immense, and their solutions are vital if trainees are to be kept on schedule.

Art: Courtesy of US Center of Military History, Washington, DC.

Chapter 11

MEDICAL THREAT ASSESSMENT

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INTRODUCTION

Medical threat has been defined as "the composite of all ongoing or potential enemy actions and environmental conditions that will reduce combat effectiveness through wounding, injuring, causing disease or performance degradation."[1(p2)] During preparation for deployment, it is critical that commanders at strategic and operational levels acquire an estimate of the medical threat for the mission. Chapter 1 reviews the concepts of medical threat assessment, medical threat estimate, and the impact of the medical threat on commanders' operational plans. This chapter will describe the generic elements of a medical threat assessment in the predeployment phase, but as it is within a textbook emphasizing the preventive medicine aspects of military operations, it will not address estimating enemy force projection and weapons capabilities or planning the countermeasures to these intentional, hostile sources of harm. Instead, the following discussion focuses on the disease and nonbattle injury (DNBI) component of the medical threat.

Commanders must know what measures to take to protect their personnel from DNBI. A good assessment will identify medical threats that can decrease the fighting force by lowering fighting effectiveness and causing morbidity and mortality. Specific countermeasures can then be identified to reduce or eliminate these threats. The threat assessment is a dynamic process. After the initial information is obtained and countermeasures instituted, the assessment must be continually evaluated during and after the operation to ensure that the preventive measures are working and to identify new threats before significant casualties can occur. Typically, a threat assessment is developed when military personnel are sent to a foreign country, but this step is just as important when those servicemembers train in the United States. Medical casualties can occur from infectious agents and environmental elements, such as heat and cold, in the United States as well as abroad. Although it is not possible to fully predict disease and injury rates before a deployment, the assessment is used to guide medical policy.

FRAMEWORK FOR ASSESSMENT

Accurately identifying threats depends on knowing basic information that answers four essential questions: Who? What? When? and Where? Figure 11-1 illustrates how these questions correspond to the traditional epidemiologic triads of host-agent-environment and person-place-time. "What" refers to the nature of the operation itself and the related activities that are predicted to occur. Table 11-1 lists more specific questions to be considered in a threat assessment. The variable "who" (ie, the population) merits brief elaboration here.

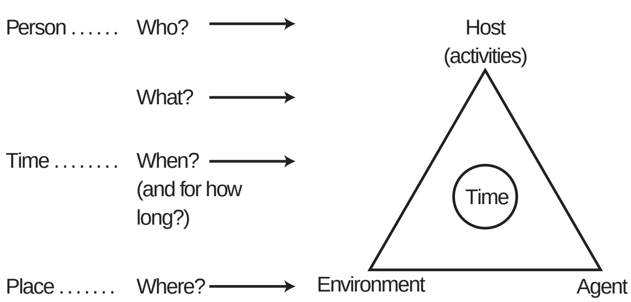

Fig. 11-1. This conceptual drawing shows the interdependent relationships among principal factors inducing a disease or injury. A host population and its activities encounter injurious agents in a given environment, during a specific time (eg, of day, of year) and for a specific duration. The synchronization or convergence of these factors determines the probability of injury and its magnitude in individuals or across groups.

The Population at Risk

Clearly defining the "who"—the group or population at risk—is the first step in developing a medical threat assessment. Generally, assessments are performed at the operational level, and the entire deployed force is treated as a single group. All threats in the area of operation are considered, but not all subgroups of personnel have the same risk of exposure to each of the threats. For example, soldiers having close contact with the indigenous population, such as military police or Special Forces teams, have a much different risk for particular diseases (eg, tuberculosis) than soldiers lacking that exposure. Sometimes, US medical officers may be asked to consider the indigenous population as the group at risk. For example, during Operation Uphold Democracy in 1994, there was initial concern that United Nations peacekeeping forces could bring chloroquine-resistant *Plasmodium falciparum* to the island of Hispaniola. Clearly, identifying the population to be protected is a prerequisite to developing a medical threat assessment.

TABLE 11-1

SPECIFIC FACTORS TO CONSIDER WHEN ASSESSING THE RISK OF DISEASE AND INJURY

Factors	Examples
Person Factors	
Number	Total population in the area of operations
Demography	Age, sex, culture
Health status	Medical history, current condition, immunity (eg, vaccinations, prior exposures)
Psychosocial	Psychological stress, sleep deprivation, desynchronosis, morale
Training	Combat, survival, physical, military occupational, hygiene
Equipment	Personal protection (eg, clothing, footwear, repellent)
Activity	Operation (eg, movement, work-rest cycles), occupation (eg, chemical, biological, physical, ergonomic), recreation (especially sports injuries, contact with water), behaviors (especially hygiene, sexuality, risk-taking)
Place Factors	
Global position	Latitude: arctic, temperate, tropical; longitude: Americas, Africa-Mediterranean, Asia, East Asia-Pacific
Development and stability	Sanitation, industrialization, waste management, vector control, stability food and water supplies, medical facilities
Terrain	Desert (eg, sand and dust, navigation), mountain (eg, altitude, energy expenditure), rain forest (eg, vectors, immersion), urban vs. rural setting
Climate	Temperature (hot vs. cold), relative humidity (wet vs. dry), wind
Biomass	Flora (eg, natural food supply, toxic plants, movement inhibition), fauna (eg, disease vectors and reservoirs, venomous animals)
Enclosures	Tentage, buildings, aircraft, ships, small vessels, vehicles, ventilation
Agent Factors	
Pathogens	Prevalence, infectivity, virulence, resistance (to immunity, drugs)
Vectors	Vector control measures applied by deploying force
Equipment	Passive safety devices in vehicles and equipment
Time Factors	
Year	Long-cycle variables (eg, pandemics)
Season	Seasonal or climate-dependent variables (eg, dry season and meningococcal disease, rainy season and malaria)
Time of day	Diurnally variable vectors, night safety, temperatures
Duration	Increased cumulative risk from longer stays

Once this is established, the other basic information of what, when, and where should be obtained. Information needed includes the planned activities of the group, the expected time and duration of the operation, and a more precise geographic location of the area of operation (see Table 11-1).

Information Sources

The next step in developing a threat assessment is to identify the potential threats themselves. Table 11-2 lists the principal military and civilian sources of pertinent information. An example of the depth of infor-

TABLE 11-2

SOURCES OF HEALTH RISK INFORMATION

Organization or Agency	Product Example
Military	
Armed Forces Medical Intelligence Center, Fort Detrick, Md	Medical Environmental Disease Intelligence and Counter measures (MEDIC) CD-ROM
Defense Pest Management Information Analysis Center, Silver Spriing, Md	Disease Vector Ecology Profiles (DVEP)
US Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, Md, and subordinate units in Japan and Europe	Surveillance data
US Navy Environmental Health Center, Norfolk, Va, and Navy Environmental Preventive Medicine Units in Pearl Harbor, San Diego, Norfolk, and Sicily Profiles	Disease Risk Assessment Profiles (DISRAP), surveillance data
US Army Medical Research and Materiel Command, Fort Detrick, Md, and overseas laboratories in Thailand and Kenya	Research reports
US Navy Medical Research Command, Bethesda, Md, and overseas laboratories in Indonesia, Peru, and Egypt	Research reports
Civilian	
World Health Organization, Geneva, Switzerland, and Washington, DC Pan American Health Organization and Caribbean Epidemiology Centre	Weekly Epidemiologic Record
US Centers for Disease Control and Prevention, Atlanta, Ga	*Health Information for International Travel*
National Library of Medicine, Bethesda, Md	MEDLINE and other literature retrieval systems
US Department of State, Washington, DC	Travelers' Advisories, Background Notes
Ministries of Health of nations in region of interest	Ad hoc reports
Universities with overseas activities	Ad hoc reports
Medical publishers, electronic conferences	Textbooks, handbooks, travel web sites, consultants medicine software programs, ProMED Mail (NY State Dept of Health)

mation available from these sources is the extensive database on country-specific flora and fauna, including the arthropod vectors of militarily important diseases, maintained by the Defense Pest Management Information Analysis Center (Silver Spring, Md). The Armed Forces Medical Intelligence Center (Fort Detrick, Md) produces timely, detailed reports of country-specific environmental, infectious disease, and other health risks of military operational importance. It draws its information from multiple sources, including official, international reports of health, morbidity, and mortality; published scientific studies; and validated reports from the lay press.

The Internet, both through the World Wide Web and electronic mail services, offers countless possible sources of international health and safety information. A useful example is the Program for Monitoring Emerging Diseases (ProMED), a free electronic mail conference through SatelLife and HealthNet, which reaches participants throughout the world. Through this medium, epidemiologists and medical scientists can immediately report emerging or reemerging problems in specific geographic areas.

Not listed in Table 11-2 but also important are institutions that house military history resources; recent, peacetime data are best extrapolated in the context of past military operations in a comparable environment. Valuable collections may be accessed at the Center for Military History (Fort McNair, Washington, DC), the Uniformed Services University of the Health Sciences (Bethesda, Md), the National Library of Medicine (Bethesda, Md), and the individual services medical doctrinal centers (Army Medical Department Center and School, San Antonio, Tex; Naval School of Health Sciences, Bethesda, Md; Air Force School of Aerospace Medicine, San Antonio, Tex). Information is sometimes available from past deployments and from special assessment teams, such as those that might be part of the advanced party for a particular deployment. Other governmental agencies can also provide useful information. For example, the National Institutes of Health have active research projects in several foreign countries. Nongovernmental sources, such as missionaries or nongovernmental humanitarian organizations, can often provide current information about health threats in the countries in which they serve. A review of the scientific literature is extremely helpful. Note that disease and injury occurrence in native populations differs from that which might be expected among expatriates. Infectious disease rates in the indigenous pediatric population of an underdeveloped country may be the best model of expected disease risk in military personnel arriving from a developed country. Those servicemembers, unlike the indigenous adults, lack immunity to diseases that are usually acquired early in life in underdeveloped areas.

Regardless of its source, information should be carefully assessed for quality and completeness. It is rare, however, for any dataset or statement about health risks to accurately reflect the actual risks to be faced by deploying personnel. Typically, for example, reported rates of infectious diseases account for 10% or less of the actual number of cases that can be identified in a given geographic area through intensive surveys. Even in industrialized countries, where compliance with public health notification requirements tends to be better than in less-developed countries, published communicable disease rates should be at least doubled to reflect actual occurrence.[2] Exhibit 11-1 lists some of the main factors contributing to the nonreliability of risk information.

As a rule, published reports are more reliable quantitatively when they are describing significant epidemics or when the disease in question is distinct in its rarity, severity, or the reliability and relative simplicity with which a laboratory test can detect its presence. Reporting also tends to be more complete from regions where modern medical facilities are available and where there are no barriers to either medical care or disease reporting[2]. It should be remembered that many of the geographic areas to which the US military deploys have had years of civil strife and lack an adequate infrastructure to obtain current, accurate medical information. Thus an absence of information does not necessarily mean there is an absence of threat.

EXHIBIT 11-1

FACTORS COMPROMISING THE RELIABILITY OF PUBLISHED DISEASE REPORTS

- Reporting Factors
  - Nonreportable diseases
  - Variable reporting criteria
  - Underreporting
  - Lack of communications
  - Reporting biases
- Data Collection Factors
  - Biased studies
  - Variable denominator
  - Variable diagnostic capability
- Social, Geographic Factors
  - Borders that are political or economic, not ecological
  - Cultural adaptation to endemic disease
- Disease Factors
  - Inapparent infections
  - Long latencies
  - Importations
  - Variable immunization
  - Disease periodicity
  - Secular trends
  - Variable persistence of agents, vectors, reservoirs
  - Agent adaptation

THREAT CATEGORIES

Potential threats to health can be divided into cause-effect categories as follows: (a) battle injuries, (b) nonbattle injuries, (c) environmental injuries, (d) psychological stress, and (e) infectious diseases. Table 11-3 presents a summary of these.

Battle Injuries

Producing an estimate of combat casualties, while extremely important to medical planning, is not primarily a task of medical personnel. Likewise, the prevention of combat wounds is in the purview of military tactics and not preventive medicine. It should be noted, however, that these injuries have accounted for an increasing proportion of total mortality during wars as the sophistication and lethality of weapon systems has rapidly increased. At the same time, the sophistication of countermeasures to DNBI has also increased, accounting for fewer dramatic disease outbreaks and fewer transportation catastrophes during military operations. Nevertheless, DNBI remains the most likely cause of morbidity among deployed military personnel and has the potential to cause a large number of casualties, particularly during prolonged missions. However, medical readiness should not focus solely on the category or source of a particular threat. For example, an early medical response to mass casualties takes precedence over determining hostile versus nonhostile cause. Likewise the potential for enemy use of chemical or biological agents cannot be ignored when planning for medical countermeasures (eg, vaccinations) to toxic or infectious threats.

Nonbattle Injuries

Nonbattle injuries include those that result from aircraft, watercraft, or motor vehicle crashes, unintended fires or explosions, unsafe operation of heavy equipment, improper lifting of excessive weight, slips, trips, falls, and collisions during activities such as construction, bivouacking, and sports. Human risk factors include alcohol use, prescribed or self-administered drug ingestion, inadequate sleep, and time zone shift.

Environmental Injuries

Environmental hazards exist in every theater and can be divided into living and non-living threats. Living environmental hazards include venomous snakes and arthropods, poisonous plants and fishes, and ectoparasites. Nonliving hazards include conditions such as heat, cold, dust, altitude, and pollution. The buildup of industrial waste, whether chemical or radioactive, in many countries has been uncontrolled and is difficult to quantitate as a health risk. The potential effects on personnel of inadvertent exposure to environmental and industrial hazards range from the chronic and subclinical to the acute and lethal. As is true with infectious diseases, there are intoxications that are "battle-stoppers" when acute effects predominate (eg, respiratory irritants in severe air pollution) and those that have little or no impact on operational effectiveness but may affect individuals over time (eg, adverse reproductive effects of a potent mutagen).

Psychological Stress

The importance of mental health in deployments is easily underestimated, partly because the real stresses of war can be neither reproduced nor simulated during even the most realistic training exercises. Ignoring the probability of psychological trauma, though, will almost surely have a major adverse impact on the health of the command. Such stresses as the absence of family and friends, uncertainties of personal safety, loss of privacy, new job requirements, and unresolved personal problems are to be expected during major deployments, even if there are no hostilities. These stresses significantly increase the risk of inappropriate behavior, anxiety disorders, depression, suicidal ideation, suicide, and homicide among deployed personnel. During hostilities, these behavioral shifts are further aggravated by the acute and delayed effects of combat stress, loss of companions, and friendly fire incidents.

Infectious Disease

Throughout human history, infectious diseases have caused the largest number of nonbattle casualties. Critical to the thoroughness and accuracy of medical threat assessments is an understanding of the basic epidemiology of significant human infections, including their modes of transmission and incubation periods, and the global distribution of geographically specific agents. In addition to the relevant, disease-specific sections of this textbook, there are numerous excellent textbooks and manuals available that permit a rapid review of all of these facts for any of the important human pathogens.

TABLE 11-3

CATEGORIES OF MEDICAL THREAT

Mode of Transmission or Etiological Group	Effects of Agents
Battle-related Injuries	
Small arms	Trauma from low and high velocity bullets, bayonets
Fragmentation ordnance	Trauma from artillery, mortars, bombs, rockets, grenades, mines
Blast effect munitions	Injuries from fuel-air explosives, blasts
Flame and incendiary munitions	Burns from napalm, white phosphorus
Directed-energy devices	Injuries from lasers, charged-particle beams, radio frequency
Chemical warfare agents	Toxicosis or tissue injury by cyanides, nerve agents, lung toxicants, vesicants, incapacitating agents, lacrimators, sternutators, vomiting agents
Biological warfare agents	Bacterial or viral disease; intoxication by bacterial, marine, fungal, plant, or venom toxins
Nonbattle Injuries	
Unintentional	Injuries from transportation, machinery, noise, fires, explosions, falls, sports, drowning, poisoning
Intentional	Homicide, suicide
Environmental Injuries	
Temperature	Heat stroke, immersion foot, frostbite, hypothermia
Solar radiation	Sunburn, photokeratitis
Altitude	Mountain sickness, pulmonary edema, cerebral edema
Plants	Dermatitis, toxic ingestion
Animals	Envenomation, bite wounds
Natural disasters and storms	Trauma, asphyxia, lightning strike
Psychological Stress	
Battle (Combat Stress Casualty)	Battle fatigue, combat and post-traumatic stress disorders
Nonbattle (Operational Stress Casualty)	Desynchronosis, depression, anxiety disorders, violence
Infectious	
Respiratory	Meningitis, pneumonia, influenza
Disease	
Fecal-oral	Diarrhea, typhoid fever, hepatitis
Arthropod-borne	Malaria, leishmaniasis, dengue
Soilborne, waterborne	Hookworm, schistosomiasis
Human contact	Sexually transmitted diseases
Animal contact	Q fever, brucellosis, rabies

Arthropod-borne diseases, such as malaria, arboviral fevers, leishmaniasis, and rickettsioses, have the potential to infect a large number of personnel and cause severe morbidity and mortality. Diseases that are transmitted by the fecal-oral route have also caused significant casualties in military forces[3–5]. Included in this category are the secretory and inflammatory enteritides that can manifest as severe diarrhea; the etiologic agents of these may be protozoal (eg, Giardia, Entamoeba), bacterial (eg, Escherichia coli, shigellae, salmonellae, vibrios), or viral (eg, caliciviruses, rotaviruses). Other enterically transmitted agents produce syndromes in which diarrhea is not a primary manifestation. Among these, typhoid fever and hepatitis A have the greatest potential for battle-stopping casualties if servicemembers are not appropriately immunized. A variety of helminthiases are also transmissible by ingestion but would rarely be expected to cause significant epidemics in the military setting.

Diseases that are transmitted by the respiratory route, either through secretions or as airborne particles, have historically been of greatest significance during basic training and not in the deployed setting. Even today, streptococcal and viral respiratory infections are mainly training camp hazards. However, the impact of respiratory pathogens on combat effectiveness may be underestimated because large, etiologically specific outbreaks have not often been identified while US forces are overseas. Medical surveillance data during large exercises and recent operations reveal that acute upper respiratory infections are a common reason for seeking medical care among deployed troops. Rates have been higher among personnel housed in fixed facilities (versus tents)[4] and among those afloat in smaller vessels (versus aircraft carriers)[6]. Universal use of meningococcal and influenza vaccines among basic trainees has nearly eliminated the diseases of greatest severity during basic training, although the potential remains for reemergence of group B meningococcus as a dominant organism since there is currently no licensed vaccine for it. The benefit of these vaccines very likely extends to overseas missions as well.

Sexually transmissible and bloodborne pathogens (eg, gonococci, treponemes, hepatitis B virus) and pathogens transmitted by contact with soil (eg, hookworm, strongyloides), water (eg, schistosoma, leptospira), and animals (eg, brucella, coxiella, rabies virus) have a wide range of virulence and of latency between infection and disease. Soil-transmitted helminths often cause subclinical infection, while rabies is universally fatal to the unimmunized. Leptospirosis, an acute systemic illness, can make personnel noneffective but full recovery without sequelae is typical, while syphilis is rarely disabling during its acute phase but can be severely disabling over the lifetime of individual patients. An epidemiologic characteristic that most of these agents share is that their potential for causing operationally significant epidemics involving large numbers of servicemembers is generally quite low. Still, the cumulative effect on clusters of individuals or relatively small, high-risk groups (eg, Special Forces units) could have a significant impact if enough persons are symptomatic during the critical phase of a mission.

A country's public health infrastructure and the availability of basic medical care to its population have an immeasurable impact on the level of disease and injury risks among nonindigenous personnel that occupy or reside in the country. Risks must be assessed from the standpoint of outcomes (eg, disease and injury rates, antibody seroprevalences) and existing controls (eg, quality and distribution of water supply, waste management, safety standards, disease case finding and treatment). Furthermore, whatever the available outcome data documented for a specific area, it can be assumed that war or natural disaster will have disrupted both the ecology and any industrial base.

PRIORITIZATION OF RISKS

Creating a list of all possible injuries and diseases that can affect personnel during the deployment is rarely helpful. A comprehensive list of possible risks for any given deployment is typically too long to be of practical value and can impede the medical staff officer's effort to focus the commander's attention on the most important countermeasures. Thus prioritization of the threat is one of the most critical steps in the entire assessment process.

Reducing the complexity of risk analysis to the two-dimensional categorization illustrated in Figure 11-2 can be helpful. Forming the axes of a four-quadrant table are (a) the likelihood that particular types of injury or disease will occur among personnel in the area of operations and (b) the potential for epidemic or mass-casualty presentation of the problem, which may be viewed as the population-level equivalent of acuteness. Events for which both of these are high (quad-

Potential for Epidemics or Mass Casualties	Probability of Occurrence: High	Probability of Occurrence: Low
High	I	II
Low	III	IV

Fig. 11-2. The projected impact of diseases, nonbattle injuries, and combat stress casualties on military operations is determined by two principal likelihoods: that of occurrence in the first place and that of causing multiple casualties within a relatively narrow time window. This categorical illustration simplifies the continuous distribution that these two probabilities, when multiplied, might produce for any given type of casualty. During operations planning, assignment of important, predicted casualties to two or more of these four quadrants is one way to prioritize countermeasures and limit the detail of command briefings, annexes, and rapid educational material.

rant I) must be reflected in the operational plan (OPLAN) and briefed as the significant threat (see chapter 13, Preventive Medicine and the Operational Plan). Less likely events deserve consideration in medical planning if they have the potential for affecting large numbers of personnel simultaneously within operational units (quadrant II). Events striking individuals in a sporadic fashion will generally not require special consideration by medical planners and logisticians, even though they may be quite likely to occur (quadrant III). Nevertheless, treatment and evacuation capabilities in the theater should be prepared for these expected events.

Within each quadrant, it is useful to prioritize predicted events further, giving greatest weight to events that are most likely to occur and to adversely affect military operations. For example, if a battalion based in the continental United States is deploying to a tropical area in February, heat casualties and arboviral fevers would probably be considered first quadrant events. Further prioritization might then depend on the timing of planned operations. For units expected to engage in battle soon after arrival, heat casualty prevention and treatment would be given top priority. Those expected to undergo a gradual build-up or remain in a defensive posture for a period of weeks will acclimatize, and any heat injuries that do occur will have little impact on the mission. For these units, arboviral fever prevention and treatment may be given the highest priority.

One of the most important determinants of epidemic or mass-casualty potential is the rapidity with which a particular event is expected to occur once a unit is in a position of risk for that event once they are exposed. In the context of infectious risks, this translates into the incubation period or latency. Short-latency conditions (2 weeks or less) are significantly more likely to disrupt operations. The incubation period in these cases varies little among exposed individuals, so events tend to occur nearly simultaneously among large numbers of servicemembers (for common-source exposures) or propagate over a relatively short period (for conditions spread from person to person). Thus diarrhea, while rarely serious in any individual, is likely to have a greater impact on the maneuver phase of an operation than schistosomiasis, even though it is likely to be a serious infection in those affected. This contrast holds true even if both of these conditions derived from a single, simultaneous exposure among hundreds of personnel. Many events may be assigned a low priority because nearly all servicemembers are resistant to them. For example, some infectious diseases are unlikely to manifest because of widespread immunity acquired through immunization (eg, typhoid, yellow fever) or natural disease (eg, varicella).

The prioritization of medical threats also depends on how successful countermeasures are likely to be during the deployment. In turn, the success of preventive measures in lowering DNBI rates depends on the degree to which personnel have been trained in these measures, on command emphasis and directives, and on the tactical situation. During the early stages of a deployment or in combat, personnel must often rely solely on individual prophylactic and preventive measures. This will work only if they have been adequately trained and that training is enforced routinely by the leaders of small units. In a more stable tactical situation, environmental controls can be instituted, such as area spraying with insecticides for vector control. Developing a medical threat assessment for a given operation is actually an art that balances the likelihood of any given disease or injury against the probability that countermeasures will prevent the disease or injury and against the expected impact of this casualty type on the operation.

QUANTITATION OF RISK

To understand the challenges and limitations presented by any attempt to estimate the anticipated number of DNBI casualties in a particular operation, it is useful to consider a theoretical, idealized model. The chance that a soldier, sailor, Marine, or airman will suffer DNBI during a mission is the function of a baseline probability (b_0), unrelated to the deployment, plus the sum of numerous factors (x_i), each multiplied by its own probability coefficient (b_i):

$$PR(DNBI) = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + \ldots b_ix_i$$

Multiplying the probability of DNBI by the total number of military personnel taking part in the mission will deliver the total number of casualties not directly resulting from combat. The factors may vary by time and place. For example, if x_2 represents ambient temperatur—which directly affects the likelihood of heat injuries, cold injuries, and other adverse health events—it will have different values for different locations, seasons, and times of day. Each of the other factors is represented by another x_i. If enough data were available from a variety of previously completed missions, solving for all of the coefficients would construct a predictive model.

Multifactorial, mathematical models to predict disease, NBI, or combat stress casualties have not been applied in practice. Models to predict outcomes from specific physiologic stresses, such as heat,[7,8] have been described, but these have not been correlated with actual casualty data. Models have been developed for predicting battle casualties, but estimates derived from applying those models to actual operations have often failed to approximate observed outcomes. Some experts have advocated the application of historical data to specific scenarios while adjusting for expected battle intensities and other variables in a very general way, without detailed formulae. Given the complexity of human, environmental, and other factors influencing force health, this same argument can certainly be made for prediction of DNBI.

In 1996, the Army Medical Department Center and School convened a subject-matter expert panel to develop estimates of DNBI hospitalization rates for the major contingency areas—namely, for a major regional conflict (MRC) in the East (ie, Southwest Asia scenario) and for an MRC in the West (ie, Korea scenario). A similar panel had been convened in 1992, and more consensus meetings are planned to continue refining the estimates. The 1996 panel members considered historical data from World War II, the Korean War, the Vietnam War, Operations Desert Shield and Desert Storm, and deployment experiences over the previous 5 years. They were assisted by decision support software. Projected rates were determined as medians of members' es-

TABLE 11-4

EXPECTED DISEASE AND NONBATTLE INJURY IN MAJOR CONTINGENCY AREAS, BY INTENSITY OF COMBAT AND POSITION IN THE AREA OF OPERATIONS*

Area of Operations	Intensity of Conflict				
	Expected Disease Rates, MRC† East (Southwest Asia)				
	None	**Light**	**Moderate**	**Heavy**	**Intense**
Division	0.60	1.62	2.13	2.51	2.89
Corps	0.59	1.32	1.69	1.96	2.15
COMMZ†	0.45	0.50	0.53	0.56	0.59
	Expected Disease Rates, MRC† West (Korea)				
Division	0.73	1.68	2.16	2.59	3.02
Corps	0.68	1.35	1.69	2.04	2.38
COMMZ‡	0.45	0.49	0.51	0.53	0.55
	Expected Nonbattle Injury Rates, MRC† East and West (Combined)				
Division	0.15	0.32	0.65	0.80	1.00
Corps	0.15	0.25	0.50	0.60	0.70
COMMZ‡	0.13	0.13	0.14	0.15	0.16

*The rates are per 1,000 personnel per day.
†Major Regional Conflict
‡Communications zone
Source: An expert panel convened at the US Army Medical Department Center and School, Fort Sam Houston, Tex: 1996.

EXHIBIT 11-2

EXPECTED RATIOS OF COMBAT STRESS CASUALTIES IN MAJOR CONTINGENCY AREAS

CS rapid return to duty:* Troop strength	1 : 1,000
CSC : Troop strength	0.025 : 1,000
CSC : Wounded in action	1 : 8
CSC : Disease	3 : 1,000

*Initial combat stress presentations that return to duty within 3 days; no diagnosis
Source: An expert panel convened at the US Army Medical Department Center and School, Fort Sam Houston, Tex: 1996.

timates. Their results are summarized in Table 11-4. A separate panel was convened to consider combat stress casualties (CSC) (Exhibit 11-2). Overall there was consensus on several assumptions and conclusions regarding prediction of DNBI and CSC:

- Rates depend on where troops are deployed, troops' linear position within the MRC (including distance from communications zone), and operational tempo.
- NBI rates vary little but disease rates differ between different MRCs.
- Rates vary by intensity of combat. (The difference in rates between moderate and light combat equals one-third of the difference in rates between moderate combat and no combat. Rates for heavy combat equal approximately the mean between moderate and intense combat.)
- Limited mobility, and thus greater concentration of troops within circumscribed areas, is correlated with higher disease rates (as reflected in data from the Korean War[9]).
- Combat, anticipated combat, and operational stress are likely to degrade emphasis on prophylactic measures and can have an adverse effect on immunity.
- Incidents such as inadvertent provision of contaminated food from host-nation or allied sources are unpredictable but can occur in any operation.
- The baseline medical condition of Reserve personnel may not be as good as that of Active Duty personnel.
- Many NBIs are due to sports and other recreational activities.
- At least 60% of CSC cases held for treatment at Level 2 (medical companies or clearing stations) will be returned to duty at that level within 3 days.
- One CSC may be expected for every eight wounded in action. (See Exhibit 11-2.)

Comparison of current estimates and ratios to historical statistics reveals moderate to marked decreases in predicted rates of disease, NBI, and CSC since previous major operations. A common conclusion of both the DNBI and the CSC panels was that improvements in training, leader development, and prevention capabilities account for these drops.

THREAT COMMUNICATION

The threat needs to be communicated to (a) commanders, to assist them in prioritizing the movement of specialized personnel and equipment and factor expected casualties into operational planning (eg, to consider time of day, season, acclimatization period), (b) medical personnel, to allow them to prepare mentally and logistically for the conditions they can expect to be treating, particularly those that are considered exotic in the United States, and (c) servicemembers, to raise their awareness, help them separate facts from myths, and induce them to use protective measures.

The format of the information, of course, will have to be suited to the recipient. For the commander, the highest priority threats should be clearly identified in a briefing or memorandum before the medical portion of the OPLAN is written. An example of this might be: "The major DNBI threats are the extreme heat, mosquito-borne fever illnesses, contaminated local food sources, and unreliable bottled water. The highest priority should be given to advanced deployment to allow for acclimatization, pretreatment of the BDU with permethrin and early shipment of deet insect repellent, rations, and water purification equipment." Threat and countermeasure information is normally placed in Annex Q of the OPLAN, but it may be appropriate to insert the most important elements of the threat into other parts of the plan, including the main body, where it will be more visible to commanders.

For the task force and unit surgeons, technical literature should be provided for transmittal to clinics and hospitals (eg, review articles or field manuals on the prevention and treatment of malaria). For the servicemembers, mass-produced educational cards or booklets should be written in clear and easily understood language and should emphasize the most important personal measures (eg, "Using your insect repellent can save your life from deadly diseases spread by mosquitoes.").

COUNTERMEASURES

Threat countermeasures that are instituted during the predeployment and sustainment phases are discussed elsewhere in this textbook. Assuming the best available engineering controls are in place, command emphasis on the enforcement of safety standards is the most important countermeasure to nonbattle injuries, and training should be as realistic as possible without compromising injury prevention. One important concept that applies equally to injury avoidance and disease control is that of preventive maintenance for the human. Unit cohesiveness, the buddy system, strong morale, fair discipline, personal hygiene, and adequate sleep are among the many elements that, though difficult to measure objectively, have a positive impact on every function of the human machine. Psychological stresses can be reduced by simple actions, such as keeping personnel informed, ensuring mail deliveries, and scheduling recreation time and meals.

Excellent vaccines have been developed against diseases that several decades ago stopped military campaigns. Chemoprophylactic drugs are also available for diseases such as malaria and leptospirosis. When safe food and water are consumed and proper sanitation and hygiene are maintained, the incidence of diseases transmitted through the fecal-oral route will be very low. Similarly, the use of personal protection measures, such as repellent and proper wearing of the uniform, will decrease the likelihood of arthropod-borne diseases.

CONTINUAL REASSESSMENT

A medical threat assessment is an evolving process. It serves different functions at different times during the deployment. Prior to the operation, it is used to obtain command approval for the necessary preventive measures and to initiate appropriate immunizations. It can also be used to educate the deploying personnel about potential medical risks in the theater, as well as risks that could occur before deployment. For example, sexually transmitted diseases and unintentional injuries may increase just prior to deployment, so preventive measures should be instituted. The medical threat assessment must be continued during the deployment. Medical information must be continually gathered and analyzed. Disease and injury surveillance is critical in assessing the health of the force and the success of the preventive measures taken. Disease vectors and reservoirs should also be assessed once personnel are in-theater. Outbreaks and unusual clinical syndromes should be investigated in-theater to help identify those agents affecting personnel. During the initial weeks of Operation Restore Democracy (Haiti, 1994–1995), rates of febrile illness among the US forces increased unexpectedly. Dengue was suspected, and dengue virus was isolated later from the blood of several febrile soldiers.[10] Although dengue was known to be present in the Caribbean islands, the intensity of transmission was not appreciated until 20,000 nonimmune US servicemembers were sent to Haiti.

Medical assessments must continue even after the force has left the theater. Diseases with long incubation periods may become apparent only after the servicemembers return home. It was after the first soldiers and Marines returned to the United States from Operation Restore Hope (Somalia, 1992) and were diagnosed with malaria that medical officers became aware of the exposure of hundreds of personnel to *Plasmodium vivax* that may have occurred along the Jubba River in Somalia. Military physicians should seek continuing education experiences that reinforce their knowledge of geographic medicine so that serious illnesses acquired by servicemembers during deployments are not misdiagnosed.

Finally, assessments should not be made in a vacuum. Many elements of an OPLAN not directly related to preventive medicine are necessary variables in the medical threat equation. Examples of these include the number of personnel deploying, the number and types of medical facilities to be established, and the laboratory diagnostic capabilities that will be available. Accounting for as many of these variables as possible allows the preventive medicine officer to predict the rapidity with which small outbreaks can be interrupted before they become larger.

SUMMARY

Providing an assessment of the medical threat is among the important strategic and operational planning steps to be taken in adequately preparing commanders for a mission. From such an assessment should logically follow recommendations for effective countermeasures. Assessment begins with a thorough consideration of who is at risk, what operation is planned, when and for how long it will occur, and where it will take place. Multiple data sources may be consulted to characterize anticipated risks. Threats are categorized in a way that aids the prioritization of countermeasures, quantified to the extent possible, and communicated to appropriate levels of command. Specific countermeasure instructions are best disseminated to small unit leaders, who can then emphasize them to individual servicemembers. The threat is continually reassessed during the operation, based on medical surveillance, and commanders are updated as necessary.

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