MILITARY PREVENTIVE MEDICINE: MOBILIZATION AND DEPLOYMENT
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Section 5: Epidemiology in the Field

Robert Thom *The Conquest of Yellow Fever* *1963*

The US Army Yellow Fever Board was established to discover the etiology of yellow fever. In Cuba in 1900, the Board completed a series of classic experiments that showed the role of the mosquito in yellow fever transmission. Attending Private John Kissinger, who volunteered to be infected with yellow fever, are (from left) Major William C. Gorgas, the sanitation officer for Havana who would go on to rid Havana of yellow fever; Contract Surgeon Dr. Aristides Agramonte; Dr. Carlos J. Finlay, a Cuban physician and an early believer in the mosquito's role in yellow fever; Contract Surgeon Dr. James Carroll; and Major Walter Reed, the president of the Yellow Fever Board. Missing from this painting is Dr. Jesse Lazear, also a member of the Board, who contracted yellow fever while conducting experiments and died.

Art: Courtesy of Pfizer Inc.; 235 E 42nd St.; New York, NY 10017-5755

Chapter 31

DISEASE AND NONBATTLE INJURY SURVEILLANCE: OUTCOME MEASURE FOR FORCE HEALTH PROTECTION

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INTRODUCTION

In recent years, a great deal of emphasis has been placed on the concept of Force Health Protection (FHP).[1,2] Under current doctrine, commanders at all levels are expected to maximize readiness by taking every reasonable measure to protect their personnel from health threats. This includes protection not only from hostile fire, but also from disease and nonbattle injury (DNBI). Whether in combat situations or in routine training, losses from DNBI have often had a tremendous impact on unit effectiveness. Ironically, most DNBIs are preventable through basic measures such as immunization, field sanitation, protection of food and water sources, personal protection measures, and an emphasis on safety. Although these measures are not new, command failure to implement them has become increasingly unacceptable under FHP.

Operational medical personnel have traditionally been responsible for providing line commanders with recommendations for preventive measures. In effect, medical personnel establish the blueprint for much of FHP. In addition to this advice, medical personnel also provide technical assistance in implementing specific FHP measures. This might include such things as designing and engineering appropriate field latrines, inspecting field dining facilities, and training personnel to use protective measures against biting insects.

Beyond these traditional roles of advising and assisting, operational medical personnel are in a unique position to provide commanders with a tremendously powerful tool in FHP—an outcome measure. By collecting and analyzing key data on DNBI, medical personnel can objectively determine how well the FHP program is working. If DNBI rates are high, this may indicate a breakdown in preventive measures. High rates may also be the first clue to an unanticipated disease threat for which no countermeasures were mounted. The ability to rapidly troubleshoot the FHP program, identify deficiencies, and take corrective action can make the difference between mission success and failure.

This type of health outcomes monitoring is known as surveillance and has long been a cornerstone of public health. The Centers for Disease Control and Prevention defines surveillance as the ongoing, systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know. The final link of the surveillance chain is the application of these data to prevention and control.[3]

Surveillance has been described as a cycle consisting of 4 steps: data collection, analysis, feedback, and action (Figure 31-1).[4] The whole point of surveillance is taking corrective action to control disease or injury. In a military context, controlling disease and injury is the essence of preserving the fighting strength—the primary focus of military medicine. DNBI surveillance is therefore an essential component of military medicine and central to an effective FHP program. A formalized, unit-level DNBI surveillance system has recently been mandated for deployed military units.[1,2,5]

DNBI rates in a unit are the military medical equivalent of vital signs for an individual patient. For the clinician, vital signs provide a quick initial assessment of the patient's overall condition. Abnormal vital signs do not, by themselves, lead to specific diagnoses, but they may be an important clue pointing to a serious problem. Recognizing this clue may stimulate and focus a more detailed clinical evaluation, leading ultimately to specific interventions.

In military medicine, the "patient" is an entire population, typically an operational unit. DNBI rates (eg, diarrhea or heat injury rates) are key indicators of unit health, and abnormally high rates indicate a threat to a unit's readiness. When DNBI rates are collected, analyzed, disseminated, and acted on, threats can be identified and countered early and the health of the force can be better protected. Continued monitoring of rates will indicate whether the corrective action has been effective, just as a patient's vital signs indicate changes in his or her condition.

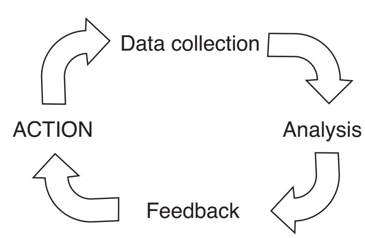


Fig. 31-1. Surveillance is actually a continuous cycle beginning with data collection. Data are continuously analyzed to identify problems. Feedback from this analysis must be given to decision makers and to the collectors of the data so that appropriate action can be taken to correct the problem—action is the focus of the entire system. Data are then collected to measure the effectiveness of the remedying actions.

DNBI SURVEILLANCE AND COMMAND EMPHASIS

One of the fundamental precepts of operational medicine is that the commanding officer prevents most DNBI. As General Slim observed during World War II after his force was almost decimated by malaria in Southeast Asia, "Good doctors are of no use without good discipline. More than half the battle against disease is fought not by medical officers, but by regimental officers."[6p180] Medical recommendations, no matter how sound, do not keep unit personnel from becoming sick. Successful DNBI prevention requires unit leaders who enforce the implementation of specific measures. Command emphasis is the key factor, one that General Slim recognized.

Command emphasis can be dramatically influenced by objective data. In the world of military operations, where resources are often highly constrained, preventive medicine (PM) recommendations must compete with many other priorities for command attention. Before supporting or emphasizing a specific measure, commanders must be persuaded with convincing evidence that it will directly contribute to FHP and operational effectiveness. DNBI surveillance provides exactly this type of evidence. If sound PM recommendations are not being followed, due to lack of command emphasis or any other reason, excessively high DNBI rates will be the measurable result. When they are backed by hard, objective surveillance data on the outcome, PM recommendations are far more convincing to a commander and are likely to receive the necessary command emphasis.

PRACTICAL ASPECTS OF AN OPERATIONAL DNBI SURVEILLANCE SYSTEM

The currently mandated operational DNBI surveillance system is a powerful tool for FHP. It provides simplified, uniform data collection and organization at all units, basic unit-level analysis, rapid transfer of information up the chain of command to appropriate PM organizations, focused PM investigation and intervention, and usable feedback from PM down the chain of command. It is the first line of defense against DNBI. Figure 31-2 summarizes the key features of optimal surveillance information flow.

Background—The Medical Infrastructure in an Operational Environment

The need for DNBI prevention is most pronounced when units are facing significant medical threats, usually during deployment or field opera-

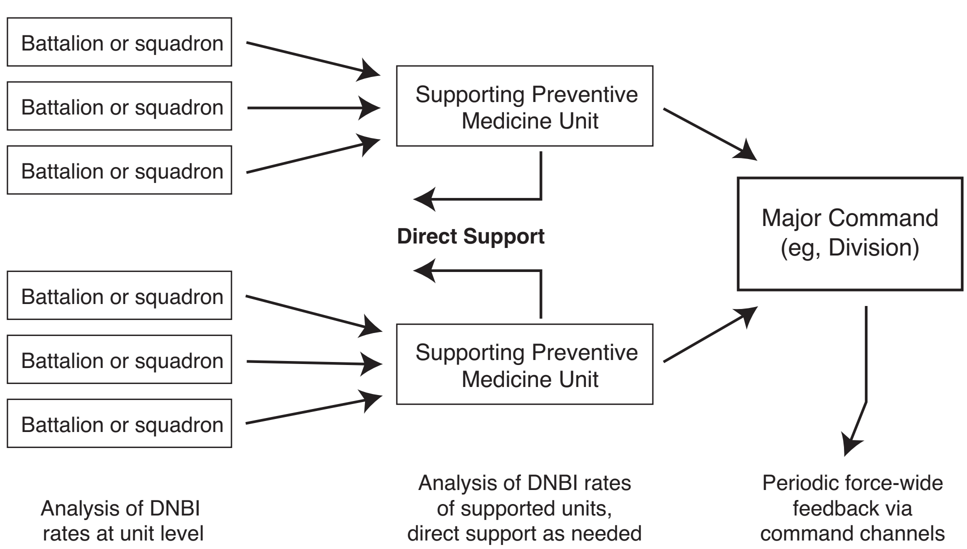


Fig. 31-2. Surveillance information flows up the chain of command and feedback flows back down that chain. The information is gathered at the battalion or squadron level and sent to the supporting preventive medicine unit, which sends information up to the major command level and also supplies feedback to the battalion or squadron. Analysis of the rates of disease and nonbattle injury take place at all three levels.
DNBI: disease nonbattle injury

tions. The medical infrastructure of deployable military units is particularly well-suited for conducting DNBI surveillance. A brief general description of this infrastructure is necessary for a discussion of the practical aspects of DNBI surveillance.

Although field medical treatment capabilities are constantly evolving, operational units such as ships, squadrons, or battalions usually provide their own primary medical care (ie, sick call) within the unit. Typically, units have a cadre of corpsmen or medics led by a medical officer or senior enlisted medical technician. Virtually all of the medical complaints arising in a particular unit will be evaluated locally, and most patients can be returned directly to duty. Diagnoses are generally recorded in a log of some type. It is important to note that the unit's senior medical representative also acts as a special adviser to the commander on all medical matters, including FHP.

Patients requiring care beyond the primary unit level are referred to supporting medical treatment facilities. Most serious illness or injury will require referral. Depending on their specific configurations, these supporting facilities can provide necessary outpatient specialty consultation, laboratory diagnostics, roentgenograms, and inpatient treatment. Patients who can be returned to duty are treated and sent back to the unit primary care provider with a consultation in their health records. Those who cannot be returned directly to duty are admitted or evacuated for the necessary medical or surgical treatment. Records are kept of the patient's unit and diagnosis for all outpatient visits and admissions.

Within this field medical structure, it is possible to capture virtually all of the illness and injury that is treated in specific units and, by extension, the entire deployed population. From a surveillance standpoint, this represents an ideal data collection mechanism. Military units have an additional advantage for surveillance: a known population or denominator. This makes it possible to calculate reasonably precise DNBI rates for individual units, as well as for larger organizations composed of individual units (eg, divisions, wings). The essential first step of the surveillance cycle, data collection, is therefore greatly facilitated.

In addition to primary care providers, operational units frequently have PM personnel assigned to them. Corpsmen, medics or PM technicians within the unit perform basic PM functions, such as testing water chlorine levels, advising on field sanitation and personal protection measures, and monitoring heat conditions. Higher-level PM support, such as disease vector identification, pesticide application, bacteriological testing of water, and food service inspections, is provided by specialized PM support units. These units, which vary in the different military services, may be staffed by PM technicians, entomologists, environmental health or environmental science officers, and PM physicians. Typically, these units are also responsible for investigating disease outbreaks. In some settings, epidemiologic investigation teams may also be assigned. Thus, there is capability within the operational medical infrastructure to conduct the analysis required in surveillance and, in many cases, to take necessary corrective action. Unlike many civilian settings, where medical treatment and public health are separated, deployed military units combine these functions into a single organization. This greatly facilitates transfer of information and feedback, essential to successful surveillance.

Perhaps the most important feature of the operational medical infrastructure from a surveillance perspective is the relationship between the commander and the senior medical representative. The senior medical representative in an individual unit serves as a special advisor to the commander. This unique relationship enables the medical representative to provide direct and immediate feedback on the unit's health to the single person who can take the necessary action. A senior medical officer is also assigned at higher levels of the organization, providing direct input and recommendations to senior commanders.

DNBI Surveillance at the Outpatient Level

In the operational setting, many of the most significant medical problems are first recognized at the outpatient level, usually at a unit's sick call. Examples include a diarrhea outbreak or a cluster of heat casualties, which might not be serious enough to require referral. A surveillance system that focuses only on hospitalizations would not recognize this significant event and would not stimulate the actions required to contain the problem. Outpatient surveillance at the unit level is therefore the first line of defense in DNBI prevention.

Organization of Data

There are many illnesses and injuries that are significant from an operational public health perspective, but attempting to individually track a large number of specific diagnoses would be complex and cumbersome. A more manageable approach is to combine related diagnoses into logical categories.

There are, for example, many different viruses, bacteria, and parasites that cause diarrhea. Since all these distinct etiologies generally represent some variation of enteric transmission, it is logical to group them into a single reporting category. From a practical disease control perspective, all require similar preventive measures. The same is true for the many types of respiratory disease and for dermatological problems. In surveillance, the precision of knowing which specific pathogens are causing a problem is less important than knowing that a certain type of transmission is occurring. Table 31-1 lists the DNBI surveillance categories for outpatient surveillance currently mandated by the Joint Staff. This framework is intended to capture those medical problems with the most significant potential impact on readiness. Diagnoses that have no operational public health significance (eg, peptic ulcer, appendicitis) are not specifically monitored and are combined into a miscellaneous category labeled "all other."

Several categories in this system are noteworthy. Injuries are classified according to the setting in which they occurred (ie, training, recreation, motor vehicle, or other), rather than by specific anatomic diagnosis. This reflects a conscious link to the preventive measures, which differ depending on the setting. For psychiatric problems, a separate category exists for those problems related to operational or combat stress. This represents a focus on recognizing and countering the significant mental health effects that have, in previous operations, jeopardized readiness.

This system also includes a category of "unexplained fever." This reflects the reality that many significant infectious diseases, such as malaria, dengue, and hemorrhagic fever with renal syndrome, present initially as a nonspecific fever. A precise diagnosis may be unobtainable at the primary care level. This surveillance category is designed to recognize patterns of unexplained fevers, which may be essential clues to their etiology and ultimate control. A cluster of fevers (or even a single case) is a significant sentinel event, which should rapidly trigger an in-depth investigation and evaluation.

Figure 31-3 is the Weekly DNBI report format used in the currently mandated DNBI surveillance system. This report is a tally of all cases seen in an individual unit during a week. This form is designed to be filled out by medical personnel at each unit. The information is ideally shared with unit-level PM personnel immediately; in some cases, PM personnel may do the actual collection and compilation of the data. The form is designed to be simple and requires no specialized epidemiologic knowledge, complex calculations, or computer databases to complete. This DNBI system is designed to focus on new complaints only. Follow-up visits for an initial complaint are not recorded because this would count a case twice. It is possible, though, for a single patient to have multiple unrelated diagnoses recorded in more than one category (eg, fungal skin infection and diarrhea). When diagnoses are closely related (eg, a patient who becomes a heat casualty due to dehydrating diarrhea), only the main underlying problem should be recorded in the appropriate category, as defined in Table 31-1.

Calculation of Rates

For each DNBI category, rates are calculated, using the average unit strength as the denominator. Rates are most conveniently expressed as percent of the unit treated per week, using this formula:

$$\frac{\text{Number of } \textit{new} \text{ cases in the unit per week} \times 100}{\text{Size of population in the unit (average for the week)}} = \text{Percentage treated per week.}$$

This relatively straightforward rate enables the medical personnel to quantify and report the magnitude of the DNBI problem in the unit in a way that is easily understood by commanders and medical personnel. Rates are also absolutely essential for comparing different units within a larger DNBI surveillance system, as will be discussed later. The 1-week reporting interval for DNBI rates represents a workable compromise between timeliness of analysis and the stability of rates. The interval is short enough to recognize an abnormality within the typical window of opportunity for intervention but long enough to provide relatively stable rates despite the normal, minor, day-to-day fluctuations of sick call visits.

Initial Unit-level Analysis

The Weekly DNBI Report also provides reference DNBI rates for direct comparison with unit rates. These were derived from surveillance data on previous deployments, as well as from garrison-based surveillance. They are intended to provide a unit with its own internal yardstick to help determine whether its DNBI rates are abnormal for a given week. They can be used to set action thresholds that when reached prompt more detailed investigation. Space is also provided to record the number of servicemembers who are placed on light duty, placed

TABLE 31-1

CURRENTLY MANDATED DISEASE NONBATTLE INJURY CATEGORIES

Category	What is Included
Combat/Operational Stress Reactions	Acute reaction to stress and transient disorders that occur without any apparent mental disorder in response to exceptional physical and mental stress; also includes post-traumatic stress disorder, which arises as a delayed or protracted response to a stressful event or situation of an exceptionally threatening or catastrophic nature
Dermatological	Diseases of the skin and subcutaneous tissue, including heat rash, fungal infection, cellulitis, impetigo, contact dermatitis, blisters, ingrown toenails, unspecified dermatitis, and sunburn
Gastrointestinal, infectious	All diagnoses consistent with infection of the intestinal tract; includes any type of diarrhea, gastroenteritis, "stomach flu," nausea/vomiting, hepatitis, etc; does NOT include noninfectious intestinal diagnoses such as hemorrhoids and ulcers
Gynecological	Menstrual abnormalities, vaginitis, pelvic inflammatory disease, or other conditions related to the female reproductive system
Heat/Cold Injuries	Climatic injuries, including heat stroke, heat exhaustion, heat cramps, dehydration, hypothermia, frostbite, trench foot, immersion foot, and chilblain
Injury, Recreational/Sports	Any injury occurring as a direct consequence of the pursuit of personal or group fitness, excluding formal training
Injury, Motor Vehicle Accidents	Any injury occurring as a direct consequence of a motor vehicle accident
Injury, Work/Training	Any injury occurring as a direct consequence of military operations/duties or of an activity carried out as part of formal military training, to include organized runs and physical fitness programs
Injury, Other	Any injury not included in the previously defined injury categories
Ophthalmologic	Any acute diagnosis involving the eye, including pink-eye, conjunctivitis, sty, corneal abrasion, foreign body, vision problems, etc; does not include routine referral for glasses (nonacute)
Psychiatric, Mental Disorders	Any conventionally defined psychiatric disorder, as well as behavioral changes and disturbance of normal conduct, which is out of normal character or is coupled with unusual physical symptoms such as paralysis
Respiratory	Any diagnosis of the (*a*) lower respiratory tract, such as bronchitis, pneumonia, emphysema, reactive airway disease, and pleurisy or (*b*) the upper respiratory tract, such as "common cold," laryngitis, tonsillitis, tracheitis, otitis, and sinusitis
Sexually Transmitted Diseases	All sexually transmitted infections, including chlamydia, human immunodeficiency virus infection, gonorrhea, syphilis, herpes, chancroid, and venereal warts
Fever, Unexplained	Temperature of 100.5°F or greater for 24 hours or history of chills and fever without a clear diagnosis (this is a screening category for many tropical diseases such as malaria, dengue fever, and typhoid); such fever cannot be explained by other inflammatory or infectious processes such as respiratory infections, heat, and overexertion
All Other, Medical/Surgical	Any medical or surgical condition not fitting into any category above
Dental	Any disease of the teeth and oral cavity, such as periodontal and gingival disorders, caries, and mandible abnormalities
Miscellaneous/Administrative/Follow-up	All other visits to the treatment facility not fitting one of the above categories, such as profile renewals, pregnancy, immunizations, prescription refills, and physical exams or laboratory tests for administrative purposes
Definable	An additional category established for a specific deployment, based upon public health concerns (eg, malaria, dengue, airborne/HALO* injuries)

*high altitude, low opening (type of parachute jump)

Source: Chairman of the Joint Chiefs of Staff. *Deployment Health Surveillance and Readiness*. Washington, DC: Dept of Defense; 1998. Joint Staff Memorandum MCM-251-98, 4 Dec 1998.

Weekly DNBI Report

Unit/Command: ______________________ Troop Strength: ______________________

Dates Covered: ______________ (Sunday 0001) Through: ______________ (Saturday 2359)

Individual Preparing Report: ______________________________

Phone: __________ E-Mail: ______________________________

CATEGORY	INITIAL VISITS	RATE	SUGGESTED REFERENCE RATE (%)		DAYS OF LIGHT DUTY	LOST WORK DAYS	ADMITS
Combat/Operational Stress Reactions			0.1				
Dermatologic			0.5				
GI, Infectious			0.5				
Gynecologic			0.5				
Heat/Cold Injuries			0.5				
Injury, Recreational/Sports			1.0				
Injury, MVA			1.0				
Injury, Work/Training			1.0				
Injury, Other			1.0				
Ophthalmologic			0.1				
Psychiatric, Mental Disorders			0.1				
Respiratory			0.4				
STDs			0.5				
Fever, Unexplained			0.0				
All Other, Medical/Surgical							
TOTAL DNBI			4.0				

Dental		**XXXXXX**					
Misc/Admin/Follow-up		**XXXXXX**					
Definable							
Definable							

Problems Identified: ______________________________

Corrective Actions: ______________________________

Fig. 31-3. This is the Weekly Disease Nonbattle Injury (DNBI) Report format used in the currently mandated DNBI surveillance system. It is a summary of a unit's rates during the week, prepared by unit medical personnel. The data are analyzed at the unit (usually by corpsmen or medics) and sent up the chain to supporting preventive medicine personnel.

on "sick in quarters status," or admitted during the week. These serve as an additional indicator of the magnitude of a problem within a unit.

The weekly DNBI report also contains an important section for specific comments on problems identified and corrective actions taken. This section is intended to prompt and document the evaluation and analysis process at the local level. For example, heat casualty rates 10 times the action threshold would be identified as a problem. Simple unit-level analysis might reveal that an extended march was conducted during excessively hot conditions in a remote training area, and that the "black flag" heat index was not posted. Based on this unit-level investigation and analysis of the problem, the action taken might have been to recommend improvements in communicating hot weather "flag" conditions throughout the training area. This recommendation, supported by the data, could have been given directly to the unit commander by the medical officer. This example is representative of a local analysis that results in an action taken at the unit level. In cases where a problem requires more detailed investigation, assistance from a supporting PM unit may be needed. To be of any benefit, though, analysis must take place in a timely fashion. If the problem is not recognized until days or weeks later, the opportunity for intervention may be lost.

It is useful for each unit to monitor its own DNBI trends from week to week. This enables a unit to customize its own baseline for a given set of conditions, rather than compare with a fixed reference, which may not apply. In addition, small increases from one week to the next may be an early indication of a developing problem. A trend of relatively small but cumulative increases may stimulate an investigation that identifies a problem before it becomes critical.

Centralized Analysis of Force-wide Data

A mechanism to assemble and centrally analyze data from all unit treatment facilities must exist to recognize significant DNBI patterns above the unit level. Actual rates (rather than simple case counts) are needed for this type of comparison. This is often the only way to recognize problems affecting multiple units or to pinpoint a specific problem at an individual unit. For example, the commander of an infantry battalion with consistently high heat injury rates (eg, 3% per week) might believe that heat casualties are unavoidable under the operational circumstances. This conclusion might be reached even with full knowledge that unit rates are above the reference level. The unit commander and medical officer may adjust their expectations and consider 3% per week "normal." However, division-wide data showing significantly lower rates (eg, 0.5% per week) in similar units engaged in similar operations may convince them that many of the casualties can be prevented through practical command measures without compromising the mission. Expectations can be adjusted based on objective, real-time data.

The weekly rates and denominator information contained in Figure 31-3 must be transferred up the appropriate chain of command to a location where it can be analyzed and acted on. Most often, this will be a PM unit with area-wide or command-wide responsibility, such as a division PM section, a PM support unit, or a designated disease surveillance team. The specific means of transferring information may vary with circumstances but can include fax, computer networks, message, radio transmission, or hand delivery. Timeliness is again a critical factor. Periodic visits to units by PM personnel may help speed up information transfer.

Although it is not essential for surveillance data to be computerized at the individual unit level, some type of computer database is needed at the central level, where reports from many units must be assimilated and analyzed. Ideally this database would be maintained by the PM section responsible for supporting a large unit, typically a division-sized element. As information technology evolves in deployed forces, the entire system could be electronic, with automated analysis algorithms and prompts to action.

Centralized Feedback

Providing general feedback to all individual commanders and medical personnel on DNBI patterns throughout a large organization or theater is a key element of an operational surveillance system. Such feedback may be the only means by which some units can develop and maintain a "DNBI situational awareness" for the area of operations and be alerted to actual disease threats. Units in a certain location, for example, may have no way of knowing that a neighboring unit has had an outbreak of malaria. With feedback from the system indicating that malaria is being transmitted nearby, all units can maximize command emphasis on protective measures before additional cases occur.

Surveillance feedback can take the form of a weekly DNBI situation report, issued by PM personnel at the division level or higher. This report can provide a valuable review of current patterns, current problems, and other relevant information derived from the surveillance system. Such information should be disseminated to individual commanders and medical personnel by whatever means are available, including message, fax, computer networks, or personal visits. This information should also be reported up the chain of command to the joint or theater level, so that theater-wide DNBI patterns can be assessed. In some situations, this information may need to be treated as confidential or classified.

INPATIENT SURVEILLANCE SYSTEMS IN MILITARY OPERATIONS

Although no specific inpatient DNBI surveillance system has been mandated for deployed forces as of this writing, it is nonetheless an important FHP tool. Those illnesses or injuries that are serious enough to warrant hospitalization in the field or evacuation out of theater merit special attention, since they are obviously the source of significant lost person-days. Inpatient surveillance can be more complex than outpatient surveillance and usually requires the skill and judgment of an epidemiologist to organize and interpret the data. Different situations may require specifically tailored approaches. Inpatient surveillance can be viewed as the second line of defense in DNBI prevention. Although usually very few patients in an operational setting require hospitalization, it is absolutely essential to have the capacity to recognize systematically those conditions severe enough to require hospitalization. This may be the only way that some of the most serious disease threats can be identified. Take, for example, a patient with an unexplained fever who is seen in an outlying unit's sick call. Since it is impossible to accurately diagnose or care for the patient in the unit, he is referred for hospitalization and specialty care. Patterns might become evident in outpatient surveillance if multiple cases of unexplained fever occur, but this single case would probably not significantly alter overall disease rates. After hospitalization and further evaluation, this patient is diagnosed with Japanese encephalitis. Without a system of inpatient surveillance, this highly significant event may have gone unrecognized, and the opportunity to institute immediate countermeasures to prevent additional cases might have been missed.

There are a number of highly significant diseases that typically require an inpatient setting for diagnosis and treatment; they include hepatitis A and E, hemorrhagic fever with renal syndrome, dengue fever, leptospirosis, and scrub typhus. There must be a system in place to recognize these illnesses even in small or sporadic numbers, investigate them immediately, and react to them quickly.

Inpatient surveillance adds a higher level of clarity to the overall DNBI surveillance picture. It is indispensable to an FHP program that effectively counters the serious disease threats the military faces. The combination of inpatient and outpatient surveillance gives a comprehensive picture that greatly increases the chances that DNBI will be recognized and dealt with before it can seriously degrade combat effectiveness. This is the goal of surveillance.

Data Sources

An accurate final diagnosis is needed for optimal inpatient surveillance. There are several sources that can provide these data or a useful surrogate. Hospital admission logs or databases usually record a presumptive diagnosis, which may change significantly during the course of hospitalization. The presumptive diagnosis can be a valuable piece of information, however, because it focuses interest on a particular patient and raises an appropriate index of suspicion. Hospital discharge logs or databases are more likely to contain the final diagnosis, and they may be the only practical way to capture accurate data routinely on the diagnoses of all patients who were admitted. Unfortunately, this information may only be available relatively long after the patient became ill; the resulting lag time may mean that the window of opportunity for intervention to prevent others from developing the same illness has closed.

PM personnel should be alerted to the final diagnosis as soon as possible after it is made. This may require direct contact between epidemiologists and key clinicians in the hospital to keep updated on particular patients. A system of immediate reporting between hospital physicians and an epidemiologist for selected diagnoses or presumptive diagnoses may also serve this purpose. Since laboratory tests are often the means by which diagnoses are made, laboratory logs are another potential source of important data on diagnoses. A system of immediate reporting of selected laboratory diagnoses to the epidemiologist may be effective. Whatever the specifics of the system, direct proactive involvement of a PM physician with all inpatient treatment facilities is the most effective way to capture and interpret appropriate data. Diagnoses of infectious diseases are of greatest interest, especially for those diseases with epidemic potential. The index of suspicion should be high for the specific diseases thought to be present in the local area of operations.

Inpatient DNBI Rates

Inpatient surveillance can also detect patterns of illness or injury, similar to the outpatient system. A general organization of categories similar to the outpatient system can be developed by an epidemiologist to summarize the rates and pattern of admissions, with the level of subclassification varying to meet the needs. For example, the outpatient category of respiratory disease might be expanded so bronchitis, viral pneumonia, bacterial pneumonia, and reactive airway disease can be monitored separately. The size of the entire population being supported by a facility should be used to calculate weekly or monthly rates, as determined by the epidemiologist.

Surveillance can also be conducted at the referral facilities in theater where patients initially seen at unit sick calls receive specialized outpatient consultation. In some situations, this may provide an important early warning mechanism to augment the outpatient unit-level DNBI surveillance. A reporting system for specific diagnoses can be tailored to a given set of operational circumstances.

Individual Epidemiologic Investigations

Cases admitted for a potentially high-impact disease such as malaria will usually require further epidemiologic investigation. This might include an interview with the patient to determine exposure location, protective measures used, chemoprophylaxis taken, and so on. Other members of the patient's unit might be interviewed using standardized questionnaires and relevant surveillance data examined to identify patterns. Unit-specific attack rates can be calculated from inpatient data if needed. Sophisticated outbreak investigation techniques may be necessary to fully appreciate patterns of certain diseases. This type of investigation is an important component of surveillance triggered by inpatient disease surveillance and is best accomplished by trained epidemiologists. Depending on the situation, this function may be performed by a surveillance and epidemiology team or by the epidemiologist who reviews inpatient data. The key is a capacity to recognize significant diseases systematically at the earliest possible point and respond appropriately.

Specialized Public Health Diagnostic Laboratories

Unexplained fevers in a tropical environment present a huge challenge to the clinician. Malaria, dengue fever, typhoid fever, hemorrhagic fever with renal syndrome, Japanese encephalitis, and many other infectious diseases initially present with very nonspecific symptom complexes that include fever and offer few other definite clinical diagnostic features. Effective treatment depends on an accurate diagnosis, and this usually requires a very capable laboratory that can provide rapid, on-site diagnosis.

The public health value of a rapid and accurate diagnosis goes far beyond an individual patient or clinician. The diagnosis may identify a threat facing an entire population at risk for the same disease. Dengue fever and typhoid fever have very different exposure mechanisms and therefore different approaches to prevention. Disease control efforts cannot be effectively targeted unless it is known whether the problem is enterically transmitted or vector-borne.

The capabilities of such a laboratory should be tailored to the anticipated medical threat in the area of operations, with emphasis on rapidity of results. Laboratory officers with highly specific diagnostic expertise may be required, as might highly specialized reagents. Sophisticated techniques, such as polymerase chain reaction and plasmid identification, are often required for the rapid identification of tropical infectious diseases. The equipment, reagents, and expertise may be available only within the military medical research community, particularly in the Army and Navy overseas laboratories located in or near the area of operations. On-site deployment of a specialized public health diagnostic laboratory with this extremely high level of capability is an invaluable addition to DNBI surveillance. Both the Army and the Navy[7] have recently developed and fielded such laboratories.

Feedback from Inpatient Surveillance

As with outpatient surveillance, the information derived from inpatient surveillance is of limited value unless it is rapidly communicated back to those responsible for preventive measures throughout the organization. If, for example, hemorrhagic fever with renal syndrome was diagnosed in a patient in a certain unit, that unit and all others in the area must be made aware of the diagnosis as quickly as possible. Knowledge of the diagnosis is the clearest possible indication of the threat and should lead to the implementation of appropriate counter-

EXHIBIT 31-1

SAMPLE WEEKLY DISEASE NONBATTLE INJURY (DNBI) SITUATION REPORT

From: Division Commanding General

To: All Division Battalion Commanders and Medical Officers

Subj: Weekly DNBI Situation Report for Operation Strong Endeavor—East Africa

1. DNBI surveillance information was available for 23 of the 25 Division units for the week of 18 August, covering 18,590 of the 19,780 personnel in theater (94%). Overall rates of DNBI continue to be low, with the exception of dermatological conditions, which continue to affect 2-3% of the force per week:

	4 Aug	11 Aug	18 Aug
Total reporting	18,980	18,640	18,590
Heat injury	0.2	0.2	0.1
Diarrhea/GI	0.7	0.6	0.7
Dermatologic	1.9	2.8	2.5
Respiratory	0.3	0.5	0.4
Injury (upper)	0.2	0.5	0.5
Injury (lower)	1.0	1.1	0.9
Injury (back)	0.4	0.2	0.5
Injury (other)	0.9	1.2	1.2
Unexplained fever	0.0	0.3	0.0
Sexually trans	0.1	0.0	0.1
Ophthalmologic	0.1	0.0	0.2
Psychiatric	0.0	0.1	0.1
All other	1.4	1.5	1.2
Totals	6.0	6.8	6.4

2. Significant events during the week of 18 August:

A. Dermatological complaints continue to occur at relatively high levels. Most cases are heat rash, impetigo, and fungal infection. Lack of shower facilities and opportunity for optimal personal hygiene throughout most units appears to be the main contributing factor. As logistics permit, additional shower units are being established. Commands should continue to emphasize basic hygiene, including frequent changes of socks.

B. Three shigella cases were diagnosed from a single unit this week. Overall diarrhea rates in the unit have been higher than average (2% per week). Investigations of food/water sources have failed to reveal a deficiency. A severe fly problem in the area appears to account for at least some of the diarrhea cases. Fly control and field sanitation measures continue to receive increased emphasis.

C. Four unexplained fever cases from a single unit during the week of 11 August were subsequently diagnosed as viral syndrome after inpatient evaluation. Malaria, hepatitis, and dengue have been ruled out. Though the threat is high, vector-borne disease continues to be rare, with a total of 6 malaria cases and 10 dengue cases scattered throughout the division in the past month. Continued emphasis on personal protective measures and chemoprophylaxis appears to be effective.

D. An artillery battalion experienced 3 gonorrhea and 2 NGU cases during the week, attributable to recent 3-day liberty outside the area of operations in Kenya. Additional briefs on the HIV threat throughout Africa have been given. STD acquired in the immediate area of operations continues to be very low.

3. There were 52 admissions during the week of 18 August, representing 0.26% of the 19,780 division personnel in theater. Approximately 60% of hospitalizations were for injuries, including 6 from a motor vehicle accident, and a variety of fractures, sprains, and lacerations scattered throughout the division. No significant disease patterns have been identified.

measures, which may not have otherwise been considered a high priority. In addition, it will alert medical personnel to be especially vigilant for the early signs of additional cases. A summary analysis of inpatient data and relevant outbreak investigations should be included in a widely distributed communication such as a weekly DNBI situation report (Exhibit 31-1).

SURVEILLANCE IN ACTION—US MARINE CORPS FORCES IN THE PERSIAN GULF WAR

During Operations Desert Shield and Desert Storm (1990-1991), a simple weekly unit-level surveillance system was instituted for Marine Corps forces operating ashore. Selected data from this system illustrate how surveillance can quickly identify a disease problem and facilitate corrective action.

Figure 31-4 shows diarrhea rates from a Marine Air Group, which initially occupied a host-nation airbase. Although Marines lived under field conditions in tent camps, they were fed in a host-nation military dining facility that was modern, air-conditioned, and operated and managed entirely by local nationals and contract personnel from other nations. Ordinarily, military PM personnel recommend strongly against relinquishing control of food service to outside organizations unless they have been previously certified and are known to meet US standards. However, under the difficult circumstances early in Desert Shield, there were distinct advantages to accepting the food service support offered by the host nation, especially since the facilities appeared to be very clean and modern. Aside from the positive impact on morale, receiving this food service assistance from a military ally reduced the logistical burden of providing rations or a field mess facility for several thousand Marines.

While it was expedient to use this host-nation dining facility, the surveillance data showed an almost immediate increase in diarrhea rates, rapidly exceeding 5% per week in a rising trend. In analyzing the problem at the airbase, Marine PM personnel on-site had already established the potability of the water supply and eliminated water as a possible source of disease. Furthermore, military personnel had no access to food on the local economy. Rates were clearly consistent with a food-related outbreak

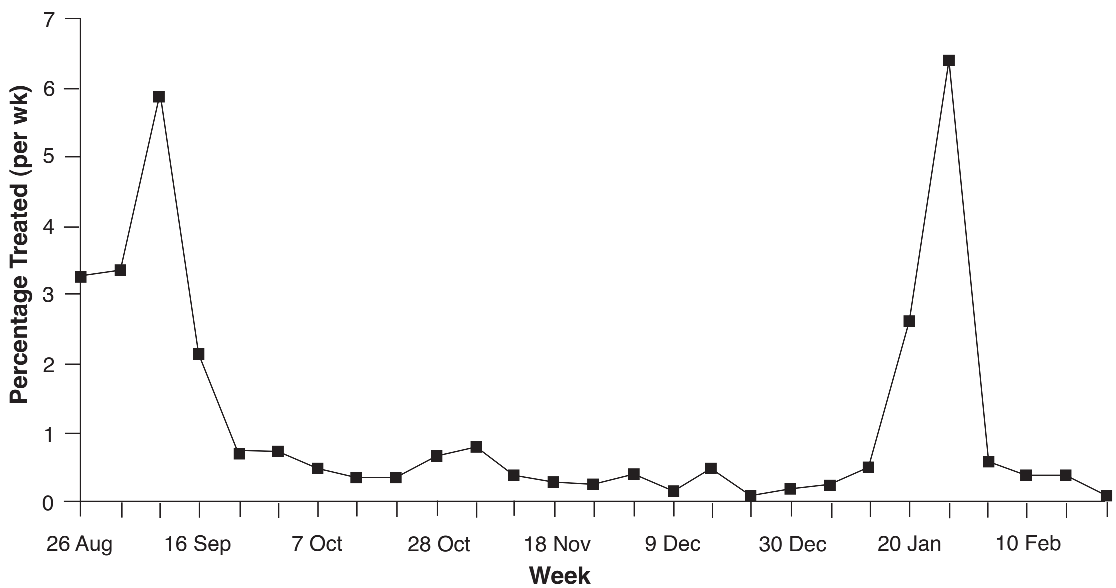


Fig. 31-4. This graph shows the rates of diarrhea in a Marine Air Group (Fixed Wing) serving in the Persian Gulf War. The first outbreak occurred early and was caused by problems in a host-nation dining facility. The diarrhea rates declined once dining facilities were brought under Marine control. The second outbreak was tied to lapses in food handling procedures during a time of heightened operational tempo. Any breakdowns in basic public health procedures were very quickly reflected in increased rates of diarrheal disease.

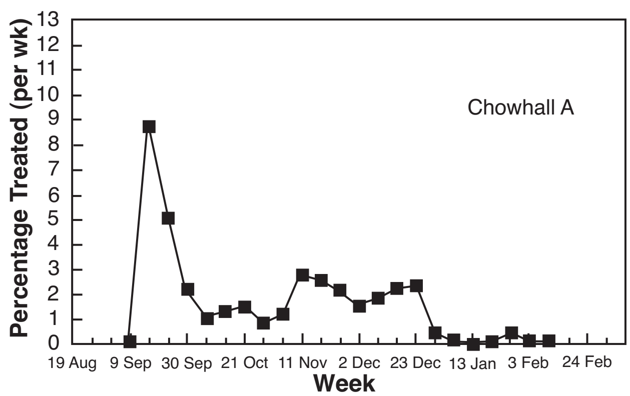
and followed an alarming upward trend, making the dining facility the most likely source. This definitive assessment was based solely on the surveillance data gathered from this unit, without knowing disease rates from any other unit in the operation.

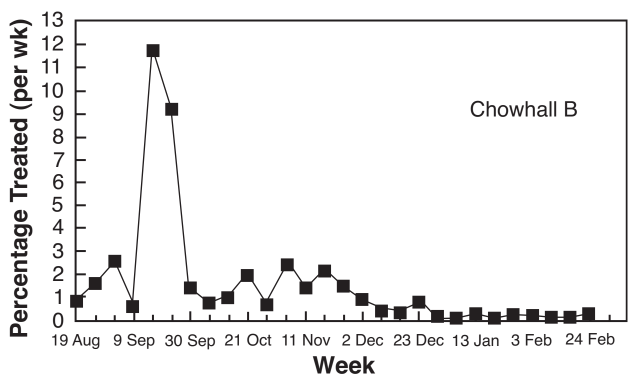
Medical recommendations citing these data prompted and facilitated the decision to quickly introduce Marine food service and PM personnel into the host-nation facility, initially in a supervisory and monitoring role. PM inspections identified numerous significant deviations from US standards of food handling practices by the local staff. Within a relatively short period of time, commanders made the necessary arrangements and committed the assets required for Marine personnel to gain complete control of food service. Diarrhea rates subsided dramatically and remained at acceptable levels through the next several months. The impact of diarrhea certainly could have been far greater, compounded as it was by the extreme heat and relatively austere field living conditions.

Figure 31-4 shows a second sudden peak in diarrhea rates occurring in January 1991. This outbreak was related to a single meal served by a Marine field mess facility near the flight line. (This field facility largely replaced the host-nation facility mentioned previously.) Several food service problems had been identified by Marine PM personnel, but correcting them was considered a low priority by food service personnel, especially as operational tempo increased markedly during the intense air campaign. Deficiencies were quickly corrected after this self-limited outbreak, which was clearly captured with objective data. This episode served to illustrate the significant risk of complacency or cutting corners in a military food service operation.

The value of central analysis of surveillance data from multiple units was also demonstrated during Desert Shield. Early in the operation, the logistical constraints of moving materiel to the theater were enormous. Sealift and airlift assets were committed heavily to the movement of combat personnel and equipment. Since on-site stockpiles of Meals Ready to Eat rations were limited, commanders placed strong emphasis on getting fresh meals to the troops at the earliest possible juncture. Marine food service personnel were deployed, along with equipment and supplies, to set up field mess facilities. In some cases, Marines took over existing kitchen facilities in industrial complexes made available by the host nation.

Due to the severe logistical constraints, the host nation provided significant contracting assistance. Items such as fruits, meats, poultry, eggs, and vegetables were obtained from sources outside the network of contractors officially approved by the US





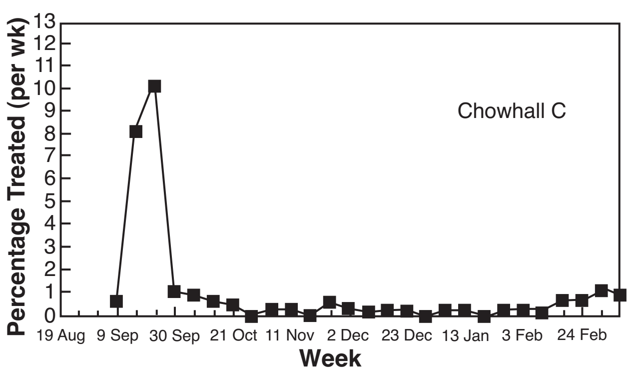


Fig. 31-5. These three graphs show simultaneous diarrhea outbreaks in Marine units during Operation Desert Shield in September and early October of 1990. The Marine units affected ate at three different chowhalls. This pattern indicates problems in centralized food procurement procedures. It turned out that nonapproved food sources were the source of the outbreaks.

military. These foodstuffs were provided in large quantities to a centralized Marine food service warehouse for distribution to a network of Marine field mess halls serving the majority of Marines throughout a large geographic area.

Figure 31-5 shows diarrhea rates at three different units served by three different field mess halls. Other units had similar rates. The epidemiologic pattern of concurrent outbreaks in several different areas strongly suggested a common factor. Marine PM personnel had already assured that the water was potable, and eating on the local economy was forbidden. It was unlikely that this force-wide outbreak was caused by individual food service facilities simultaneously experiencing unrelated difficulties. The remaining common factor was the fresh food being distributed centrally from unapproved sources. Lettuce was of particular concern due to its susceptibility to fecal contamination, and subsequent PM investigation implicated this item as a source of at least some of the diarrhea.[8]

Based on the surveillance data and subsequent investigation, a force-wide policy was issued that discontinued the use of lettuce in Marine Corps mess facilities. Diarrhea rates very rapidly declined to approximately 1% per week or less in virtually all units. Without the capacity to look at the overall patterns across several units, it probably would have taken considerably longer to pinpoint or prove the source of the problem and prompt the necessary policy shift. Individual units looking at their own diarrhea rates would have had no way of knowing the exact source of the problem and may not have been able to correct it as quickly.

FUTURE DIRECTIONS

Technological improvements in the flow of information may make surveillance much easier in the future. Advancing technology may enable physicians, corpsmen, and medics to enter diagnoses into a hand-held computer as they treat patients. Such a device might be capable of continuously assimilating and analyzing a unit's rates of disease and injury and transmitting data to a central system. Through advanced data gathering and information management, it may be possible to link outpatient data with inpatient data to describe instantaneously the exact pattern of all disease and injury in a force.

Although surveillance is most critical during deployments where the medical threat is increased, it is also a useful tool during routine training in garrison. Exotic infectious diseases are not a significant threat on most US training bases, but other problems, such as heat injury, musculoskeletal injuries, sexually transmitted diseases, and psychiatric conditions, can also affect a unit. An emphasis on FHP is still needed, and specific PM strategies must be applied to keep servicemembers healthy. Outcome measures are no less important. Monitoring diseases and injuries in the unit should be a part of the everyday routine of any operational military medical department. Commanders should come to expect that outcome measures of command preventive programs are being monitored and should be familiar with how the information can be used.

SUMMARY

DNBI surveillance is a simple but powerful tool in the military setting. It can cut through the medical equivalent of the "fog of war" and bring specific problems into sharp focus at an early stage. Surveillance is a critical part of maintaining the medical situational awareness needed to stay ahead of problems and drive an effective FHP program. The military medical system is very well suited to capturing the right data, translating it into attack rates, analyzing it, and getting sound recommendations into the hands of those who can act decisively on the problems identified. Medical personnel and commanders can quickly target their efforts to protect the force from disease and injuries and preserve the fighting strength.

REFERENCES

1. US Department of Defense. *Joint Medical Surveillance*. Washington, DC: DoD; 1997. DoD Directive 6490.2.

2. US Department of Defense. *Implementation and Application of Joint Medical Surveillance for Deployments*. Washington, DC: DoD; 1997. DoD Instruction 6490.3.

3. Centers for Disease Control. Guidelines for evaluating surveillance systems. *MMWR*. 1988;37(Suppl 5):1–18.

4. Wallace RB, ed. *Maxcy-Rosenau-Last Public Health and Preventive Medicine.* 14th ed. Stamford, Conn: Appleton & Lange; 1998: 10.

5. Chairman of the Joint Chiefs of Staff. *Deployment Health Surveillance and Readiness*. Washington, DC: Dept of Defense; 1998. Joint Staff Memorandum MCM-251-98, 4 Dec 1998.

6. Slim W. *Defeat Into Victory*. London: Cassell and Company, Ltd; 1956.

7. Dept of the Navy. *Forward Deployable Laboratory*. Washington, DC: DN; 1995. Naval Warfare Publication 4-02.4 Part C.

8. Hyams KC, Bourgeois AL, Merrell BR, et al. Diarrheal disease during Operation Desert Shield. *N Engl J Med*. 1991;325:1423–1428.