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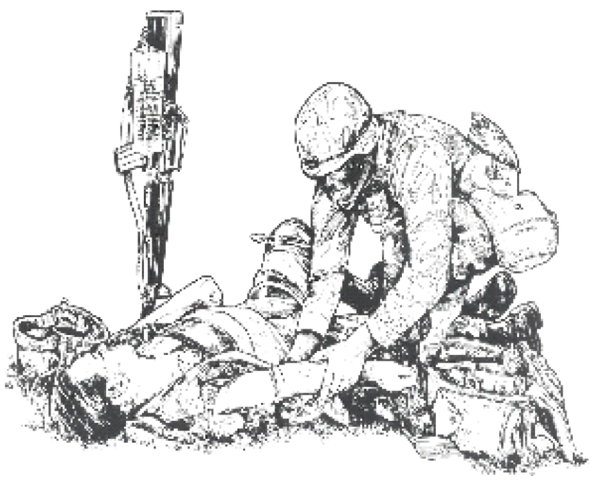

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Perspective

Major General George W. Weightman

This will be my last issue to review as the Commanding General, Army Medical Department Center and School and Fort Sam Houston and I want to thank all of the readers and contributors for their interest and intellectual rigor in making this Journal a more relevant and respected publication over the last two years. The breadth and depth of the issues we have covered have been indicative of how complex the AMEDD has become as we constantly strive to support the Warfighter. All of us at the Center and School appreciate your support and I encourage you to continue to conduct and report on your research as we all do our very best to broaden the knowledge base of all of our Warrior Medics. The AMEDD Journal is an important venue to help us all understand the "big picture" as well as brush up on our own specialties.

I think you will find this edition of the AMEDD Journal particularly useful and informational. This issue's focus is on Preventive Medicine and I'm sure you will all find that the articles will expose you to areas of this specialty which you were not familiar with. What makes this topic particularly relevant as we find ourselves in our fifth year of the Global War on Terrorism is what a tremendous impact our preventive medicine initiatives are making, and how they have drastically changed the epidemiology of the casualties we are seeing in just a few years of intensive effort.

This issue is kicked off by a capstone article on preventive medicine by BG Michael Cates, the Commanding General of the US Army Center for Health Promotion and Preventive Medicine. With "Prevention is the Best Way to Health," BG Cates gives us a brief look at the history and background of military preventive medicine, notes the current status, and offers up several considerations for future endeavors. He reminds us that 97% of our nation's healthcare dollars are spent on restorative care while only 3% are designated for government preventive medicine programs. Our Disease and Nonbattle Injury hospitalization rates for Operations Iraqi Freedom and Enduring Freedom are less than 10% of what they were in World War II and Korea. This is a great overview and easy read.

"The Evolution of Public Health Education in the US Army, 1893-1966" by COL Stephen Craig traces the preventive medicine residency program and how it paralleled civilian public health education. Of particular note is that we learn that in 1893 Surgeon General BG George Sternberg established the Army Medical School in Washington, DC with an emphasis on public health. This same school evolved into our modern day Walter Reed Army Institute of Research. Finally, he documents well the persistent conflicts between Preventive and Clinical Medicine through the last 100+ years.

"The Evolving Role of Environmental Science Officers and Environmental Engineers in the Medical Service Corps" by COL John Ciesla helps all of us understand how both specialties evolved and how they differ in their academic preparation, backgrounds, and primary focus. He notes the present increased demand for both specialties as we get more concerned about Soldier exposure to environmental toxins. The great news is that there is a continued strong demand for both in the new Army formations being created under Transformation.

"Army Epidemiology and Health Surveillance" by COL Bruno Petruccelli and Dr Joe Knapik starts by defining both concepts and then proceeds with a brief history of both. The authors remind us that the Army is the Executive Agent for all the Department of Defense for health surveillance, and does a great job telling us how we're using such tools as DOEHRS* and GEIS[†] to accomplish today's very complex and sophisticated battlefield surveillance mission.

"Vector Control and Pest Management" by LTC Debboun et al provides us with an overview of the relevance, scope, and agencies involved in DoD Vector Control and Pest management. He gives us all a timely reminder that the cornerstone of these programs is personal protective measures.

"Field Preventive Medicine: Challenges for the Future" by LTC Sames et al gives us a brief description of the manning available to accomplish operational field sanitation, from individual soldiers, to Field Sanitation Teams, to the multiple AMEDD specialists available. He points out several drawbacks of the current manning/training and points out a few future challenges to improve our present systems.

"Deployment Occupational and Environmental Health Risk Management" by COL Robert Eng and COL (ret) Curtis Pearson, starts by giving us a brief history of the Deployment Occupational and Environmental Health Risk Management program and then further describes several existing and planned initiatives. Interestingly, they point out that this initiative grew out of our deficiencies in dealing with the issues from our veterans returning from Operation Desert Storm.

"Deployment Occupational and Environmental Health Surveillance: Enhancing the War Fighter's Force Health Protection and Readiness" by Jeffrey Kirkpatrick et al basically lays out the three programs which comprise the Directorate of Health Risk Management. These include 1) the Global Threat Assessment Program which identifies and assesses deployment Occupation and Environmental hazards and threats worldwide. 2) The Deployment Environmental Surveillance Program which provides commanders reach-back capability for environment and occupational issues, informs them of present health risks associated with their occupations and environment, and gives them actual exposure data. 3) The Deployment Data Archive and Policy Integration Program is the information technology system which captures and archives occupational and environmental health (OEH) data and helps with integration of OEH into the DOTMLPF[‡] model methodology.

"Making the Modern Army Public Health Nurse: Establishing Essential Service Skills" by MAJ James Madison and LTC Bryan Alsip traces the evolution of the Community Health Nurse from their original focus on assisting new parents adjust to family life, to being responsible for many community programs, to their current professional training and assignments in the increased responsibilities of a public health official. In recognition of their new skills and responsibilities, their title has been changed Public Health Nurse.

"Force Health Protection Through Laboratory Analysis and Health Risk Assessment" by MAJ Patterson Taylor et al describes the unique capabilities of the 1st and 9th Area Medical Labs, which are the only Army deployable labs with a robust analytical capability to provide health hazard surveillance with a remarkable short response time.

Finally, "Bullis Fever: A Fleeting Epidemic of Unknown Etiology", by LTC Michael Zapor is a medical "Who Dun It?" mystery about an unknown pathogen which sickened over 1,000 soldiers right here at Camp Bullis from 1941-1944. Although a vector was identified, the pathogen was never proven.

Thanks for your continued support of our AMEDD Journal. I ask that you help me in welcoming the new commander, MG Russ Czerw, with the next edition.

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*Defense Occupational and Environmental Health Readiness System
[†]Global Emerging Infections Surveillance and Response System
[‡]Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities

Prevention is the Best Way to Health

BG Michael B. Cates, VC, USA

BG Cates is the Commanding General, US Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, Maryland, and the Functional Proponent, US Army Preventive Medicine.

Health is an essential element of military readiness, and prevention is and always will be the best way to health. Preventing diseases and conditions that threaten the health of the warfighter is more operationally sound since it maximizes available manpower. It is more beneficial to the Soldier, from a well-being perspective, to stay healthy and avoid all that the hospital has to offer, such as long waiting room times, diagnostics, and treatment. When considering healthcare costs, both short-term and long-term, prevention again wins out. In an ideal world, the military would be able to minimize disease and nonbattle injuries (DNBI), through prevention and health promotion, while optimizing the restorative medicine resources and applying them toward those diseases and conditions that are not readily preventable, especially combat injuries. This article takes a brief look at military preventive medicine, its background, its current status, and some future considerations for its use in improving the health of our warfighters.

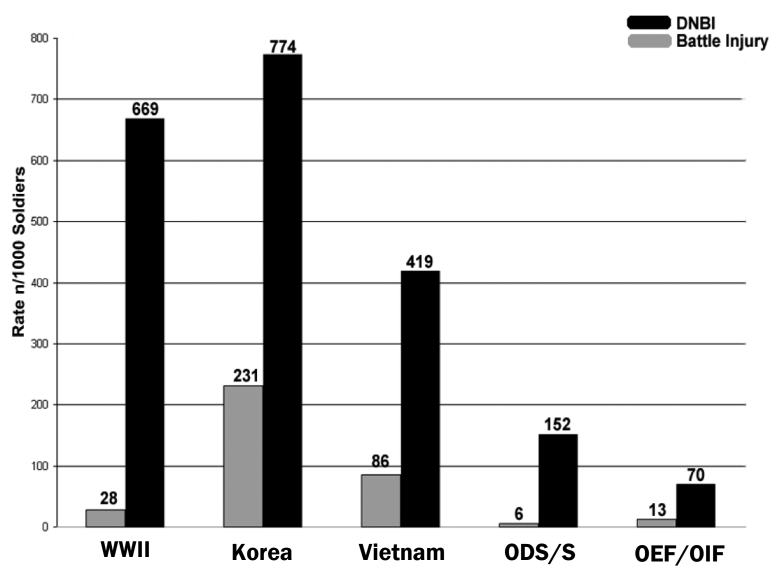

Figure 1. Decrease in DNBI and BI during US conflicts.[2,*]

*Statistics for OEF/OIF were obtained from the US Transportation Command Regulating, Command and Control Evacuation System (TRAC2ES)

Currently, in our nation, approximately 97% of our medical costs are focused on the "restorative" aspect of health care or "fixing" our medical problems. The other 3% goes to governmental public health expenditures.[1] Military health expenses are similar. Over the past century, applying the appropriate levels of proactive and responsive approaches to health care seems to have worked well. Figure 1 shows the dramatic decrease in both DNBI and battle injuries (BI), using hospitalization rates, during various wars and conflicts from World War II, through Operations Enduring Freedom and Iraqi Freedom (OEF/OIF), including Operations Desert Shield and Desert Storm (ODS/S). The rates for Operations Enduring Freedom and Iraqi Freedom are approximately one-tenth that of World War II and the Korean Conflict. However, the proportion of hospitalizations for DNBI compared to BI has not changed significantly and is actually almost the same or higher now than during the conflicts in Korea and Vietnam, as shown in Figure 2. In other words, while Army medicine has dramatically improved overall, the Army is still forced to dedicate a tremendous amount of resources to DNBI. The Army must do a better job of prevention, ultimately requiring a larger investment than the current 3%.

Leadership clearly recognizes the value of prevention. The recent Department of Defense (DoD) *Quadrennial Defense Review Report* (6 February 2006), states: "It is the Department's goal to have a lifetime relationship with the entire Department of Defense family which maximizes prevention, wellness and personal choices, and responsibility."[3] The DoD *Force Health Protection Capstone Document* adds: "Medical assets must be configured to support health promotion, health hazard assessment, implementation of countermeasures and the provision of essential care of the injured and ill in theater and their rapid evacuation to definitive medical care outside of theater of operations. Force Health Protection supports service members with a full spectrum of health services that (1) emphasize fitness, preparedness, and preventive medicine; (2) improve the monitoring and surveillance of forces in military operations; (3) enhance Soldiers' and Commanders' awareness of health threats before they can affect the force; and (4) support the healthcare needs of the fighting forces and their families across the continuum of medical services."[4] *DoD Directive 6200.4* directs all members of the Active Components and the selected Reserve Components to be physically and mentally fit. Commanders, supervisors, individual service members, and our health system have been given the responsibility to "promote, improve, conserve, and restore the physical and mental well being of members of the Army Forces across the full range of military activities and operations."[5] Specific verbiage regarding prevention includes its requirements for all service components to "promote and sustain a healthy and fit force, prevent injury and illness, [and] protect the force from health hazards."[5]

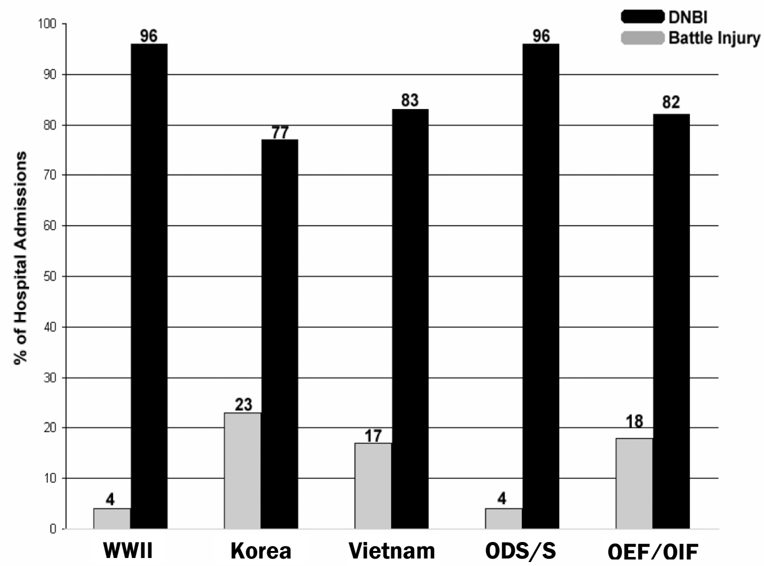

Figure 2. Proportion of hospitalizations for DNBI and BI from WWII to Operations Enduring Freedom and Iraqi Freedom.[2,*]

*Statistics for OEF/OIF were obtained from the US Transportation Command Regulating, Command and Control Evacuation System (TRAC2ES)

The Army's "bible" for these preventive measures is *Army Regulation 40-5*, in which preventive medicine is described as "the anticipation, prediction, identification, surveillance, evaluation, prevention, and control of diseases and injuries."[6] The regulation also delineates 9 major functional areas of support to military personnel and their families, in garrison and deployed settings, throughout the world. What is key to this publication is that responsibilities for preventive medicine are given to a wide variety of people, from 3 different assistant secretaries of the Army, to 4 primary deputy chiefs of staff, The Surgeon General, major commands, regional medical commands, military treatment facilities, veterinarians, dentists, commanders at all levels, installation commanders, leaders, supervisors, and individuals.[6] Dr. Craig Llewellyn, in the *Textbook of Military Medicine…*,[7] talks of the far-reaching scope of preventive medicine throughout the entire military force. He says the "promotion and preservation of health and the prevention of illness and injury can rarely be accomplished solely through medical channels."

What we call preventive medicine encompasses a very broad spectrum of identifying, assessing, and mitigating health risks to our personnel. Because the Army deploys globally, those health risks are spread out geographically as well as culturally. In today's world of easy, quick transportation, one country's endemic diseases can become an outbreak in another country's populace almost overnight. Public health in one country clearly influences public health in many other countries. Laurie Garrett, in *Betrayal of Trust, the Collapse of Global Public Health*, agrees, saying "Public Health needs to be—must be—global prevention."[8] With the stresses and operational tempo of our military deployments, it is imperative to recognize the potential for exposures to unusual diseases and environmental conditions. Also, lifestyle, nutrition, vehicles, weapons and equipment, and disease vectors all have potential impact on the Soldier's health. The proactive approach toward minimizing the negative effects of these health impacts is critical, not only to the individual Soldiers but also to their units, our nation, and our nation's healthcare system. There are multiple examples of preventive medicine successes and failures throughout our military history. The *Textbook of Military Medicine* names many successes, including yellow fever in Cuba and skin disease in Vietnam. Failures include British dealings with typhoid fever in the Second Boer War and with malaria in World War I, and the US involvement with heat and cold injuries in World War II. It should be noted that all were heavily influenced by command emphasis on prevention, or the lack thereof.[7]

In today's world, there are emerging or reemerging diseases, such as tuberculosis, malaria, Acinetobacter infections, leishmaniasis, and E.coli O157:H7 infections; zoonotic diseases associated with the animals of the various regions; chronic diseases, many of which are related to nutrition and other lifestyle choices, such as heart disease, lung cancer, diabetes, etc; and illnesses related to exposure to toxic industrial chemicals, toxic industrial materials, and pesticides. Our Soldiers deploy to locations with threatening environmental conditions, where the soil, air, water, and food, in many cases, pose far different threats than most areas of the US. Our military personnel use weaponry, vehicles, and other equipment that present inherent risks to hearing, vision, and other organ functions. Occupational and environmental exposures go beyond just the deployed setting; the garrisons, and their buildings, roads, property, and waterways can be dangerous as well. Natural and man-made disasters on our own soil and in other nations have presented their own form of health threats and, accordingly, the need for public health-related interventions.

The Army Medical Department (AMEDD) preventive medicine team encompasses a wide range of expertise in a myriad of locations, with the ability and flexibility to provide local support while maintaining the ability to project wherever and whenever the need arises. The Proponency Office for Preventive Medicine is responsible for policy making and oversight in the Office of The Surgeon General. The US Army Center for Health Promotion and Preventive Medicine provides the operational foundation for Army military public health, preventive medicine and health promotion. The Center is globally positioned, with capabilities which are easily projected when needed. Smaller but fully functional capabilities are found with individual officers and enlisted Soldiers assigned to brigade combat teams, preventive medicine detachments assigned to medical brigades and medical commands, the two area medical laboratories, and the preventive medicine departments found at the Army military treatment facilities. From local installation support (such as industrial hygiene, immunizations and occupational health services) to the projected support provided by deployed individuals, detachments, and Special Medical Augmentation Response Teams–Preventive Medicine to Iraq and Afghanistan, the Center's entire team does a lot with relatively few resources. After Hurricane Katrina hit the southern US coast, military preventive medicine personnel were deployed quickly. When the earthquake hit Pakistan in 2005 and the US Army sent medical personnel to help, preventive medicine experts were an important and visible part of the humanitarian assistance operation. When there were potential outbreaks of hepatitis C in El Paso, meningococcal disease in Europe, or tuberculosis in Afghanistan, preventive medicine experts were on the scene to determine the cause of the disease and the potential health threats to personnel. Health promotion initiatives continue to be an integral part of preventive medicine to drive down injuries, tobacco use, and alcohol abuse while enhancing nutrition and overall fitness. We are part of the continuing surveillance of occupational and environmental health threats to our military personnel, both in deployed and garrison settings, providing broad-ranging, very effective, globally committed preventive medicine capabilities, with constrained resources.

At the national level, there has been a renewed focus on health promotion and prevention, as evidenced by the *Healthy People 2010* initiative by the Department of Health and Human Services. This initiative has set out to "identify the most significant preventable threats to our health and to establish national goals to reduce those threats." Certain statistics justify this effort: Heart disease and stroke account for 40% of all US deaths each year, 64% of US adults are obese or overweight, and 31 million have asthma.[9] Diabetes now affects 20.8 million Americans, 7% of our population and a 6.3% increase since 2002.[10] Like the military, the US as a whole spends an inordinate amount on health care—15% of the gross domestic product in 2003, the highest of any member country of the Organisation for Economic Cooperation and Development (OECD). The US spends over $5,600 per capita on total health care, more than twice the OECD average; despite that, there are indications we are no healthier than other developed countries.[11]

As the Army moves forward, our deployments are longer and more dispersed throughout the world. Therefore, environmental exposures will increase in diversity as well as intensity. The AMEDD preventive medicine teams must keep up their vigilance of medical and environmental surveillance, communicating quickly and effectively when necessary to correct deficiencies and have a positive impact on the health of individual Soldiers or units. Health promotion efforts must continue to be aggressive. Similar to our civilian counterparts, the military has to contend with many of the heath risks associated with lifestyle choices, such as tobacco use, poor nutrition, and alcohol abuse. Among male Soldiers age 18 to 25, 48% use tobacco. Over 27% of our military personnel, age 26 to 34, are overweight (with body mass index as the indicator), and over 40% of our Soldiers engage in "binge drinking" (that is, 5 or more drinks at one occasion at least once in 30 days).[12] These statistics present short-term and long-term implications, impacting not only individuals but also entire units, our military as a whole, and our military healthcare system. In the future, medical technology will help us do a better job of identifying, assessing, and mitigating health risks, and, hopefully, leaders at all levels will become actively engaged in promoting better prevention and the overall medical readiness of their Soldiers.

Just as preventive maintenance is a crucial aspect of the logistics community, drastically improving the availability, workability, and durability of our equipment and vehicles, preventive medicine is crucial to our most important resource—our people. Fixing something much more inefficient than sustaining, maintaining and improving it; this directly applies to our health. Maintaining and even improving a Soldier's health is a much more appropriate, wiser use of resources than waiting until that Soldier becomes sick or is hospitalized. The more we prevent diseases and improve poor environmental conditions, the more resources will be available to apply to those things we cannot prevent. Prevention efforts have been and still are effective, invaluable pieces of the medical health system. And while there is continuing and growing emphasis on proactive approaches to health in today's society and military, we must all strive toward translating that into real, even greater long-term investments in the future health of our personnel.

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The Evolution of Public Health Education in the US Army, 1893-1966

COL Stephen C. Craig, MC, USA

The Army Preventive Medicine Residency is now officially 47 years old. Firmly established, accredited, and respected, its graduates sit for their boards with their civilian contemporaries, become Fellows of the American College of Preventive Medicine, and pursue careers in public health practice, education, administration, and research, the same as their civilian colleagues. It was not always the case. The development of civilian preventive medicine/public health education and acceptance progressed over a rocky road of professional animosity while its military counterpart, by virtue of necessity, evolved on a smoother path. Although preventive medicine, as an accredited residency, was a latecomer to Army graduate medical education, as a continuous, systematic course of instruction, it is the oldest postgraduate medical training program in the military. This article traces the evolution of that training and how it paralleled civilian public health education.

The idea of a graduate Army medical school was first proposed by Surgeon General William A. Hammond in 1862. A progressive thinker, he had already created an Army museum for pathological research and ordered the preparation of a medical history of the war of the rebellion.[1(pp179-180)] Hammond felt there was a better way for physicians to learn the art of military medicine and surgery than by trial and error while on campaign. He envisioned an Army medical school that would, in Major John Brinton's words,

> …teach [the surgeons] how soldiers should be looked after in health, on marches, in camp, how they should be treated when sick or wounded, how cared for in hospitals or in the field, and how properly transported.[1(pp257-258)]

There was little money to support this educational venture. Therefore, Hammond established a classroom and a couple of laboratories in the rooms beneath the main hall of the Army Medical Museum which was housed in the old Riggs Bank building in Washington.

Only Secretary of War Edwin M. Stanton's approval was needed to begin classes in the fall of 1863. Regrettably, Hammond had clashed with the Secretary of War early in his tenure and had been removed as Surgeon General the previous summer. When Acting Surgeon General Joseph K. Barnes showed Stanton the school, the Secretary of War inquired, "Are these lectures to be given in the evenings?" The acting surgeon general replied in the affirmative, to which Stanton thundered "They will go to the theatre and neglect their duties. It shan't be!"[1(p259)] This seed of an idea did not die, but rather went into dormancy waiting for a new champion and a more agreeable time.

That time came in the spring of 1893. The Gilded Age was receding and the tide of the Progressive Era was beginning to roll in. On that tide came a very different age as social, economic, technological, and scientific changes indelibly altered the American way of life. Bacteriology, developed by Koch, Pasteur, and others, and the nascent science of immunology were establishing a foundation for public health practice that was being effectively applied by innovative physicians in state and metropolitan public health departments.[2] In the Army Medical Department, George Miller Sternberg was selected as Surgeon General over 10 senior officers. A career officer, experienced military campaigner, and medical educator, he was an internationally known and respected bacteriologist and sanitarian.[3(pp6,13,60,94),4,5] To his supporters he was the personification of this new medical science.

BG George Sternberg
Army Surgeon General
1893–1902

On June 24, 1893, just a little over three weeks from the time he took office, Sternberg resurrected

Army Medical Museum and Library at 7th and B Streets, SW, Washington DC. BG Sternberg established the Army Medical School in this building in June 1893.

Hammond's idea, by establishing the Army Medical School (AMS) in available space at the Army Medical Museum and Library. The permanent faculty was composed of medical officers stationed in Washington, DC. COL Charles H. Alden became president of the faculty and lectured on the duties of medical officers. COL William H. Forwood taught military surgery, and military hygiene was taught by MAJ John S. Billings. MAJ Charles Smart lectured on military medicine and directed the chemical laboratory, and CPT Walter Reed lectured in bacteriology and was secretary of the faculty. CPT Julian M. Cabell was brought in to assist Forwood and teach Hospital Corps drill on Saturdays at Fort Myer, Virginia.[6(pp21,23)]

In a note sent to the Secretary of War, Sternberg was very clear about the purpose of the school:

> There is no need to teach medicine and surgery to graduates of our medical colleges, but there are certain duties of an Army medical officer — which the college course has not prepared them — which are more important than the clinical treatment of individual cases of disease and injury….A special education is needful to prepare a military man to undertake the protection of the public health. The course at the army medical school will prepare him to cope with the questions of practical sanitation that will be presented to him at every turn in his military career.[7]

Indeed, Sternberg considered preventive medicine and public health as the foundation for military medical practice, and teaching these principles to be the primary function of the school. He also sought to prepare them for their roles as military officers and modern physicians. If medical officers were to be effective in garrison and on the battlefield, it was imperative that they learn to function and communicate in a military framework. Sternberg expected a number of these students to rise to command hospitals in the future where success depended upon a thorough understanding of hospital administration, logistics, and military law. Furthermore, the modern medical officer had a responsibility to maintain educational currency, pursue practical research at every opportunity, and share his results with his colleagues.[8]

Courses in military surgery, medicine, and hygiene, the duties of medical officers in war and peace, military law, and medical jurisprudence were developed. Laboratory instruction in sanitary microscopy, pathological histology, bacteriology, and urinology was provided.[6(pp26-29,32-33)] Establishing a modern professional commitment to lifelong learning, however, would only begin with classroom and laboratory instruction and mentorship. Its realization would depend upon an officer's interest in research and a continuing example from the school. Sternberg enlarged and modernized the Medical Museum Laboratory, not only for the benefit of the students, but also to expand its mission to include modern investigative research. In the execution of this endeavor he relied heavily upon CPT Walter Reed and Dr. James Carroll. Reed, who became Sternberg's alter ego in the laboratory and on numerous field assignments, and Carroll began conducting experiments into the value of cresol as a disinfectant, smallpox, and, later, yellow fever. Epidemiological field investigations were conducted as required.[9-13]

First Army Medical School Graduating Class, 1894. Standing left to right: TS Bratton, AS Porter, DC Howard, WH Wilson; Seated: WW Quinton

The school got off to a fine start, graduating its first class in 1894. It graduated three more classes, and began awarding the Hoff medal for academic excellence in 1898, before the War with Spain closed the school for three years.[6(p24),14,15] When the war ended, America had a new empire, rife with endemic diseases, in which Sternberg saw not only challenges for the Medical Department, but also opportunities for it to advance medical science. Public health would play a major and interdependent role in accomplishing the nation building goals of the McKinley administration. Boards of health were created which directed sanitation and large scale smallpox immunization programs. In November 1899, Assistant Surgeon General Bailey K. Ashford, with only basic laboratory equipment and techniques acquired at the AMS, demonstrated that Puerto Rican anemia was due to the hookworm, *Necator americanus*.*

In January 1900 Sternberg sponsored a Board for the Study of Tropical Diseases in the Philippines.[16(p531)] The organizational format of the formal board was known and understood by the Army, and Sternberg had applied this format to the typhoid fever investigation conducted by Reed, Victor C. Vaughn, and Edward O. Shakespeare during the war.[13]

Sternberg told Secretary of War Elihu Root that

> It was my desire that this [Tropical Disease] board should be given all the appliances and assistance necessary for conducting their researches and every opportunity for obtaining access to cases and making autopsies, etc. In my letter of instruction to the chief surgeon I stated that the members of the board…while pursuing their general investigations…could make blood examinations and bacteriological researches for the purpose of clinical diagnosis as well as with a view to the promotion of our knowledge of infectious disease.[16(p531)]

Sternberg also created the Yellow Fever Board in Cuba a few months later with a similar intent.[16(p532)] While these boards focused on diseases most commonly encountered by soldiers, and certainly provided immediate diagnostic assistance to clinicians, his instructions defined a larger, more autonomous and permanent goal: the establishment of a productive, enduring research capability in the US Army Medical Department. By the time Sternberg retired in June 1902, the medical school, laboratory, and tropical disease boards provided a firm foundation for the integration and management of public health education and research science within the Army.[3(p237)] He had produced the first post graduate, schoolhouse trained preventive medicine officers.

Academic motivation among the student officers was a problem, however. Reed recognized this fact and commented about the first class: "Although no member of the class has exhibited any special enthusiasm for the work pursued in this laboratory, all have acquitted themselves to my satisfaction."[6(p31)] COL Alden identified the root cause for this lack of incentive when he stated

> The rank of the student officers is already fixed before they enter the school, and is not affected by their proficiency at the school….It is very desirable that the future rank of those student officers who have entered the service just before the session should be determined by the combined results of the examination for entrance into the corps and their work at the school.[6(p24)]

Between 1902 and 1907, Army Medical Service courses were made more robust. The academic session was lengthened to eight months duration, military medicine became military and tropical medicine, and three new courses were added: operative surgery, ophthalmology,optometry, and radiology.[17(p12),18(p121)] To gain more control over medical officer candidates, commissions were not awarded until after the officer had successfully completed all courses with a score of 80% or better.[17(p13),19]

Class size, however, was on the decline. In his annual report for 1907, Surgeon General Robert M. O'Reilly commented

> Obviously, the army medical service has lost much of its attraction for the bright young graduates from our best medical schools, and unless a remedy is soon supplied, by suitable legislation, it will be impossible to fill vacancies in the medical corps without lowering the present standard of examination, a resort which, if adopted, would leave us distinctly outclassed by the medical corps of the armies of all other civilized countries.[18(p122)]

The pay was low and promotions were slow in the Medical Department. O'Reilly was grappling with a perennial problem that Sternberg had never solved, and his successors still worry about on a regular basis — how to obtain and keep medical officers in uniform.

Secretary of War Root and his successor, William Taft, agreed with the surgeon general that sufficient numbers of medical officers had to be trained in peacetime to be available in a crisis. In 1904, O'Reilly drafted a bill to increase the efficiency and enlarge the Medical Department. Although congress did not act on it until April 1908, when they did, a number of significant changes occurred. The legislation created 123 new medical officer vacancies, relieved slow

**References 16(pp 610, 681, 699-700, 701, 723-724)* promotions by requiring examinations for promotion from major to lieutenant colonel, increased pay, allowed physicians to moonlight only if it did not interfere with Army duties nor require an off-post office, and created the Medical Reserve Corps, the Army's first reserve corps.[20(pp321-22)] The AMS noted an immediate increase in class size and two years later moved into larger quarters in the old Builders Exchange on 13th Street, NW.[21(p133),22(p132)]

In the decade from 1908 to 1917, military medical education and research, and the Army Medical Service overall began the slow metamorphosis into the form recognized today as the Walter Reed Army Institute of Research. Frederick Russell, who developed an effective typhoid vaccine in 1908 that was tested on the staff and students and made mandatory in the Army and Navy in 1911, served on the faculty, as did Percy Ashburn and Charles Craig.[20(p348),22(p131),23] Ashburn and Craig were fresh from the Philippines where they had conducted original research on plague, dengue, and malaria. Edward Vedder, who solved the problem of infantile beri-beri in those islands by supplementing breast milk with an extract of rice polishings, taught bacteriology.[24,25(p162)] Carl Darnall, who developed a practical field apparatus for chlorinating water in 1910, taught chemistry.[22(p131)] William Lyster, who gave us clean water using calcium hypocholorite in a canvas bag in 1913, served for a time as the military hygiene instructor.[25(p162)] These young officers were Sternberg's disciples, dedicated to military medical education, research, and mentoring.

Valery Havard and Percy Ashburn each published handbooks on military hygiene in 1909 to update Munson's comprehensive work from 1901. In 1915 the first postgraduate course in preventive medicine was offered to more senior officers.* To the Hoff Medal was added the Sternberg Medal for excellence in bacteriology and serum therapy. Sternberg awarded the first one himself in 1913.[28]

However, the commandant of the school, COL William H. Arthur, lamented in 1916 that

> …too much time is given up to laboratory work and not enough attention paid to sanitary tactics. While the laboratory work is very important, it is not strictly military, and the students have no opportunity of learning to care for themselves in camp, the details of camp sanitation, and the general duties of medical officers in the field.[27(p200)]

However, this too was part of the ongoing metamorphosis.

Army Inspector General Ernest Garlington commented in 1910 that medical officers required more training in "campaign work." A year later the Field Service and Correspondence School for Medical Officers was created at Fort Leavenworth under the direction of MAJ Edward Munson to instruct Regular and National Guard physicians in staff, field, and administrative duties.[20(p324)] But there was no longer any room at the AMS for such training. The school moved once again in 1917, this time to offices vacated by the Department of Commerce on Louisiana Avenue, just in time to absorb the massive influx of physicians who would put their skills to immediate use with the American Expeditionary Forces in France, and a variety of other wartime responsibilities. Training courses expanded and were set up at a variety of posts. Three hundred officers were trained in five sessions and over 200 other reserve officers received refresher courses and preparation for overseas movement. Large numbers of enlisted laboratory and x-ray technicians were trained, an orthopedic section was established to give instruction in orthopedic theory and practice, and 750 physical examinations — for appointment and promotion in the Reserve Corps — were performed each month. Eighteen million doses of typhoid vaccine were produced and shipped, and oil suspension

Offices vacated by the Department of Commerce on Louisiana Avenue became the home of the Army Medical School in 1917

*References 21(p 136), 26(p 171), 28(p 198) vaccines for dysentery, pneumococcal pneumonia, meningitis, streptococcal infections, and cholera were developed and tested in the laboratory.[29,30]

In the late fall of 1917, Surgeon General William C. Gorgas led a team, consisting of COL Deane Howard and reserve officers COL William Welch and MAJ Victor Vaughn, on an inspection tour of a number of southern and western mobilization and training camps. There was a growing concern that the amount of measles, mumps, meningitis, and pneumonia at these camps was excessive. They determined that the Sanitary Inspectors at these camps needed assistance in the form of trained epidemiologists who would conduct surveillance, evaluate the examinations of incoming and outgoing soldiers, recommend control measures, educate medical officers on communicable diseases, and report routinely to the Surgeon General's Office. Gorgas issued orders to this effect in January 1918.[31] Epidemiologists became an integral part of the robust preventive medicine teams that served stateside, particularly during the Influenza Pandemic, in Europe during the war, and in the post-war occupation of the Rhineland.

Civilian public health education was also developing in the early part of the twentieth century, and its evolution provides some interesting contrasts to events occurring in the Army. According to Welch, Sternberg had created America's first school of public health at the AMS,[32] but it is a little known fact that Sternberg also assisted in creating one of the first civilian schools of public health, where he also served as faculty president. A joint venture of the Georgetown and Columbian University Medical departments, the Washington Post Graduate Medical School opened its doors in January 1903. It gave special attention to preventive medicine, tropical diseases, and laboratory work in bacteriology and sanitary chemistry, as these subjects would be extremely valuable to general practitioners, specialists, and health officers in the government service. Thirteen months later, the President and University Council of Columbian University, soon to be George Washington University, presented a petition to the Board of Trustees for the establishment of a graduate Department of Public Health which offered Masters and Doctorate of Public Health degrees. Sternberg accepted the Dean's chair for the department and continued to teach classes in hygiene and preventive medicine.[33,34,35,36]

The prominent growth of bacteriology and immunology, emergence of state boards of health, the continuing urbanization of the country and resulting sanitary problems, and the need for properly trained professionals to deal with these issues was a powerful stimulus for the establishment of other postgraduate programs. In 1906 William Sedgwick was teaching principles of public health practice at the Massachusetts Institute of Technology.* By 1912 his program had joined with that of Milton Rosenau at Harvard. Their School for Health Officers offered a Certificate in Public Health and a doctorate. Public health training programs were established by Victor C. Vaughn at the University of Michigan in 1912, Alexander Abbott at the University of Pennsylvania in 1914, C. E-A. Winslow at Yale the following year, and a School of Public Health opened at Johns Hopkins University in 1918.† However, standard course work, such as sanitary engineering and legislation, sanitary surveys, and inspections of consumable animal products, took the physician outside the realm of traditional medical education and practice. The public health doctor also had to embrace a broad range of co-equal colleagues as public health professionals. Sedgwick's program began with nonphysicians, and by the time Hopkins opened, applicants included sanitary engineers, chemists, epidemiologists, nurses, and social workers.[37(pp148-149)] As the schools matured, their advocates hoped that public health and preventive medicine would become part of clinical training in all medical schools.[37(p183)] However, many physicians were simply not interested in public health training, and physician dominance in the field diminished during the interwar years. Public Health Officer jobs were low paying, lacked the excitement of curative medicine, were frequently given to physicians without specialized training, and therefore offered little incentive for bright young physicians.[37(pp184,189-190)]

Furthermore, this was the era when specialization began to grow — residency programs doubled between 1934 and 1940 — and with that growth came the complexities of standardized training, licensing, and regulation. General practitioners saw their autonomy and scope of practice diminish with the arrival of each new specialist.‡ When that specialist worked for the public health he also bore the stigma of "state medicine." Governmental influence in the delivery of health care, such as the Sheppard-Towner Act of 1921 which gave federal monies to states for mother and child health maintenance, threatened to

**References 37(pp 150-183), 38(p 194)*
†References 37(pp 151-152), 38(p 253), 39
‡References 40(pp149-153, 155, 258)

alter traditional fee-for-service practices and physician autonomy.* Public Health Department efforts to control infectious diseases were interpreted by local practitioners as unfair state competition, and the profession of public health became increasingly at odds with clinical medicine. While the indifferent, and often blatantly hostile, established medical community pushed preventive medicine farther away from the clinical realm and precluded its incorporation into medical school and hospital training, the Army Medical Department (AMEDD) pursued a different approach.

In September 1923, the Army Medical Service (AMS) began moving into Building 40 on the Walter Reed campus, and became part of the Army Medical Center which was established the same month.[41(p247)] Consisting of Walter Reed General Hospital, which had opened in 1909, and the Army Medical, Nursing, Veterinary, and Dental Schools, the medical center represented the culmination of Army Medical Department efforts to secure suitable facilities for furthering the medical education system of the Army in the national capital area. The medical center concept improved and strengthened the relationship of the medical school with the other schools and the hospital.[41(p246)] A considerable amount of hospital radiographic and laboratory work was done at the school, more time was given to clinical work, and closer contact was maintained with hospital cases. Directors at the school were given consultancies in the hospital and house officers were made instructors in the school. In addition to the basic preventive medicine course and postgraduate roentgenology course, the school now offered a 14 week postgraduate session in preventive medicine which included instruction in bacteriology, personal hygiene, protozoology, immunology, epidemiology, helminthology, entomology, chemistry, and vital statistics.[41(pp247-48),42] In 1928 preventive medicine achieved departmental status when it became part of the Department of Laboratories, Preventive Medicine, and Clinical Pathology.[43] Three years later, two new wings were added to the school to accommodate its growth. Four years after that the Army Medical, Dental, and Veterinary Schools (the Army School of Nursing had closed in January 1933) were renamed the Medical Department Professional Service School.[44]

In 1936 Surgeon General Charles Reynolds recognized the need for a strong preventive medicine service in wartime.[45(p177)] A member of the AMS faculty 30 years before and Deputy Chief Surgeon in the American Expeditionary Forces in 1917, Reynolds had a keen appreciation for the specialty, and commented "The most valuable contributions of the Medical Department of the Army have been in the field of preventive medicine. The dividends from intelligent service in the future will be no less."[45(p179)] To direct the Preventive Medicine Service, later the Preventive Medicine Division, in the Office of the Surgeon General, he brought in COL James S. Simmons. One of the few officers to hold a doctorate in public health,

The Army Medical School on the Walter Reed Campus, 1925

Simmons had a distinguished career in infectious disease research at the AMS, had been president of the medical research boards in the Philippines and Canal Zone, and was an acknowledged authority on malaria.[45(pp178-79)] In late 1939 the US began to mobilize for war. Simmons, with only a small cadre of trained public health officers, successfully co-opted a wide range of national resources, such as the US Public Health Service, National Research Council, and Rockefeller Foundation, to train the large numbers of physicians required to preserve the health of an expanded Army. The Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army, established in 1940 and now known as the Armed Forces Epidemiological Board, consisted of distinguished civilian scientists and Medical Department officers who worked in coordination with their respective research facilities to solve major disease problems affecting the Army. Short courses in

References 37(p 185), 40(pp 136-137, 143) sanitation and hygiene, which taught methods to preclude and interrupt respiratory, venereal, and vector-borne diseases, were developed as they had been in 1917–18. For officers assigned to the tropics and adjacent areas, the AMS initiated a four-week, malaria and dysentery intensive course that was lengthened to eight weeks after Pearl Harbor. Although classes began with 20 to 30 officers, by 1943 each session was graduating 100 officers. Naturally, Simmons recognized the school could not possibly educate the nearly 40,000 Army medical officers on duty that year. With the aid of the National Research Council, he began building a pool of trained civilian physicians by having medical schools and teaching hospitals provide tropical medicine courses to their senior students and interns.[47(pp11-14)]

Field training in malaria control also received close attention. Instruction was conducted for selected medical and sanitary officers in Florida and along the Pan-American Highway being constructed by Army Engineers from Panama to Mexico.[47(pp19-20)] Malaria was proving to be the bane of commanders in the southwest Pacific. Forces on Guadalcanal and the Buna Islands were saturated with it. When General MacArthur was briefed after the Buna fight in January 1943 that 72% of the combined force was sick—60% with malaria—he commented to his malaria consultant,

> Doctor, this will be a long war if for every division I have facing the enemy, I must count on a second division in hospital with malaria and a third division convalescing from this debilitating disease.[46(p2)]

In response to the malaria crisis in the Pacific, an Army School of Malariology was established in the Canal Zone to provide training and advanced instruction to medical and sanitary officers and enlisted technicians, who made up special vector control teams. All of these efforts, plus intensive troop education and the introduction of Atabrine for malaria chemoprophylaxis, brought malaria under control in endemic areas during the last year of the war.[47(pp21-25)]

By 1945, the strife between public health and clinical medicine of the interwar years had left America with too few trained public health physicians.[48] Determined to enlarge their ranks, leaders in public health recognized and embraced the fact that medical specialization was the only way to expand and gain credibility and acceptance within the profession, whether civilian or military. During the war the government, by giving higher rank and pay and larger responsibilities to certified specialists, had acknowledged their superior professional status.[40(pp279-280),49] While the number of residencies continued to grow through the 1940s, specialty boards sought quality control by requiring at least three years of post-internship training and working in conjunction with the residency inspection system conducted by the American Medical Association Council on Medical Education.[40(p258)]

To achieve the professional status and prestige so long desired, the American Public Health Association and the American Medical Association (AMA) came together in 1948 to create the American Board of Preventive Medicine and Public Health and begin to define training standards and establish residency programs.[40(p330)] After completion of internship, preventive medicine residents completed one year of graduate study leading to a masters in public health followed by two years of academic and field training in an approved preventive medicine program.[50] By 1951, public health departments in 12 states had approved pubic health residency programs of three years duration.[51] Although originally intended to generate public health specialists, subspecialties in the field soon followed, aviation medicine was added in 1953 and occupational medicine in 1955.[40(pp330-331)] While the civilian community wrestled with these educational issues, events were transpiring in the AMEDD that would culminate in the establishment of a formal Army Preventive Medicine Residency Program.

During the tenure of Surgeon General Raymond Bliss, Army hospitals began offering residency training programs to career officers. Health education and preventive medicine programs were expanded as were laboratories, and the AMS continued to produce preventive medicine officers.[52(pp118,120-21)] The war in Korea emphasized again the need for these well-trained specialists. Lessons in cold injury prevention from WWII had to be re-learned by commanders,[53] a temperate strain of *Plasmodium vivax* — which liked to hide in the liver for months — put a new complication in malaria chemoprophylaxis and treatment until primaquine was developed and issued in 1951,[54,55] and on the peninsula US forces also got their first introduction to the hanta virus.[56]

**References 46(p 48), 47(pp 11-12, 16-17)*

By the early 1950s, the Military Preventive Medicine Course offered at the recently renamed Army Medical Department Research and Graduate School was 11 months long.[57] While a steady supply of well trained preventive medicine officers was needed, recruiting into this specialty was difficult. With this in mind, Surgeon General Bliss proposed that the school be given Masters of Public Health (MPH) and Masters of Science degree granting authority, and his successor, George Armstrong, took the action to Congress. These efforts failed, but the gauntlet was taken up by Surgeon General Silas B. Hays in 1956.[57] Early in his tenure the Professional Service School was renamed the Walter Reed Army Institute of Research (WRAIR) and the American Board of Preventive Medicine declared the Military Preventive Medicine Course equivalent to a civilian MPH program. The board also retroactively approved granting MPH degrees to the WRAIR classes of 1954 and 1955.[57] However, attempts to secure these degrees by affiliating with either Johns Hopkins or George Washington University were rejected by those institutions.[57] Therefore, Hays presented the degree granting bill to Congress once again in February 1957 stating "The proposed legislation would recognize the responsibility placed on this institute and would provide it with the status commensurate with its activities." He noted the recognition given by the American Board of Preventive Medicine and that there was precedent for the proposed legislation, in that the Navy Postgraduate School and the Air Force Institute of Technology both had degree granting authority.[57(p3)] However, Dr. Arthur S. Adams, President of the American Council on Education, who spoke for leaders in higher education, testified that it was not in the public interest for any federal agency to be given such authority, and, thereby, essentially defeated the bill.[58]

Surgeon General Hays abandoned his efforts to obtain degree granting authority for WRAIR in September and discontinued the 11-month Military Preventive Medicine Course after the 1957-58 session. From that point on, preventive medicine residents took their MPH training at civilian institutions and completed the last two years of academic and field training requirements by performing them concurrently in a one year course at designated Army medical facilities.[59,60(pp613-614)]

Beginning in 1958, the military preventive medicine residency consisted of a three-month course in advanced military preventive medicine at WRAIR and one year at residency programs established at the Fort Dix Health Center and First US Army Preventive Medicine Division in New Jersey, under the directorship of COL George R. Carpenter and at the hospital at Fort Ord and the Presidio in California under COL G. L. Orth. Plans were also developed for an Army Occupational Medicine Residency Program at the Army Environmental Health Laboratory, Edgewood, Maryland.[60(p613),61]

On June 1, 1959 Leonard D. Heaton began a long and distinguished career as the Army's 31st Surgeon General. Heaton had a high regard for preventive medicine, and recognized that it was more than a specialty within itself, but one that "permeated the realms of other disciplines," and as such was a crucial link in maintaining the strength of the Army.[52(pp1,16)] The Army began to grow in the early 1960s. The Cold War heated up in Berlin in 1961, left the city divided and stimulated a buildup of US forces in Europe. A year later Soviet missiles in Cuba put all services on high alert and reinforced the need for a rapidly responsive military force. During this time also, civic action programs conducted by Army Special Forces units in Southeast Asia and Latin America were increasing.[62(ppiii,58,62),63] These activities were preventive medicine intensive, but attracting young officers into the specialty remained problematic. Through intensified recruiting the Surgeon General began to fill the preventive medicine ranks. While the AMEDD depended heavily on short course trained preventive medicine officers, a third residency program at Fort Bragg was approved by the AMA in 1962, and a fourth program at WRAIR two years later.[62(p58),64]

The initiation of the WRAIR program in 1964 coincided temporally with President Johnson's announcement of the Gulf of Tonkin resolutions and the major buildup of forces in Vietnam that began in early 1965. A Preventive Medicine Division, Office of the Surgeon, US Army, Republic of Vietnam was organized to advise the command on the incidence, prevalence, and epidemiological aspects of diseases which were likely to impact combat operations. Indeed, in this conflict, preventive medicine was in the van of the deployment.[65(p108)]

In 1973, MG Spurgeon Neel wrote

> One of the most striking achievements of military medicine in Vietnam was the rapid and effective

The Walter Reed Institute of Research, circa 1971

> establishment of a preventive medicine program that blunted the impact of disease on combat operations. In World War II, preventive medicine programs in the Far East did not begin to make inroads upon disease incidence until 1945.…In Korea the delay was less, but still considerable. In Vietnam, however, effective disease control programs were introduced in 1965 and…maintained throughout the stress of the troop buildup.[65(p32)]

Neel was technically correct, but his preventive medicine efforts in Vietnam were materially assisted by medical technologies and logistical capabilities that were not available as America entered the Second World War or Korea. What had not changed, however, and it is a shame that MG Neel did not point it out, were the essentials of postgraduate training in preventive medicine and public health and the ability of the WRAIR to expand to meet mission demands. Although accredited residency programs changed the form of this education, the basics had been taught and practiced in the Army for three quarters of a century and through five wars.

Surgeon General Sternberg did not call his graduate students "residents," but in reality that is exactly what they were. With a little brushing up on current therapeutic practices and modern field sanitation and hygiene technologies, the Army Medical School class of 1894 would have been just as comfortable in the jungles of Vietnam, the mountains of Afghanistan, or the deserts of Iraq as the graduates of today.

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COL Adams joins the board replacing COL George J. Dydek, MS, USA. COL Dydek has been a member of the Board since January, 2000. We thank COL Dydek for his dedication to the high standards and professional quality of this publication, and his years of service and support to our mission.

The Editors

The Evolving Role of Environmental Science Officers and Environmental Engineers in the Medical Service Corps

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Over the past 25 years, Environmental Science Officers (Area of Concentration [AOC] 72D) and Environmental Engineers (AOC 72E) have played an increasingly vital role in what has become known as force health protection. The Army has historically recognized the importance of environmental and occupational health services as the preeminent tools to "conserve the fighting strength" of Soldiers (and civilians), whether these personnel are deployed operationally or working and training on myriad installations around the world. This has remained true even as the Army has changed to adapt from the requirements of the Cold War to meet the challenges of the Global War on Terrorism. However, it is my observation that the roles and missions of 72D and 72E officers have not only evolved, but have also grown so close to one another that they are virtually indistinguishable.

Environmental Science Officers (ESOs) and Environmental Engineers are both concerned with that portion of the public health spectrum known as environmental health. Broadly defined, environmental health and protection refers to protection against environmental factors which may adversely impact human health or the ecological balances essential to long-term human and environmental quality, whether in the natural or man-made environment.[1] Although complementary to each other, 72D and 72E officers differ in their academic backgrounds and primary focus. Environmental engineers possess undergraduate degrees in civil, mechanical, or environmental engineering, and are traditionally concerned with the construction, maintenance, and development of water and wastewater systems, air pollution control measures, and solid waste management systems, all of which play important roles in the maintenance of public health. On the other hand, ESOs have traditionally earned undergraduate degrees in the biological or physical sciences and are concerned with the implementation and execution of programs for drinking water quality surveillance; applied food service sanitation, housing sanitation, pest control, disease surveillance, and general environmental quality. Both ESOs and environmental engineers can find themselves engaged in providing industrial hygiene support to installation occupational health programs, as well as monitoring for the presence and extent of toxic industrial materials/compounds in the surrounding air, soil, and water. While the contributions of these specialties to the Army and the Army Medical Department (AMEDD) have never been more important, it is interesting to note that the relative proportion of engineers and ESOs within the Medical Service Corps has changed dramatically along with the Army's expectation of what these officers must deliver in the way of support to deployed forces.

Origin of Sanitary/Environmental Engineers and Environmental Science Officers

Environmental engineers (until recently known as sanitary engineers) have served in the Army since the First World War. In June 1917, then Surgeon General William Gorgas created the US Army Sanitary Corps which enrolled newly commissioned officers with "special skills in sanitation, sanitary engineering, in bacteriology, or other sciences related to sanitation and preventive medicine, or who possess other knowledge of special advantage to the Medical Department."[2] The first officer appointed in the new Sanitary Corps was an engineer by the name of William Wrightson who had served with Gorgas in Panama during the construction of the Panama Canal. By November 1918, sanitary engineers numbered 213 and comprised 7.5% of entire Sanitary Corps. Sanitary/Environmental engineers have been with the AMEDD ever since that time, providing sanitary/public health support and industrial hygiene services around the world and in every major conflict and contingency throughout the 20th century. In 1961 there were 99 Sanitary

Engineers on active duty, a number that remained fairly steady for the next 20 years (94 were serving with the Medical Service Corps in 1982).[3(apndx K,L)]

Environmental Science Officers are a more recent development. In November 1968, the first 7 sanitarians (later called environmental science officers) deployed to Vietnam. Praised by both the US Army Vietnam (USARV) Surgeon and USARV Sanitary Engineer, these officers were judged more effective at the division level for day-to-day preventive medicine activities than the Medical Corps preventive medicine officers they replaced.[4,5] By 1972 the number of ESOs serving in the Medical Service Corps had risen to 90; and by 1982 this number had risen further still to 143.

By 1994 the aggregate number of ESOs and Sanitary Engineers totaled 240, although ESOs outnumbered engineers by about 2 to 1.[3(apndx M)] In 2006, there are 197 ESOs and 54 Environmental/Sanitary Engineers on active duty in the Medical Service Corps.[6]

CHANGING ROLES AND MISSIONS

Prior to 1985, the tendency was to assign environmental engineers to scientific/technical organizations within the AMEDD, such as the US Army Environmental Hygiene Agency or the 10th Medical Laboratory. These engineers also provided support as staff officers at the Department of the Army level or Office of The Surgeon General, as well as at major subordinate commands such as HSC (Health Services Command, the precursor to the Medical Command). They also served as instructors and combat developers with the AMEDD Center & School. Although environmental engineers were rarely directly involved in the construction of water and wastewater plants or sanitary landfills (because the Army increasingly privatized these activities), they nonetheless continued to advise on or perform professional and scientific work utilizing engineering practices to protect Soldiers' health, and support Army environmental protection and preservation efforts. Duties could also include the assessment of existing and proposed weapons systems, equipment, clothing, training devices, and materiel systems. Engineers with training and experience in industrial hygiene provided invaluable assessments of workplace health and safety in support of the Army Occupational Health Program.

At this same time, ESOs were primarily assigned at installation level to the MEDDAC (Medical Department activity) Preventive Medicine Services to serve as the Chief of Environmental Health. Just as they had done in 1968 in Vietnam, ESOs consistently demonstrated their flexibility and adaptability in directing environmental health programs that included drinking water surveillance, food service facility inspections, support for child care center and housing sanitation, pest control, and industrial hygiene surveys. In the absence of a preventive medicine physician, these 72D officers could also find themselves pressed into service as the Chief of Preventive Medicine. Alternatively, ESOs could also find themselves assigned to Table of Organization & Equipment (TO&E) preventive medicine positions as the division ESO, commander of a preventive medicine detachment, special forces group ESO, or staff ESO at a Medical Group or Brigade. Like their 72E counterparts, ESOs also were assigned to the AMEDD Center & School as both instructors and combat developers.

Around 1985, an increasing number of environmental engineers expressed a desire to serve in field (TO&E) units. Consequently, engineers were assigned to 72D positions at Army divisions, special forces groups, and preventive medicine detachments. At this same time, ESOs were increasingly assigned to those positions that, although previously reserved for 72E officers, were no longer determined to strictly require an engineer or engineering expertise. Consequently, 72D and 72E officers became increasingly interchangeable for all but a relative handful of TO&E or Table of Distribution and Allowances (TDA) assignments. This situation remains unchanged today.

While expectations on what constitutes installation environmental health and environmental quality support has not changed over the past 25 years (and is still spelled out in *Army Regulation 40-5* and its supporting documents[7]), it is noteworthy that the understanding of what constitutes the mission for TO&E preventive medicine organizations providing operational support to deployed forces has been revolutionized. Prior to the first Gulf War in 1991, field preventive medicine support was considered important but not particularly challenging from a technical standpoint. For example, field water surveillance was largely limited to coliform bacteria determinations, testing chlorine residuals, and performing a relatively limited suite of inorganic chemical tests. Environmental surveillance was usually limited to what was directly observed during sanitary surveys, and with the introduction of hermetically-sealed field rations such as MREs (Meal, Ready-to-Eat) and T-Rations, there was less to be concerned about from an applied foodservice sanitation standpoint. Industrial hygiene surveys were ordinarily limited to measurements of carbon monoxide. Even entomological surveillance techniques were rudimentary.

However, the 1991 Gulf War and resulting oil well fires produced a dramatic increase in concern about Soldier exposure to industrial chemicals and toxic materials during deployments. As a result, ESOs and environmental engineers assigned to TO&E preventive medicine units are now expected to perform environmental contaminant risk assessments which are then incorporated into commanders' risk management activities. Beginning with the deployment of US armed forces to Bosnia in 1996, new protocols for what would become known as Deployment Occupational and Environmental Health Surveillance (OEHS) would require 72D and 72E officers to perform analysis of the air, soil, and water supplies at every major base camp or forward operating base. These analyses would exceed in scope and complexity what is routinely accomplished at Army posts around the world—and in most US municipalities. This trend has continued because US troops increasingly make use of former Soviet bases and infrastructure or encounter third-world environmental conditions that increase the potential for exposure to toxic industrial compounds and chemicals. From 1996 to the present, wherever US ground forces were employed, ESOs and environmental engineers assigned to TO&E units collaborated with their colleagues from the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) to produce detailed OEHS assessments

of major base camps and forward operating sites in Macedonia, Kosovo, Uzbekistan, Afghanistan, Kuwait, and Iraq, as well as other locations of operational interest around the world. Although classic field sanitation and hygiene missions remain important (as underscored during the early phases of Operations Enduring Freedom and Iraqi Freedom), this new demand for OEHS support requires equipment, tactics and techniques that are just as technically challenging as that required to provide industrial hygiene and environmental health support at any permanent installation. It has produced new challenges for the AMEDD in how it trains and employs ESOs and environmental engineers. OEHS and force health protection requirements have also made the presence of a 72D/E officer on the staff of most combatant commands (Central Command, Southern Command, etc.) more important than ever.

Army Transformation

The value placed on the support provided by 72D/E officers has been unambiguously reinforced by the new modular organizations developed to support Army Transformation. Beginning in 2004, each new brigade combat team has a 72D assigned, as does each division headquarters. This brings the total number of ESOs within a division to four, a dramatic increase from the single officer assigned in the past. Additionally, every army and corps headquarters may have up to three 72D officers assigned to its main and operational command posts. Add to these positions new authorizations for both company-grade and field-grade 72D/E officers at every proposed medical deployment support command, medical support command (MSC), multifunctional medical battalion, sustainment command, military police battalion, and civil affairs brigade, and the result is a 4-fold increase in the number of 72D TO&E authorizations within the Active Component. In 2007, the 197 active ESO authorizations are almost evenly divided between TDA and TO&E positions at every grade level, something which will facilitate the career development of ESOs and environmental engineers by permitting officers to rotate back and forth between operational and institutional assignments throughout their careers.

The Future of ESOs and Environmental Engineers

ESOs and environmental engineers will continue to serve as valuable members of the AMEDD team and make a direct contribution to force health protection. The future is undeniably bright. But even with a growing demand for 72D/E officers, several issues remain to be addressed in the next few years:

- The Medical Service Corps will need to determine how many 72D and 72E officers it needs as a component of its total budgeted end strength. In 1980, there were approximately 245 ESOs and environmental engineers on active duty providing support to a 780,000 Soldier Army. In 2006, more than 275 72D/E officers serve in an Army almost one-third smaller, and based upon projections, the number of authorizations for 72D officers in the TO&E force will continue to grow to support Army Transformation. At what point will the MSC decide that it has all the ESOs that it can afford in lieu of other operational requirements?
- Since ESOs exceed the number of environmental engineers by almost 3 to 1, and the 2 AOCs are interchangeable in most assignments, is maintaining 2 separate AOCs for ESOs and engineers still viable? Would an additional skill identifier for engineers be a better means to identify this valuable skill set for the MSC?
- Which positions within the AMEDD absolutely require the skills of an engineer and should be designated as such? Are 72E engineers at risk of becoming civilianized because of their currently low representation in the TO&E force? Approximately 10% of 72E positions are TO&E versus approximately 50% of ESO positions.
- Which TDA positions within MEDCOM will provide the best technical and professional opportunities for 72D/E officers? Is an assignment to USACHPPM better than an assignment to a MEDDAC? Should some MEDDAC ESO positions be converted under current military-to-civilian initiatives in order to provide better developmental opportunities for junior officers elsewhere?

These and other questions will be discussed in the next few years by the senior leadership of the Medical Service Corps in collaboration with the company- and field-grade ESOs and environmental engineers currently serving around the world. Regardless of the outcome of these deliberations, the future for MSC environmental science officers and environmental engineers will continue to be exciting and full of enormous potential for personal and professional development. With the increased emphasis by the Army on force health protection in a global environment, these officers will continue to play an indispensable role in the AMEDD's mission to "protect the fighting strength."

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Army Epidemiology and Health Surveillance

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Introduction

Epidemiology is the study of patterns and risk factors for disease and injury occurrence in populations with the intent to determine approaches to mitigate adverse health outcomes and prevent future morbidity and mortality. Health surveillance is the routine and systematic collection, analysis, interpretation, and reporting of population-based data for the purposes of detecting, characterizing, and countering threats to the health, fitness, and well being of populations. In military settings, epidemiology and surveillance are required to maintain healthy, fit, and operationally effective forces and to ensure their health and safety during both training and real-world missions. Public health practitioners use epidemiology and surveillance to serve populations in the same way that medical care providers use clinical diagnosis and screening to serve individual patients. Figure 1 compares individual care and population medicine with regard to the scientific problem-solving process. Figure 2 shows how epidemiology and surveillance function in the broader scheme of continuous public health assessment and intervention.

Historical Perspective

Just as combat casualty care and the treatment of acute diseases for which deployed troops are at high risk have evolved with each major US military engagement through history, so too have epidemiological tools and procedures. The earliest Medical Department regulation that attempted to tie the monitoring of scientific data to predicting disease occurrence in populations was published in 1826. It required physicians to maintain meteorological records. The Army Surgeon General at that time was Joseph Lovell, who also initiated the use of physical standards for soldier recruitment and mass vaccination (against smallpox) of new recruits based on their history of prior vaccination or disease. In 1874, *War Department General Orders No. 125* substantially strengthened hygiene requirements at military posts, stations, and camps. In particular, the Monthly Sanitary Report was

Scientific Problem Solving Process

Practitioner	Database →	Assessment →	Hypothesis Testing →	Action
Clinician	History Physical Exam	Differential Diagnosis	Diagnostic Studies	Treatment
Epidemiologist	Surveillance Descriptive Epidemiology	Inference	Analytical Epidemiology	Community Intervention

Figure 1. Comparison of individual care (clinician) and population medicine (epidemiologist) practitioner functions with regard to steps in the scientific problem-solving process.

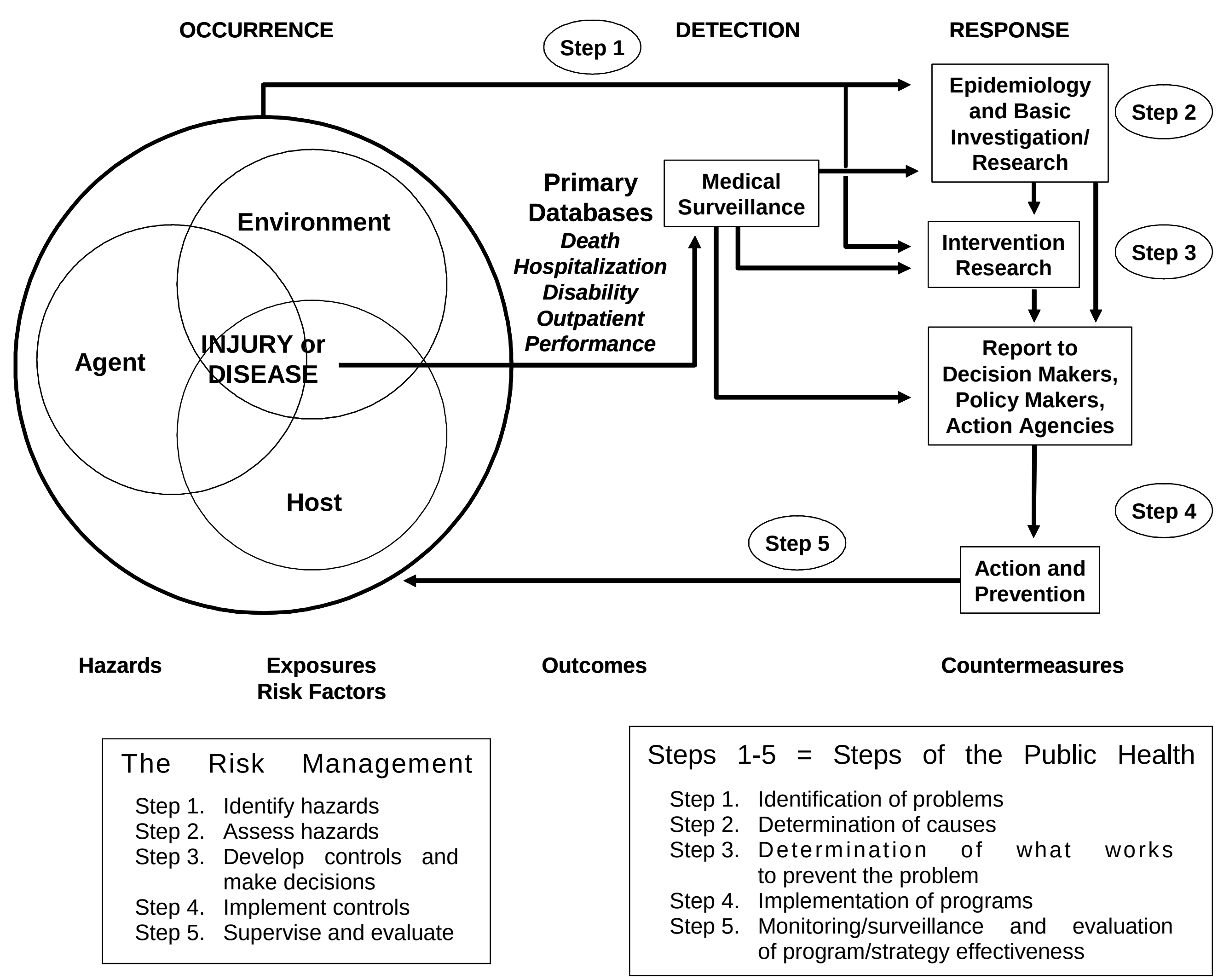

Figure 2. The relationship of epidemiology and surveillance in the broader scheme of continuous public health assessment and intervention.[1]

established—a precursor of local command health reports and, centrally, today's Medical Surveillance Monthly Report.* Twenty years later, Surgeon General George Sternberg established a graduate institution preparing physicians to become Army medical officers: The Army Medical School, precursor of the Walter Reed Army Institute of Research. It was here that the earliest epidemiological field investigations of military importance were launched, including those directed by the famous Typhoid and Yellow Fever Boards in which Walter Reed played a central role.[2] Later, World War II raised the need for 2 relatively small but important US military public health entities: the Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army (which today is named the Armed Forces Epidemiology Board), and the Army Industrial Hygiene Laboratory (which today is the much larger US Army Center for Health Promotion and Preventive Medicine).

Surveillance and Analysis

There are 2 broad surveillance procedure categories, active and passive. In simple terms, active surveillance requires either the data collector or the reporter to be "on the lookout" for events of public health interest and to record or transmit the relevant data as part of an

**Available at: http://www.amsa.army.mil* exerted effort. Examples include local preventive medicine personnel regularly searching records or querying databases to find clinical outcomes of interest, or clinical personnel at sentinel sites sending reports because they are participating in an organized surveillance program. Passive surveillance occurs in the background, in that either the reporter is making no special effort to transmit data for public health purposes (eg, the data are being collected for billing or other purposes anyway) or the agency collecting, archiving, and analyzing data of interest relies on the independent knowledge and effort of reporters to feed such data, simply because it is the appropriate thing for such reporters to do (eg, clinician or microbiologist originated reportable disease communication). Factors that dictate whether or not a particular condition should be reportable include preventability (eg, interruptible transmission, available vaccine, and proven safety procedures that may require renewed command emphasis), outbreak potential, possible offensive use of the causative agent, and the degree to which the condition is known to be very rare or eliminated—either globally or in a particular geographic area.

The base of reporting varies both by location within the healthcare system (clinic versus laboratory) and by military setting (deployment versus garrison). The underlying events or conditions of interest are either exposure- or outcome-based. Exposure-based events or conditions are from the general or immediate (eg, occupational) environment, or they are imposed directly on individuals (eg, vaccinations). Outcome-based events are either diseases or injuries, though at the tissue level these are usually one and the same, hence the generic meaning of disease surveillance. The data themselves represent episodic events of interest (eg, reportable conditions) or complete capture of all healthcare encounters. Grouping or categorization of data can occur at either the site where reports are generated (eg, disease and nonbattle injury reports) or the archiving center (eg, for analysis or [automatically] using modern syndromic surveillance* programs).

The Army is the executive agent for health surveillance. The US Army Center for Health Promotion and Preventive Medicine (CHPPM) oversees the collection, archiving, and analysis of health surveillance data to execute this mission. CHPPM's Army Medical Surveillance Activity manages the Defense Medical Surveillance System (Figure 3) which archives health-relevant data that are linked directly to military personnel and which, in turn, is also linkable to the Department of Defense Serum Repository (DoDSR). CHPPM's Deployment Environmental Surveillance Program performs functions linked directly to specific geographic and workplace environments such as field testing, data monitoring, and creating and maintaining archives of the results of laboratory analysis of environmental samples (eg, air, soil, water). Knowledge of the health risks from occupational and environmental exposures can benefit field commanders and unit surgeons to assess the medical threat and determine appropriate countermeasures. CHPPM has also managed the design, development, implementation, integration, and support activities for the Defense Occupational & Environmental Health Readiness System (DOEHRS), which is currently being fielded.† The DOEHRS will help integrate force health protection information by providing automated support for the military health system industrial hygienists, environmental health specialists, audiologists responsible for hearing conservation, and other preventive and occupational medicine personnel. The goal is to have a repository of retrievable and analyzable records containing a history of individual worker (especially troop) exposures in both garrison and deployed settings.

The Global Emerging Infections Surveillance and Response System (DoD-GEIS), for which the Army is also executive agent, oversees the conduct of focused, microbiological surveillance activities at various DoD laboratories worldwide, and at the public health centers of the Air Force, Army, and Navy. While its central organization is still relatively small, the DoD-GEIS taps a broad network of collaborating experts and laboratories to provide emerging infectious disease consultation; identify vulnerabilities in surveillance, response, and infrastructure; and assist DoD partners to develop projects and implement programs that mitigate emerging infection threats. Another Army executive agency with surveillance-related activities is the Armed Forces Institute of Pathology, within which the Office of the Armed Forces Medical Examiner maintains a database documenting occurrences and causes of deaths of US military personnel worldwide.

*Syndromic surveillance – The tracking of categories of outpatient clinical presentations from multiple geographic sites to reveal trends requiring further investigation of possible epidemics or attacks with weapons of mass destruction, or to characterize such trends over time.

†See related article on page 46.

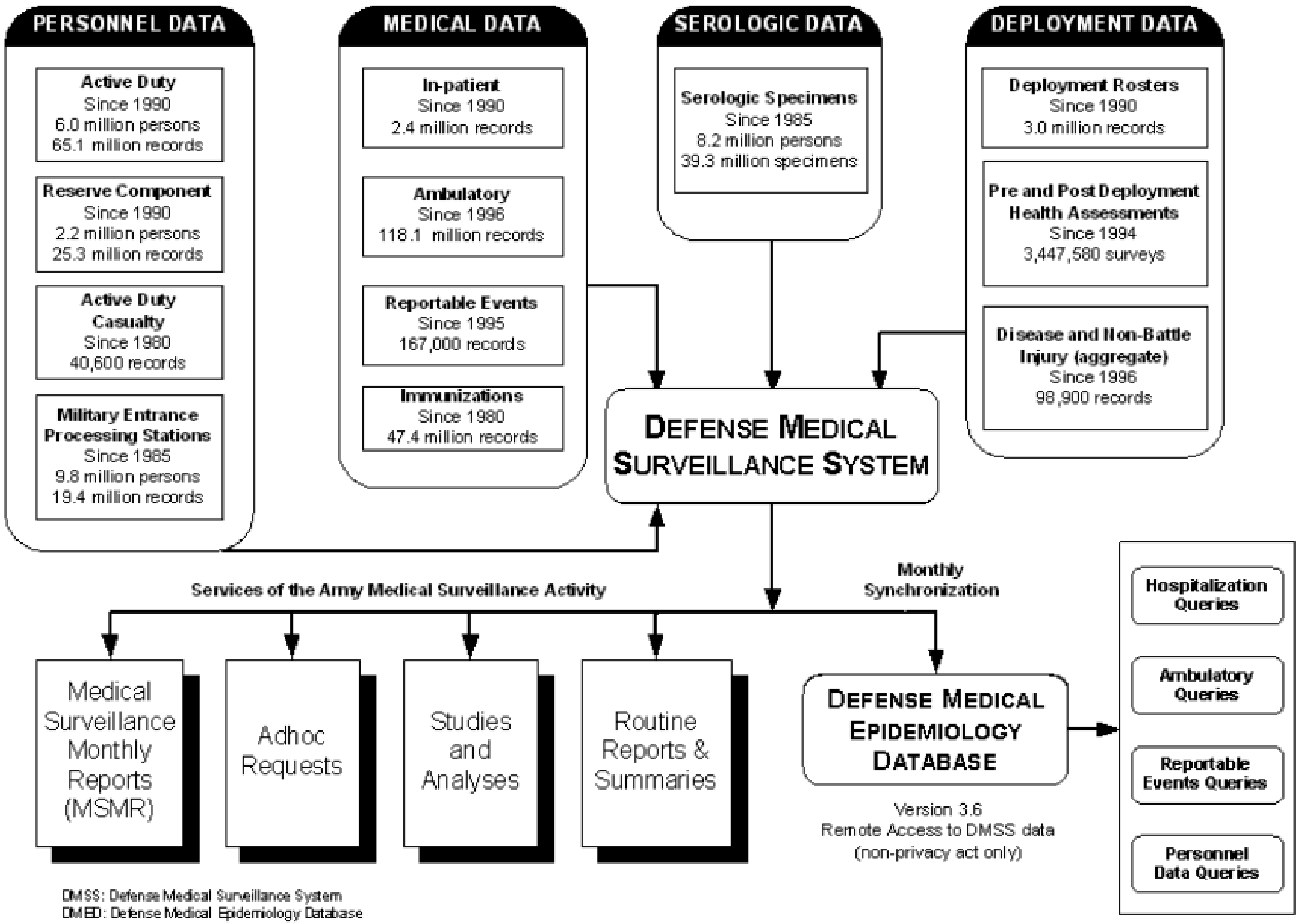

Figure 3. Schematic representation of the structure and functional relationships of the Defense Medical Surveillance System.
(Source: COL Mark Rubertone, Army Medical Surveillance Activity, US Army Center for Health Promotion and Preventive Medicine)

The Office of the Assistant Secretary of Defense for Health Affairs (ASD-HA), through the Deputy ASD for Force Health Protection, is overseeing a process of improved networking among these various entities, as well as an actual integration of centralized archiving, analysis, and reporting functions to establish what may become an Armed Forces Health Surveillance Center. The Army Medical Department (AMEDD) would then manage a truly multi-Service organization with enhanced capability. In the meantime, some of the staff of the ASD-HA are themselves directly managing contracts to maintain specific surveillance functions that evolved very quickly since the attacks of September 11, 2001, and the associated recognition of the increased threat of weapons of mass destruction, particularly biological agents. In particular, a secure environment with robust web based access was required to receive disease and nonbattle injury (DNBI) data in near real time from the rather complex Central Command areas of operation; and a dedicated server was required for operation of daily, worldwide syndromic surveillance. To meet these requirements, respectively, the Joint Medical Work Station and the Electronic Surveillance System for Early Notification of Community-based Events were developed and are currently operated at Health Affairs collocated offices.

Disease and nonbattle injury surveillance has evolved substantially over the years. For most of the 20th century, diseases and injuries treated at corps or theater level hospitals allowed command surgeons to monitor trends that might require special intervention. Over the last 25 years the practice of including nonhospital encounters in DNBI surveillance has strengthened the ability to intervene early when particular disease or injury trends demand attention. The first Bright Star exercise in Egypt took place two years after the 1978 Camp David Accords, and became a biennial event in 1983. Battalion-level DNBI surveillance was among the many procedures piloted and refined during Bright Star iterations. DNBI categories became standardized at Joint Chiefs of Staff level and include, among other broad but relatively sensitive groupings, gastrointestinal, respiratory, febrile, dermatological, psychological, and cause-stratified traumatic injuries.

It should be mentioned that a number of registries and special studies support the epidemiology and surveillance mission, and vice versa. The DoDSR currently houses nearly 40 million serum specimens in large walk-in freezers, and continues to grow by approximately 2.3 million specimens per year. This rich repository is an invaluable resource to address important questions, such as those exemplified by the list in Figure 4. One example of a rich data registry is the Joint Theater Trauma Registry, which is supported by the US Army Research Institute of Surgical Research and the Center for AMEDD Strategic Studies at Fort Sam Houston, Texas. Another example is the Total Army Injury and Health Outcomes Database maintained by the US Army Research Institute of Environmental Medicine at Natick, Massachusetts. Finally, effective analysis requires denominators, and thus feeds from personnel data systems such as the Defense Manpower Data Center in Monterrey, CA.

- Susceptibility of measles and rubella among US Army recruits
- Leishmaniasis serology in Gulf War veterans
- Persistence of antibody to Japanese encephalitis vaccine
- Sero-prevalence of hepatitis A, B, and C in recruit applicants
- Hantavirus in military personnel from four corners area
- Hepatitis C in orthopedic surgeons and dentists
- Risk of late HIV sero-conversion in US soldiers
- Serologic evaluation for mycoplasma in Gulf War veterans
- PSA levels and PSA velocity and the risk of prostate cancer
- Prevalence of West Nile Virus in NY military applicants
- Hepatitis C prevalence and incidence in US service members

Figure 4. Selection of previous studies using the DoD Serum Repository

INVESTIGATION

Problems that have a real or potential impact on groups of people or an entire population typically come to the attention of public health leaders either because epidemiologists monitoring events from a central location see a trend that is not visible at any single location, or because clinicians at a particular location note a local trend or individual case that warrants an alert. The level of response, in terms of both chain of command and number of required consultants, is usually dictated by the predictable breadth of potential health impact and the perceptions of leaders and the public. The immediacy of response is dictated by the level of alarm aroused by the severity of a particular disease, or how quickly a disease or injury problem affects an increasing number of people, which in turn is usually determined by the frequency and latency of adverse health outcomes.

Just as disease, injury, and adverse exposure surveillance occurs both locally and centrally, so too does the investigation of unusual diseases of immediate public health importance and diseases and injuries occurring at a higher-than-expected incidence. This is one of the many roles of unit or installation preventive medicine personnel. In a manner similar to clinical consultation, assistance from higher levels in the medical chain comes into play when additional expertise is needed or when there are competing tasks occupying local manpower. Figure 5 shows the levels of PM consultation in a typical garrison setting, and also implies interorganizational coordination and communication that may occur in response to an outbreak, including civilian liaison activities. For many years Epidemiological Consultations (EPICON) were executed from the Walter Reed Army Institute of Research (WRAIR). When the Army Environmental Hygiene Agency transformed to become the CHPPM in 1994, a number of new missions were added to consolidate central support to operational and garrison units in several preventive medicine arenas, including epidemiology and health promotion. The Current Operations section of the CHPPM now receives US Army Medical Command (MEDCOM) orders and requests to investigate outbreaks, clusters, and sentinels. Still, teams are task organized such that CHPPM frequently partners with the WRAIR and other US Army Medical Research and Material Command organizations, as well as other MEDCOM subordinate commands. EPICONs are comparable to Epi-Aids conducted by the Centers for Disease Control and Prevention (CDC), and, in a similar manner, EPICONs use military preventive medicine residents, just as Epi-Aids utilize Epidemic Intelligence Service officers and CDC preventive medicine residents. This enhances the intellectual approach to problem solving while also providing hands-on teaching, and is no different from clinical case management in hospital-based graduate medical education programs. The concept and procedures of an EPICON already existed when Special Medical Augmentation Response Teams were established within the Army Medical Department. Under a new concept a SMART-PM (EPI)* deployment is synonymous with EPICON.

INTERVENTION

Public health interventions in military settings are not very different from those in the civilian context, and may target small groups of contacts, a community at large, or an entire population. Familiar examples include the use of immunizations, chemoprophylaxis, isolation, quarantine, active case finding and aggressive treatment. Other equally important kinds of intervention include risk communication, health education, equipment redesign, environmental controls and reengineering, new and enforced safety procedures, and new policies, guidelines, procedures, regulations, or laws. The general medical literature frequently includes papers describing population-level interventions, but most of these are disease related. Since measures aimed at reducing the incidence of trauma are more concentrated in specialty journals, the following paragraphs briefly discuss military injury prevention to illustrate how interventions can derive from surveillance and epidemiological investigations.

An example of an intervention involving military equipment was the use of a specialized ankle brace to reduce the incidence of ankle injuries during airborne operations. Surveys of injuries incurred during airborne operations suggest that 30% to 60% involve the ankle.[3-7] The sports medicine literature suggested that fewer ankle injuries occurred among athletes wearing ankle braces.[6,9] A specialized parachute ankle brace that fit outside the combat boot and is easily donned and doffed with Velcro straps was developed. A randomized study of airborne trainees showed that during jump operations, those wearing this brace had fewer inversion ankle sprains compared to those who did not (0.6 versus 3.8 injuries per 1000 jumps, $p=0.04$).[10] Later, a 3-year surveillance of ankle injuries in a US Army Airborne Ranger Battalion showed that those wearing the ankle brace had significantly fewer ankle injuries compared to those not wearing the brace (1.5 versus 4.5 injuries/1000 jumps, $p<0.01$).[11] Ankle braces were discontinued in 2001 because of the cost and unsubstantiated anecdotal suggestions that they were causing other types of injuries. A study was conducted using a surveillance database that demonstrated that the odds of hospitalization for an ankle injury was 2.2 (95%CI=1.8–2.8) times higher in

*Special Medical Augmentation Response Team-Preventive Medicine (Epidemiological)

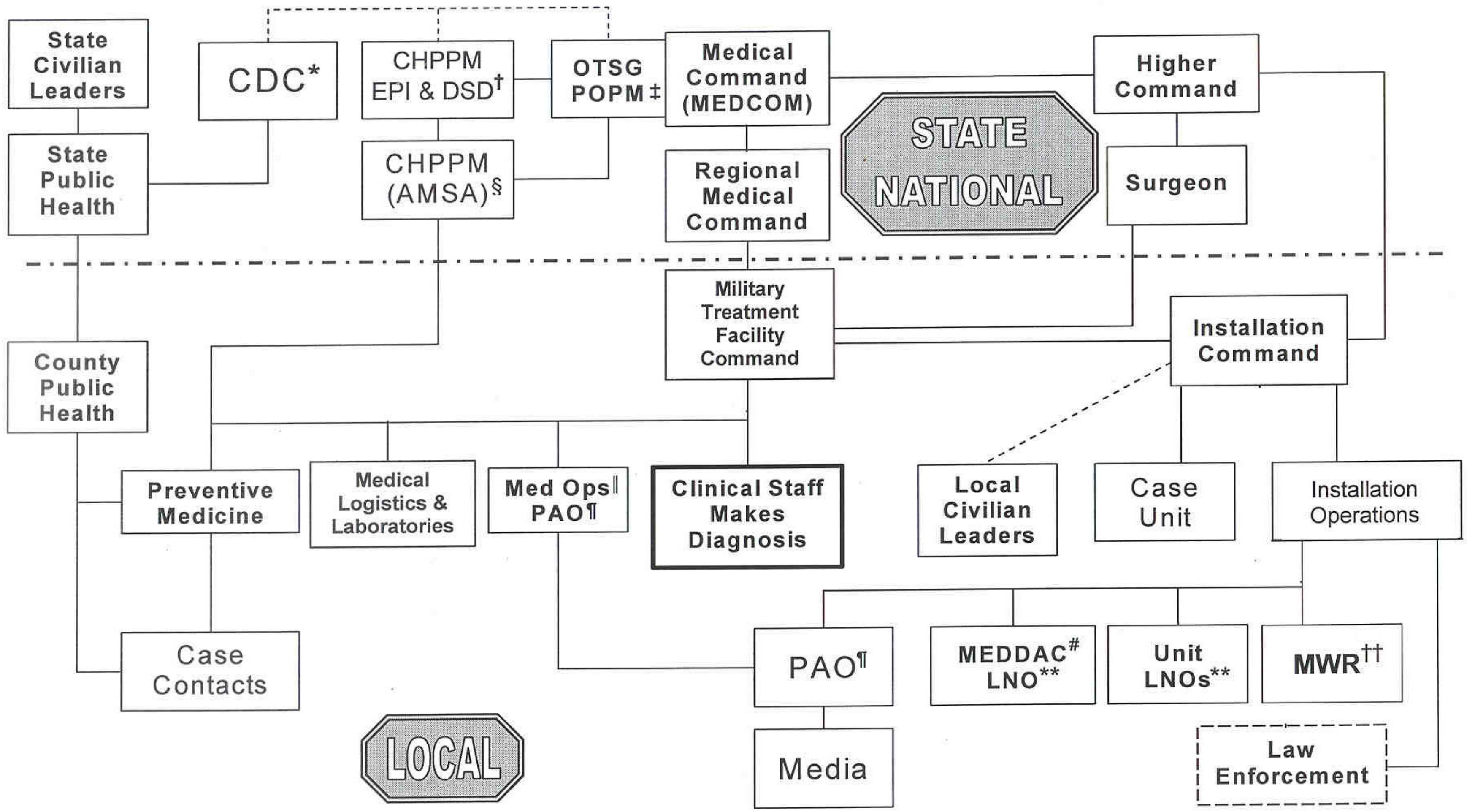

Figure 5. The levels of vertical and lateral coordination in preventive medicine consultation in response to an outbreak. Schematic demonstrates actions in a typical garrison setting, with representations of the interorganizational coordination and communication that may occur, including civilian liaison activities. (Chart courtesy of LTC Robert Mott, Walter Reed Army Institute of Research.)

Key to Acronyms

*Centers for Disease Control and Prevention; †US Army Center for Health Promotion and Preventive Medicine, Epidemiology and Disease Surveillance Directorate; ‡Office of the Surgeon General, Proponency Office for Preventive Medicine; §Army Medical Surveillance Activity; ‖Medical Operations; ¶Public Affairs Officer; #Medical Department Activity; **Liaison Officer; ††Morale, Welfare, Recreation the period before the brace was used and 1.7 (95% CI=1.2–2.2) times higher after the brace was discontinued. The brace is now being reintegrated into Army airborne units as a result of advocacy efforts by the Defense Safety Oversight Council.

An example of an intervention that involved physical training was conducted during the 9-week basic combat training (BCT) cycle.[12] Previous studies suggested that reducing running mileage could reduce injuries without reducing aerobic training effects,[13,14]and cross training with a wide variety of exercises has been recommended to reduce injuries.[15] A new training program, incorporating these and other injury reduction principles was developed by the Army Physical Fitness School. A phase-in of this program in BCT allowed a comparison of 2 battalions. One battalion (n=1284) ran only 17 miles and performed a wide variety of cross training exercises that included calisthenics, dumbbell drills, movement drills, interval training, long-distance running, and end-of-training stretching. Another battalion (n=1296) conducted the usual BCT physical training program consisting of 38 miles of running and a limited variety of exercises. Men and women in the usual BCT program were at 1.6 and 1.5 (respectively) times higher risk of injury than those in the reduced running and increased cross training program. Improvements in 2-mile run times were almost identical in the 2 groups. Despite the success of the program, concern was expressed by the Army leadership because of the cost and logistics associated with the dumbbell portion of the program and potential problems with some of the exercises. Army leadership also thought that the Army field manual on physical training[16] contained many of the necessary principles for enhancing fitness and reducing injuries, but inadequately presented how these principles should be applied in BCT. A new BCT physical training program was developed by the Fitness School to take these considerations into account and a second project was undertaken.[17] One battalion (Battalion A, n=829) implemented the revised physical training program and was compared to another battalion (Battalion B, n=1138) that implemented a traditional BCT physical training program. At the end of the 9-week BCT cycle, injury surveillance data showed that men and women in Battalion B were1.6 (95% CI=1.2-2.0) and 1.5 (95% CI=1.2-1.8) times more likely to be injured compared to Battalion A men and women, respectively. APFT failures were also higher in Battalion B than in Battalion A (1.7% vs. 3.3%, p=0.03). These studies demonstrated that injuries could be considerably reduced and fitness improvement maintained by specific training modifications and that surveillance data could be used to compare groups. In 2003, the commander of the Army Accessions Command mandated the new physical training program for all basic combat training.

CONCLUSION

In the civilian world, population medicine and clinical medicine began to drift apart a hundred years ago, just a few decades after the germ theory began to revolutionize medicine as a whole. While ironic, this is not surprising. The means to combat disease grew out of research laboratories working in parallel to develop both “weapons of mass protection” (vaccines) and “guns” (pharmaceuticals for individual treatment). The latter gave such power to physicians who treat the sick that the isolation of public health departments from hospitals and private clinics was inevitable, given the way health care evolved in American society. It would seem that the managed care and health maintenance revolution should have brought mass prevention and individual care back together, but with beneficiaries moving among so many competing organizations (both insurers and employers), a parallel focus on entire, covered populations is not economical. There are exceptions in the armamentarium, such as childhood vaccines, but in those cases the need to comply with state laws is often the primary driver. While the Military Health System struggles with similar issues of cost when considering the majority of beneficiaries at any point in time, the active duty sector in particular is a workforce for which health protection serves both the corporate customer (commanders) and the beneficiary. Still, the focus is on prevention of short-latency conditions such as acute infections, acute environmental illnesses (eg, due to hot and cold weather conditions), and trauma—and even for these the process of “target acquisition” for those who man the big guns remains unacceptably slow. As information technology continues to advance, and epidemiological tools integrate with the tools that facilitate clinical care, the border between population and individual care is beginning to fade. Like the elegant feedback mechanisms that characterize human physiology itself, information systems will permit a “population health and safety equilibrium,” and, just as with individual access to care, the Armed Services of the United States are leading the way.

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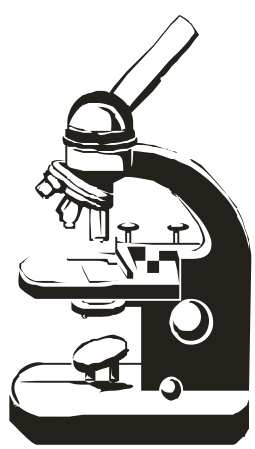

Vector Control and Pest Management

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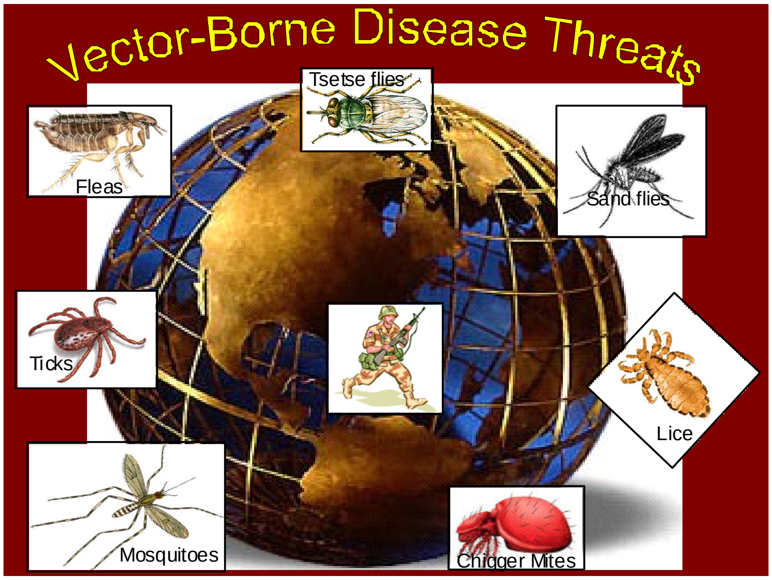
INTRODUCTION

The first discovery of an arthropod-borne pathogen was in 1893, and it was quickly followed by notable successes in the prevention of yellow fever and malaria through mosquito control. Despite continual progress in the technology of vector control during the last century, US military forces remain vulnerable to many serious diseases caused by pathogens transmitted by mosquitoes, ticks, and other arthropods that cause considerable morbidity and mortality. The hundreds of recently-returning veterans from Iraq and Afghanistan who had contracted cutaneous leishmaniasis transmitted by sand flies is a testimony to this fact.[1] Other recent military operations have also been negatively impacted by arthropod-borne infections. In September 2003, when 290 Marines went ashore in Liberia as military advisors to oversee a civil transition, 80 contracted malaria (28% attack rate).[2] Malaria remains a significant threat on the Korean peninsula and elsewhere throughout Asia. Japanese encephalitis is one of approximately 100 viruses spread by insects and ticks and is a significant threat to US forces in the Pacific region. These are but a few examples of how arthropod-borne disease prevention is a top priority for force health protection of the Army. In addition to vector-borne and zoonotic diseases, biological threats during deployments include biting and stinging arthropods (fire ants, mites/chiggers, scorpions, etc.); vertebrate animals (rodents, bats, snakes, etc.); and poisonous plants (e.g., poison oak and poison sumac). Biting and stinging arthropods can degrade mission readiness and combat effectiveness even when they do not transmit disease. These arthropods can cause casualties ranging in severity from secondary infections to death from allergic reaction. Annoyance from persistent pests, itching bites, and loss of sleep can also erode morale.

Whether engaged in combat operations, or deployed in support of peacekeeping or humanitarian relief, commanders throughout the Army are concerned about vector-borne diseases and pest threats that can adversely affect the health of their troops and compromise the success of the mission. Medical entomologists, as members of the preventive medicine team, work to minimize these threats by applying safe pest control where it is most needed. During deployments, this mission becomes focused on issues that affect the health of Soldiers and their ability to accomplish their mission. Pathogens transmitted by such vectors as mosquitoes, ticks, and mites are the primary concern because outbreaks of associated diseases can occur suddenly and affect the deployed unit. The Department of Defense (DoD) and Department of the Army recognize that vector control to protect the health and lives of personnel must be balanced with the risks associated with the use of pesticides. Thus, the US Army has taken many steps to reduce the chances of unnecessary exposure of its personnel to pesticides through a sustained emphasis on the use of personal protective equipment, integrated pest management practices, the use of safer pesticides,



better recordkeeping, and maintenance of a certified pesticide applicator training program.

The Army's constant goal is full spectrum dominance (to defeat any adversary and control any situation across the range of military operations) over the threat of arthropod-borne diseases and direct injury. The Army does this by forming partnerships with industry and supporting academic research to develop improved (more efficacious and cost effective) surveillance and control techniques and equipment, as well as by identifying and implementing the use of off-the-shelf technologies. The Army also strives to attract and retain high-quality military and civilian personnel to initiate, implement, and support these efforts. Achievement of full spectrum dominance requires investment in the development of new military capabilities, which will lead to multidimensional protection against harmful arthropods and the diseases they transmit. The purpose of this article is to describe current methodologies and future developments for vector control and pest management in the US Army.

ENTOMOLOGY JOINT/MULTIAGENCY EFFORT

Military vector control and pest management programs not only must prevent or control pests and disease vectors that adversely impact readiness or military operations, but must also prevent structure, materiel, or property damage. This is a huge joint/multiagency effort that extends far beyond protecting deployed service members from blood-feeding arthropods. Each of the military components has its own military and civilian pest management personnel employed to counter the threat. The pest management effort is guided by applicable Executive Orders, Federal, State, and local statutory and regulatory requirements in the US. Overseas, US legal requirements as well as international agreements, Status of Forces agreements, Final Governing Standards issued for host nations, and criteria in the Overseas Environmental Baseline Guidance Document must be followed. The DoD requires that its personnel follow the strictest policies, including Environmental Protection Agency (EPA) regulations, relevant to the area in which an operation is occurring, even though an operation may be outside the jurisdiction of EPA. An important exception is possible in case of need. The Command Entomologist of an operation can authorize the use of unregistered pesticides (such as those locally purchased) or the use of registered pesticides in sites not on the label.

The Armed Forces Pest Management Board (AFPMB) is the tri-Service organization which monitors and guides this international effort, recommending policy for the DoD. Military and civilian members of the armed forces actively participate in the joint policy development process. Advisors from other federal agencies such as the EPA, the Centers for Disease Control and Prevention (CDC), the US Dept of Agriculture (USDA), US Dept of Homeland Security, and others provide valuable advice during the process. The AFPMB works with the military services, the Joint Staff (principally the J-4, Medical Readiness Division) and the combatant commands to ensure DoD policy is effective in meeting the threat to personnel, real property, and materiel. Through an Army entomologist assigned as Contingency Liaison Officer, the AFPMB ensures that deploying and deployed entomologists have the tools to complete the mission. In cases where the tools do not exist or are no longer effective, research aimed at developing new technologies or methodologies is necessary. This requirement led to a new research program that began in October 2003, the Deployed Warfighter Research Program Against Insects that Carry Diseases of Military Importance, or DWFP. The goal of the DWFP is to develop new public health insecticides and formulations, personal protection systems, and application equipment for vector control. New insecticides or formulations developed under this program will require EPA registration to ensure the level of chemical safety that Americans expect.

The Defense Pest Management Information Analysis Center (DPMIAC), a subdirectorate of the AFPMB, analyzes open source pest management literature (refereed publications, trade journals, etc.) to provide information on pest issues for deployments and DoD installations. An Army entomologist assigned to DPMIAC ensures that information products (Technical Guides, Disease Vector Ecology Profiles, and literature searches) meet the requirements of Army customers around the world. Information relevant for deployments is provided to the Armed Forces Medical Intelligence Center (AFMIC) for integration with their data. AFMIC then produces intelligence products such as the AFMIC Medical Environmental Disease Intelligence and Countermeasures (MEDIC) CD, Infectious Disease Risk Assessments, and others. The US Army Veterinary Command often collaborates on management issues involving vertebrate pests such as feral animals and rabies control.

The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) also has an important Entomological Sciences Program (ESP) with a mission to maximize the ability for US Army units and installations to protect the Soldier from the health threat posed by vector-borne disease and medically important pests and to minimize the adverse effects of pesticides. For example, under the direction and leadership of ESP, the West Nile virus (WNV) Surveillance Program was a good example of a multiagency effort in pest management. Following the emergence of WNV in the US in the late summer of 1999, the Army Surgeon General directed the creation and implementation of a WNV Surveillance and Control Program for Army installations. Through collaboration with the CDC, state and local health departments, the US Army Center for Health Promotion and Preventive Medicine (USACHPPM), the US Army Veterinary Command, and others, military installations were able to use mosquito surveillance and control, dead bird surveillance, and human case monitoring to minimize the risk of WNV to personnel on Army installations. Navy, Marine, and Air Force installations conducted similar programs with mutual interactions on pest management-related issues discussed by an ad hoc WNV committee of the AFPMB.

PERSONAL PROTECTION

Vector-borne diseases and associated discomfort caused by biting arthropods can be largely prevented with proper use of personal protective measures (PPMs) by individual Soldiers. Personal protective measures include arthropod repellents, clothing impregnants, and equipment and techniques which, when appropriately applied, will preserve the fighting strength of the troops.

History and Military Significance

Of 80 diseases of military importance, over two-thirds are caused by pathogens transmitted by arthropods.[3] In addition, arthropods can inflict severe physical, psychological, and economic stresses that threaten the military mission. For example, arthropod bites can be painfully distracting and can lead to secondary infections, dermatitis, or allergic reactions. During the Vietnam conflict, the irritation caused by blister beetles (family Meloidae) was a major source of casualties in some locations. In the recent military actions, pest control was necessary to stop an outbreak of dermatitis caused by a different kind of beetle (*Paederus* rove beetles) in Pakistan. If there is one lesson to be learned from the medical management of disease casualties from all past wars, it is that, during peacetime we should prepare our response to any vector-borne diseases we could encounter during future operations. Due to the lack of effective vaccines or chemoprophylaxis for many vector-borne diseases, proper use of PPMs may provide the only available protection from arthropod-borne diseases. Proper use of PPMs by all Soldiers at risk of vector-borne diseases is critical for reducing the occurrence of disease or nonbattle injuries in current conflicts.

Repellents are one commonly used form of PPM. They provide the commander with a quick and inexpensive measure to protect the force in any military situation, no matter how quickly the unit is called into action. They can be applied effectively to prevent any arthropod-borne disease, whether or not surveillance has identified the pathogen. Repellents are often the only means of protection against arthropod-borne diseases in combat environments when vector control measures are not possible or when the speed of military developments prevents the use of chemoprophylaxis or vaccines. In addition, commanders will be able to minimize incidence of any vector-borne disease, providing a tactical advantage against an unprotected enemy force which does not have the benefit of an effective, long-lasting arthropod repellent.

Topical Repellents

The US military has been a major customer for the development of repellents beginning in 1942 when it was recognized that arthropod-borne disease was an important source of casualties during World War II. This program produced a series of active ingredients. The current military repellent, N,N-diethyl-3-methyl-benzamide (deet), was first marketed commercially in 1956. Early formulations were effective, but had drawbacks — the application lasted for only 1 or 2 hours in warm and humid conditions, felt very oily on the skin, had an objectionable odor, and was a strong plasticizer (it dissolved some kinds of plastics).[4] As a result, troops did not like to use it, and most did not. Over 62% of 1,500 Soldiers who responded to a questionnaire urged the Army to get a better repellent. In 1990, the standard military topical arthropod repellent was changed to a sustained-release, polymer formulation containing 35% deet and dubbed the Extended Duration Topical Insect and Arthropod

Repellent (EDTIAR). This product was developed by the DoD in collaboration with the 3M Corporation following extensive testing of experimental products by the Letterman Army Institute of Research.

The search for better repellents is still going on. In 1999, the Department of the Army approved a Science and Technology Objective (STO) for development of a new topical standard military insect repellent in collaboration with the USDA's Chemicals Affecting Insect Behavior Laboratory in Beltsville, MD. To support this work, the Department of Entomology at the Walter Reed Army Institute of Research (WRAIR) developed new methods—new statistics, computer modeling of repellent activity,[5] in vivo testing,[6] and in vitro testing[7]—for repellent evaluation that expanded on the excellent work at USDA. The STO was completed in 2005, producing a new candidate active ingredient, (1S,2'S)-methylpiperidinyl-3-cyclohexene-1-carboxamide (SS220) in new formulations that are easier to use than the EDTIAR.

In addition to the development of new repellent chemistries, a new formulation of deet was developed. In order to provide Soldiers and Marines in a tactical environment with more convenient protection from biting arthropods, the WRAIR Repellent Program collaborated with Iguana LLC to produce a new, improved formulation of camouflage face paint insect repellent with 30% deet.

The objective in the evaluation of any repellent test is how it performs in the field. With 5 overseas laboratories (Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand; US Army Medical Research Unit-Kenya, Nairobi; Naval Medical Research Center Detachment, Lima, Peru; Naval Medical Research Unit-3, Cairo, Egypt; and Naval Medical Research Unit 2, Jakarta, Indonesia) and collaboration with the Australian Army Malaria Institute, the US military is in an excellent position to test repellents against vectors of many disease causing pathogens.

Repellents

Many of the pathogens of military importance are vectored by ticks, chigger mites, fleas, and body lice. All of these vectors have close contact to clothing when they bite, making the development of repellents to be applied to clothing a logical development.

An effective clothing repellent based on the synthetic pyrethroid, permethrin was fielded in 1991 and is still in use today as the standard military clothing repellent.[4] Currently, military personnel use permethrin to repel and kill arthropods that land on many kinds of treated surfaces, including field uniforms, tents, bed nets, and helmet covers.

Clothing and Equipment

Although often neglected, one of the most practical means of reducing arthropod bites is the proper wearing of the BDU/ACU (battle dress uniform/Army combat uniform). Most arthropods cannot bite through the BDU/ACU material unless it is tightly stretched against the skin. Therefore, Soldiers must wear loosely fitted uniforms and minimize the amount of bare skin that is exposed to blood-sucking arthropods.[4] Field observations on the relationship between clothing and localization of cutaneous leishmaniasis lesions (at the site of a sand fly bite) have confirmed the importance of proper clothing wear in personal protection.[8]

Mosquito Bed Net

The mosquito bed net is a finely woven, nylon canopy that can be used with the folding cot, hammock, steel bed, or shelter half-tent. For all applications, the bed net must be supported and tucked in to prevent contact with the occupant's body while sleeping to prevent mosquitoes and other biting arthropods from biting through the mesh. Standard military permethrin and insecticide space spray (2% d-

phenothrin) can be sprayed on the mesh or on insects that are trapped inside the net. Details are in the Armed Forces Pest Management Board's (AFPMB) *Technical Guide 36*.[4]

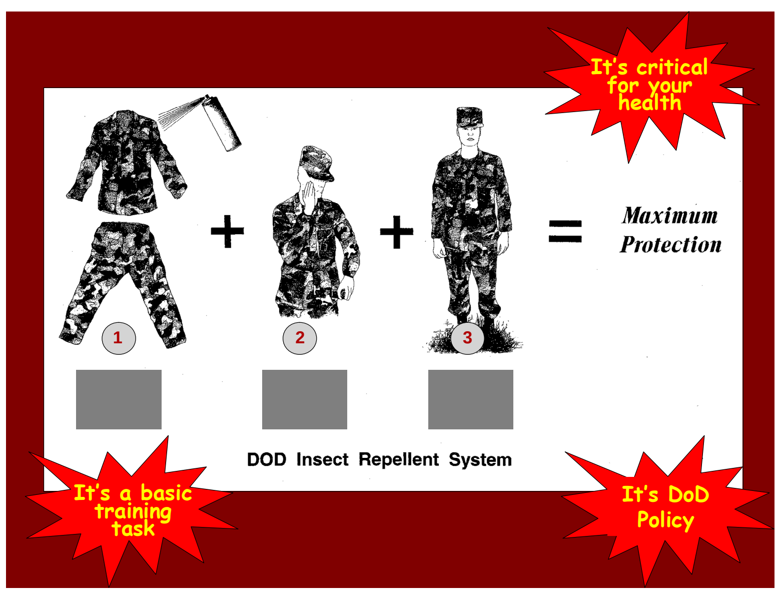
The new Self-Supporting Low-Profile Bed Net can be carried inside the backpack or between the backpack and frame. It has a built-in frame designed for single step, "pop-up" assembly. Permethrin-impregnated tight weave mesh provides increased protection against very small biting arthropods such as sand flies. The bed net may be used directly on the ground. Infrared signature, forest camouflage pattern and carrying capacity are compatible with military requirements. Thus, the new bed net is less visible to the enemy, lighter in weight (2 lbs), and easier to set up and take down than the older bed net.

DoD Insect Repellent System

The DoD Insect Repellent System is available for use by all leaders and troops to prevent arthropod-borne pathogens that cause diseases such as malaria, leishmaniasis, scrub typhus, West Nile fever, and Lyme disease. When used properly, the DoD Insect Repellent System will prevent disease, pain, and the annoyance caused by bites of insects such as mosquitoes, sand flies, and other arthropods such as ticks and chiggers. The system consists of three components—permethrin on uniforms (and bed nets), deet on exposed skin, and proper wear of the uniform—and is critical to the Army Medical Regiment's motto to "Conserve the Fighting Strength." It is a mission essential task located in STP-21-1-SMCT "Soldier's Manual of Common Task Testing, Skill Level 1" dated 11 Oct 2005. This system is a DoD Policy that every Soldier, Sailor, Airman, and Marine, need to strictly follow. Details are in the AFPMB *Technical Guide 36*[4] and in the USACHPPM fact sheet on the DoD Insect Repellent System[9] and at the Army Medical Department Center and School deployment training portal.[10]

Immunizations and Chemoprophylaxis

Both immunizations and chemoprophylactic measures are considered personal protective measures although they are not controlled by the individual Soldier. Chemoprophylaxis is available for some of the protozoan (malaria) and bacterial (scrub typhus) pathogens transmitted by arthropods. Vaccines are routinely available for only a few of the viral pathogens (yellow fever virus, Japanese encephalitis virus) and are available on an experimental use protocol for a few others (Venezuelan equine encephalitis virus, Rift Valley fever virus). Even when appropriate chemoprophylaxis or vaccination is available for the disease of greatest concern, their use entails considerable medical management. When risk is unknown or considered to be low, personal protection may be the appropriate strategy for prevention. Therefore, the proper use of other personal protective measures described earlier offer the most practical means of interrupting and preventing arthropod-borne disease transmission.



In summary, there are 3 required components for effective personal protection. First, the measure itself must be efficacious when properly used. Second, the development and continual maintenance of a well-defined education program is of paramount importance. Every enlisted Soldier, every officer, and especially every commander must be informed about the importance of personal protective measures for reducing the occurrence of disease caused by arthropod-borne pathogens. Field sanitation teams at the company level can serve the commander by educating Soldiers and ensuring adequate personal protective supplies are maintained and used properly. Finally, enforcement of PPM is sometimes appropriate to assure individual compliance. Discipline in using proven personal protective measures must be reinforced through command emphasis and involvement.

The individual Soldier is the most important element in any combat system. Protection of his/her health is absolutely critical to maintenance of a high state of combat readiness. Medical advisors have the job of supporting the commander by providing sound technical advice and training in the prevention of arthropod-borne diseases. Thus, it is imperative that DoD leaders at all levels understand and endorse the need and the use of these personal protective measures.

SURVEILLANCE

Disease vector and pest surveillance is designed to:

1. measure the relative population levels of known pests to determine when and where to begin specific management techniques;
2. detect invasions of new and potentially important vectors and pests;
3. detect breeding sites that can be eliminated; and
4. measure the effectiveness of previous management efforts.

The Army has 2 major groups involved in pest surveillance and management. One group primarily researches medical aspects of arthropod-borne pathogens, conducts medical personnel training in these diseases, and provides pest management in contingency operations. The other group is the facilities engineering element responsible for protecting property and materiel subject to pest infestation or destruction, including most pest management operations at DoD installations. Cooperation between these two elements is essential to ensure complete, efficient protection of DoD personnel, property, and material.

Prevention of vector-borne diseases through timely surveillance and subsequent integrated pest management (IPM) relies on effective decision-making. Decision-making tools include protocols for deciding the need for some management action based on an assessment of the pest population and its potential for the transmission of vector-borne disease to humans. Monitoring and use of *action thresholds* are standard practice in military preventive medicine. These protocols (also known as control decision rules) consist of standardized procedures for assessing the density of pest populations and an action threshold, in this case the lowest population density above an acceptable baseline value that will cause nuisance and/ or disease. Thus, carefully planned surveillance plays a critical role in assessing vector-borne disease threats because the information gained can influence decisions on the use of medical preventive interventions, such as chemoprophylaxis, and pesticide usage. One recent example of a success in this area was the role mosquito and malaria parasite surveillance played to help shape an improved theater malaria chemoprophylaxis program for Operations Iraqi Freedom (OIF) and Enduring Freedom. Malaria chemoprophylaxis was substantially reduced in areas with no active transmission, thus lowering costs, limiting logistics concerns, and diminishing undesirable side effects of chemoprophylactic drugs.

Flying insect vectors of disease such as mosquitoes and sand flies currently pose the greatest threat to deployed armed forces. Standardized flying insect trapping programs use CDC light traps (small, battery operated traps with flashlight-like bulbs and often supplemented with dry ice as an attractant) during the hours of darkness. Collected mosquitoes can be tested immediately in the field using the VecTest® kit (Microgenics Corp., Fremont, CA, 800-232-3342) and results are obtained within 15 minutes. The VecTest® is an antigen panel assay that uses a rapid detection dipstick designed to specifically test for presence of malaria parasites in mosquitoes. The test kit employs a wicking dipstick assay that detects *Plasmodium falciparum* and *P. vivax* (variants 210 & 247) in pools of up to 10 anopheline mosquitoes. The Malaria VecTest® Kit uses specific monoclonal antibodies targeting the circumsporozoite antigens found on the surface of the *Plasmodium* parasites. This innovative, effective, and inexpensive test was developed cooperatively by WRAIR and Medical Analysis Systems, Inc.

During the early stages of OIF, Soldier complaints of sand fly bites were high, as was the risk of contracting leishmaniasis. Army entomologists working at Tallil Air Base in 2003 collected over 21,000 female phlebotomine sand flies and sent them to WRAIR where they were tested for the presence of leishmania parasites using fluorogenic PCR (polymerase chain reaction) assay.[11] These entomologists quickly calculated that the minimum field infection rate was 1.58%. By mapping out the temporal and geographic distribution of all sand flies and infected sand flies, the team was able to focus control efforts in areas that were at highest risk for leishmaniasis. A diverse team of US Army, Air Force, and Navy entomologists, along with colleagues from various coalition forces (British, Italian, Dutch, and Korean), and pest control contractors implemented an aggressive leishmaniasis control plan.

Accurate vector identification and knowledge of vector biology are essential for arthropod-borne disease risk assessment and for development of appropriate strategies for vector suppression, arthropod-borne disease reduction, and vaccine and drug development. There are hundreds of species with varying capabilities of transmitting diseases, depending on factors such as physiological compatibility with the disease organism, host species preference, and feeding times and locations. Potential vectors must be identified at least to the species level to provide the most useful information. Insect identification is greatly assisted through the *reach back* capabilities provided by the Walter Reed Biosystematics Unit, part of the WRAIR, located at the Museum Support Center of the Smithsonian Institution in Suitland, MD. This unique national resource provides online mosquito and sand fly identification keys, laboratory and field protocols, high-resolution images of mosquito morphology, and many other online products to assist military entomologists deployed around the world to correctly and quickly identify arthropod vectors of disease.

New and innovative surveillance techniques are currently being developed by military entomologists. The WRAIR, in partnership with the American Biophysics Corp., is currently evaluating new and innovative insect surveillance tools and control devices. Entomologists at WRAIR and the Uniformed Services University of the Health Sciences are developing remote sensing capabilities that can be applied in disease vector surveillance. We have all become accustomed to the "birds-eye" view of the earth provided by photographs and images acquired from aircraft as well as from manned and unmanned spacecraft. It is this birds-eye view that military entomologists plan to exploit to collect more informative and predictive insect surveillance data.

CONTROL

The DoD pest management community is firmly committed to the principles of IPM as stated in *DoD Instruction 4150.7*.[12] Integrated pest management describes many approaches to pest control including non-chemical activities such as sanitation, habitat modification, and development of surveillance programs to specifically target pest locations and activity times. Use of IPM must not compromise the effectiveness of control and must be tailored to best address the specific needs of each pest or disease vector problem. The Army recognizes that pesticides are indispensable management tools, and takes seriously the responsibility for their safe and effective use. As part of any IPM program, when choosing to use chemical control tools, pest managers are directed to select the least hazardous pesticides that will still provide acceptable results. For example, pesticides in the organophosphate and carbamate chemical classes are still used if specific conditions warrant, but effective substitutes such as newer generation pyrethrins or insect growth regulators are preferred choices. In addition, since the DoD Measures of Merit were instituted over a decade ago with the one stated goal of a 50% reduction in pesticide use by the year 2000, the entire existing pesticide list has been carefully evaluated and updated. When possible, lower application rate pesticides were substituted for higher rate products and lower toxicity chemicals were added to the inventory. This, in addition to a DoD culture that emphasizes IPM, has enabled the DoD to achieve a 61% reduction in pesticide use by 2006. since the program inception, while still maintaining appropriate levels of pest and disease vector control. The DoD has exceeded all its pesticide use reduction goals, and will continue to focus on further reductions wherever possible.

The Defense Logistic Agency regularly updates the national stock list to reflect this goal. However, this effort succeeds only as new, effective, and less toxic active ingredients are developed and registered for use by the EPA, a slow and extremely costly endeavor for pesticide manufacturers. When such products are brought to the market, the AFPMB makes every effort to evaluate their potential for use by DoD components and to add them as needed to the stock list. Examples that appear on the current stock list include insect growth regulators, such as fenoxycarb and methoprene, and microbial pesticides, such as *Bacillus thuringiensis* and spinosad. Members of the AFPMB are also periodically approached by vendors attempting to sell products to the DoD which they label as "natural" or otherwise having low/no toxicity. Unfortunately, in most of these cases, the data supporting these products is either insufficient or nonexistent, particularly if the product does not require EPA registration. Nevertheless, if these products meet the military's rigorous efficacy requirements, they could be supported by professional pest managers and added to the national stock list.

Use of less toxic and more effective pesticides is obviously advantageous to the DoD Pest Management Program to protect human health and the environment. Pest management professionals in the DoD also recognize the need to maintain a sufficiently diverse inventory of pesticides to delay the onset of resistance, which makes certain pesticides ineffective and threatens the military's ability to prevent diseases. To address these issues, DoD pest management professionals, in conjunction with representatives from the CDC, National Institutes of Health, US Agency for International Development, USDA, private industry, and professional pest control organizations, actively seek more effective and less toxic or environmentally hazardous pesticides that will still meet diverse military pest management needs. This group of concerned stakeholders and pesticide users recognizes the fact that some pesticides are being removed from the inventory not only due to concerns about human exposures and environmental safety, but also due to development of resistance to insecticides and lack of economic incentives to develop and maintain products used for disease vector control. The group is currently identifying strategies to promote and support the development of much-needed new products.

The DoD views careful screening and selection of the pesticides authorized for use as one crucial component of any effective IPM program. Another crucial component is the type of pest management equipment and methodology used in applying pesticides. In addition to using the most effective and efficient commercially produced pesticide application equipment, the military services conduct research, either intramurally or collaboratively, with USDA to develop new or improve existing pesticide application technologies for increasing efficacy of pesticide dispersal, and/or reducing the amount of pesticide needed for effective control. The DWFP supplies competitive funding specifically for research relating to pesticide technologies. Of particular promise is current military research on the integration of global positioning systems, new high-pressure systems for C-130 aircraft aerial pesticide application, and the evaluation of unmanned aerial vehicles for pesticide application in hard-to-reach or dangerous areas. The AFPMB Pesticide and Equipment Committees take the lead on identifying and recommending new products and equipment for inclusion on the national stock list. This process supports the ongoing efforts within the DoD to provide effective pest and vector control in the safest possible manner.

Summary

Entomological hazards, including vector-borne diseases, stinging and biting arthropods, and harmful animals and plants remain a significant threat to US military forces both at home and abroad. Military entomologists continue to use safe, effective, established methods of surveillance and control while continuing to develop new, innovative, safer, and more effective methods. This is due in large part to the synergy that results from joint efforts between the Army, Air Force, and Navy through the continued coordination of the AFPMB. Partnering with other government agencies (USDA), industry, and universities has also stimulated the development and implementation of new and more effective technologies that can be quickly delivered to field forces. All of these activities are continually bringing military entomology closer to the goal of full spectrum dominance over harmful arthropods and noxious animals and plants that otherwise would cause US forces to suffer morbidity and mortality.

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Aedes albopictus (Asian Tiger Mosquito)

Phlebotomus papatasi (Sand Fly)

Field Preventive Medicine: Challenges for the Future

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Field Preventive Medicine refers to all actions that provide commanders with a fit and healthy deployable force, sustain the health and fitness of the force during a military operation, and prevent casualties caused by disease and nonbattle injury (DNBI). Preventing or reducing DNBI allows the warfighter to focus manpower and resources on mission accomplishment and allows medical assets to focus on treating combat related injuries. Actions that affect Field Preventive Medicine occur prior to, during, and after deployment, and involve command responsibility, unit leadership standards and enforcement, individual actions, unit level support through the Field Sanitation Team (FLD SAN TM), and direct and general support from preventive medicine personnel. These first 4 components—commander, unit leaders, individual Soldiers, FLD SAN TM—are the primary resources for maintaining the health of the command and preventing DNBI. The Army Medical Department, through its preventive medicine personnel, provides supporting services as a resource for the commander's health program.

Personnel Responsibilities

Commanders

The commander is the authority for actions that occur within the unit and is, therefore, responsible for the health and welfare of the unit, and thereby the prevention of DNBI. The commander provides the time, training, resources, and emphasis needed to implement a DNBI prevention program. The commander sets the standards, leads by example, and ensures the establishment of devices or practices that promote unit or collective Preventive Medicine Measures (PMM). These include latrines, hand washing stations, shaving areas, showers, arthropod and rodent control, and food and water sanitation and quality issues. The commander is responsible for ensuring that FLD SAN TM supplies are on-hand and taken with the unit when it deploys.

Unit Leaders

Unit leaders must support the command's health program and ensure that all unit members adhere to command policies and procedures. Unit leaders must be knowledgeable on health issues and the application of PMM, which are the methods used to prevent and mitigate DNBI.

Soldiers

Soldiers at all levels are responsible for implementing individual PMM. These individual tasks may be very basic, eg, hand washing, bathing, changing socks, and brushing teeth. Or they may be more complex, eg, using insect repellents and consuming food and water only from approved sources. Utilizing PMM takes time and resources, but primarily discipline. Most Soldiers know how to implement the majority of PMM, but may not do it because of the perceived inconvenience.

Field Sanitation Teams

To assist the command in mitigation of DNBI through the use of unit-level PMM, each company sized unit is required, per *Army Regulation 40-5*,[1] to establish and equip a two-person FLD SAN TM. This team is composed of one noncommissioned officer and one junior enlisted. For units assigned a unit health care specialist (ie, medic), the health care specialist should be one of these members. Personnel selected for this additional duty must be highly capable individuals, possess above average leadership skills, and should be expected to stay with the unit for at least 6 months after being trained. Preventive medicine personnel certify each team member through a 40-hour course on field sanitation. This certification should take place

Note: The doctrine of field preventive medicine services discussed in this paper is delineated in Department of the Army *Field Manual 4-02.17, Preventive Medicine Services*.

while in garrison, but preventive medicine personnel can provide the required training while deployed.

Field Sanitation Teams employ the information contained in *Field Manual* (FM) *4-25.12*,[2] and *FM 21-10*.[3] Currently these manuals are being revised and combined into one comprehensive document.* The FLD SAN TM monitors the use of individual and unit PMM, and provides guidance and direction on the construction of unit level devices for implementing PMM. The information gathered, along with their recommendations for enhancing individual and unit PMM, is reported to the commander and unit leaders. As necessary, the commander decides on a course of action for correcting or enhancing PMM, and unit leaders implement this plan. If a work detail is required to implement the action, the FLD SAN TM should provide guidance and monitor the activity to ensure that it is being properly implemented.

Army Medical Department

The Army Medical Department (AMEDD) supports this command program by providing field preventive medicine service support from 5 medical functional areas: preventive medicine services, veterinary services, preventive dentistry, combat and operational stress control, and preventive laboratory services. The AMEDD also conducts field preventive medicine research and development for each of these functional areas to further assist the command in the mitigation of DNBI.

Preventive Medicine Services

The services provided by preventive medicine personnel are the most diverse and constitute the bulk of applied field preventive medicine (see *FM 4-02.17*[4]). These services are provided by officers from 8 Areas of Concentration: Preventive Medicine Officer (60C), Occupational Medicine Officer (60D), Public Health Nurse (66B), Nuclear Medical Science Officer (72A), Entomologist (72B), Audiologist (72C), Environmental Science Officer (72D), and Sanitary Engineer (72E). These services are also provided by 3 enlisted Military Occupational Specialties: Preventive Medicine Specialist (68S [formerly 91S]), Health Physics Specialist (68SN4), and Ear, Nose, and Throat Technician (68WP2). In deployed situations, the 68S, 72D, and 72B are the primary personnel who interact with units to resolve field preventive medicine issues. Other preventive medicine personnel are represented on the staff of various medical and nonmedical units.

Preventive medicine personnel support units in medical surveillance, as well as occupational and environmental health surveillance. This support is accomplished through analyzing DNBI data, unit inspections for compliance with PMM, disease surveillance, area vector and disease suppression, health risk communication, technical consultations, food service sanitation inspections, water quality monitoring, pest management services, retrograde operations inspections, hearing and vision conservation, industrial hygiene surveys, field sanitation practices, environmental sampling for short and long-term health risk exposures, community health services, and radiological safety.

Preventive medicine personnel are located throughout the battlefield, and must be deployed during early operations. Some, such as the Preventive Medicine Section in the brigade combat team's medical company, are organic to units and provide direct support. This section is currently composed of a 72D and a 68S. Others provide staff support and are found in Preventive Medicine Sections or the Surgeon Cells of command and control organizations. Preventive medicine personnel are also found in Military Police battalions (Internment/Resettlement), Special Forces groups, Civil Affairs battalions/brigades, Armored Cavalry regiments, Engineer units, and some Quartermaster battalions.

Medical Detachments (Preventive Medicine) are 13-member units that provide direct support to units that do not have organic preventive medicine personnel, and general support to units that have organic preventive medicine personnel. The Medical Detachments are attached to multifunctional medical battalions (MMB), operate on an area basis, and have the capability to provide expanded services (especially pest management services) to supported units.

Veterinary Services

Veterinary services include the surveillance and testing of food and water sources to ensure the safety and quality of food, ice, and bottled water (see *FM 4-02.18*[5]). Veterinary personnel establish and provide a list of approved food, ice, and bottled water sources to the theater commander and staff for dissemination to subordinate units, and they provide health services to

* The comprehensive document will be *FM 4-25.10: Field Sanitation Team and Preventive Medicine Measures*

military working dogs (MWDs). Veterinary personnel are seldom found at lower echelons on the battlefield, but primarily interact with quartermaster units, preventive medicine units, and units that have MWDs. Veterinary units will also be assigned to the MMB.

Preventive Dental Services

Preventive dental services primarily involve individual PMM such as regular dental hygiene (brushing, flossing). *FM 4-02.19* delineates doctrine for dental operations.[6] Dentists also provide preventive support through annual dental exams and cleanings (including preventive measures such as fluoride treatments), and will provide consultations on how to properly brush and floss teeth and gums. Deployed dental units can provide in-theater treatment and preventive services, normally with a high return to duty rate.[7] To further assist with preventive dental health, dentists look for strategies that maintain an individual's dental health that are effective, easy to use, and require no additional action on the part of the Soldier. For example, the military dental community has succeeded in having Xylitol chewing gum added to the field rations, Meal, Ready to Eat (MREs).[8] Xylitol is a naturally occurring sugar alcohol that kills the bacteria that causes cavities. Adding Xylitol to MREs assists in the prevention of tooth decay and is a no-effort benefit to those Soldiers who chew this gum.

Combat/Operational Stress Control

Deployed Soldiers are subjected to a multitude of issues that may that lead to suicide, fratricide, a significant reduction in work performance, or other disruptive behavior. These issues include preexisting conditions that are corrected by medications; separation from a spouse, a significant other, or other family members; fear of the unknown combat situation; stress from boredom, overwork, lack of sleep, seeing peers killed or maimed, and experiencing other war conditions; and other personality disorders. Preventing behavioral issues in deployed Soldiers is the role of combat and operational stress control personnel (see *FM 4-02.51*[9]) located in Combat and Operational Stress Control Detachments. These detachments are attached to MMBs and provide contact teams to their supported units. These contact teams have the capability to interview Soldiers, evaluate the stress issues within a command, provide guidance on the prevention of disruptive behavior to the individual for specific issues or to the commander for unit issues, and, if necessary, provide some rehabilitatory or reconstitution services.

Preventive Laboratory Services

Preventive laboratory services are those services that support the field preventive medicine effort by testing clinical or environmental samples for infectious agents or hazardous materials. The information from these services are used as part of the DNBI analysis process and as diagnostics for understanding surveillance data. These services are located within the Area Medical Laboratory or outside theater in regional or continental United States support laboratories.

Individual Medical Readiness

Personnel are screened prior to entry into military service to prevent entry of recruits that have a preexisting medical condition which would hinder their performance, or disrupt or burden other military personnel. For those in the service, periodic medical exams or tests (periodic health assessments, deployment limiting conditions, dental readiness, immunization status, readiness laboratory studies, individual medical equipment, hearing readiness, and vision readiness) are required. These individual medical readiness data are entered into the Medical Protection System via the internet and allow medical personnel to assess each Soldier, and prevent or treat a condition in advance of deployment. This in turn serves to maintain individual health, unit integrity, morale, and saves deployment activities for warfighter issues. Commanders assist this process by ensuring that their Soldiers complete these periodic requirements.

Disease and Nonbattle Injuries: Preventive Medicine Measures and Soldiers

Even with the best preventive medicine practices in place, some DNBI will occur. This DNBI may fluctuate. However, over time a fairly stable rate of DNBI—a baseline—may be established. Ideally, this baseline should be the same in both nondeployed and deployed settings. If the measured DNBI exceeds the expected baseline or an established threshold, preventive medicine personnel investigate the issue, look for a potential break in PMM, and implement the means to mitigate the DNBI. Within the body of preventive medicine knowledge, much is already known on the prevention of the majority of militarily and medically important DNBI. Unfortunately, DNBIs are based upon laws of probability, and it is not always clear that a specific action yields a direct consequence. Hence, Soldiers who do not practice effective PMM may not have DNBI, while Soldiers who practice PMM may have some DNBI. This may cause a sense of security when PMM are not followed and no DNBI occurs. Conversely, it may cause Soldiers to mistrust recommended PMM and rely on home-remedies or recommendations from peers when they practice PMM but DNBI occurs. Both situations may cause Soldiers to stray from using PMM as they perceive PMM as being ineffective or to have no added value. However, unit leaders must understand that the PMM is not at fault, but that there is a break somewhere in the implementation of the PMM or the disease process that is preventing or allowing the DNBI. Preventive medicine personnel are trained in locating these breaks, can explain why DNBI situations exist or do not exist, and can assist the command with correcting the issue. In some cases, the PMM may have a side effect on the Soldier, and to avoid the side effect the Soldier may avoid implementing the PMM. An example of this situation was the administration of chloroquine as a chemoprophylaxis for malaria. Soldiers often had gastrointestinal pain for several days after taking the weekly dose of chloroquine. Soldiers did not like this side effect and would avoid taking the once-a-week medication. Unit leaders countered this by having Soldiers line up in formation and observe each Soldier swallow the pill. Preventive medicine measures must be sustained on a routine to periodic basis, which is costly in time and resources to the Soldier and unit. The multitude of tasks that must be completed daily in a field situation to maintain Soldier and unit health can appear enormous. Many of these tasks are expected in garrison (bathe, brush and floss, wash hands after using the latrine and before eating, put on clean clothes, change your socks and underwear daily, etc.), but in the field they can become an inconvenience and, without command emphasis, resourcing, and enforcement, Soldiers may neglect these basic hygiene practices. For Soldiers who take prescribed medications to counter behavioral health issues, the loss of these medications or arriving in theater with an insufficient supply can be disruptive to the unit. To mitigate this issue during Operation Iraqi Freedom, the Army authorized unit medical personnel to carry and issue psychotropic medications. Soldiers may also develop a "we're tough" or a "we don't need to wash our hands or take showers on a regular basis" attitude. Soldiers may also risk eating or drinking from unapproved sources. Both of these can lead to significant DNBI, and overcoming them is a leadership and training issue. Theater policies designed to gain support of the local population or to overcome cultural differences may encourage Soldiers to interact with the local population and consume their food and water in the traditional host nation manner. Since this food and water may not have been handled, prepared, stored, or served using military standards, the Soldiers may be exposed to a local bacterial or viral fauna to which they are susceptible, resulting in increased DNBI. Commanders must consider the health-related implications of these policies as they conduct their risk assessments.

Current Preventive Medicine Issues

Currently there are a number of issues that must be addressed to improve the effectiveness of preventive medicine services and protect the health of warfighters. Three significant issues are:

1. The current brigade combat team (BCT) organizational structure places 2 initial entry-level personnel (a 72D and a 68S) in the BCT medical company's Preventive Medicine Section. These Soldiers are the warfighter's most forward-deployed preventive medicine professionals in theater, therefore, they are the first line of "technical" defense in the BCT commander's battle against DNBI. Unfortunately, these personnel lack the technical and tactical experience to fully accomplish this important mission. Unlike many of the Army's areas of concentration (AOC)/Military Occupational Specialties (MOS) which "grow" their junior ranks in field assignments, the preventive medicine personnel are expected to have the level of knowledge, experience, and professional bearing found in personnel who have been in the military for several years. These professionals are not only expected to interact with Soldiers and the FLD SAN TM, but they also interact directly with commanders and senior NCOs. We propose correcting this situation by replacing the BCT's junior 68S (68S10) with a more senior specialist (68S30). This action would provide the knowledge, experience, and professional bearing required to successfully interact with Soldiers and unit leaders, resulting in increased mission success. The 68S10s should first be grown in other assignments where they would have noncommissioned officer supervision and mentorship.

2. Preventive medicine units are equipped with a variety of highly specialized, low density equipment to conduct their mission. Identifying and resourcing these equipment items present significant challenges: they are expensive, they usually require specialized and routine maintenance, they may require specialized operation and maintenance training, and technological advances may make these items obsolete 3 to 5 years after procurement. Also, although the Medical Equipment Set cyclic review process requires Combat Developers to review and update these items every 3 years (as a minimum), due to resourcing constraints units may not actually see these items for another 2 to 3 years after the review process. As an interim solution, the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) has provided valuable assistance to field preventive units by procuring, maintaining, providing technical training, and temporarily issuing specialized, low-density equipment to these units in support of military operations. Examples include air particulate samplers and combination photoionization detectors/multigas analyzers provided to preventive medicine units deployed to the Balkans, Southwest Asia, and other parts of the world to conduct their occupational and environmental health surveillance missions. Perhaps the procurement, maintenance, training, and fielding of low density, high technology preventive medicine support equipment should be further explored as a core USACHPPM mission, and the organization should be adequately resourced to provide this service.

3. Preventive medicine units are theoretically designed (i.e., staffed and equipped) to provide a variety of services depending on their preventive medicine support capability level. The two-person BCT Preventive Medicine Section provides direct and basic (Level II) support to its brigade, while the 13-person Medical Detachment (Preventive Medicine) provides general area and slightly more advanced (Level III) support to units (to include BCTs) at the corps level. The Area Medical Laboratory (AML), on the other hand, is designed to provide theater-wide, more technically advanced (Level IV) support to these units. However, other than containing more personnel and increased pest management capabilities, the Preventive Medicine Detachment does not provide significantly different services than the BCT Preventive Medicine Section. Although the AML can provide other services, the unit may not be properly organized to deploy in a modular (and timely) manner to maximize its operational footprint while minimizing its logistical footprint. Therefore, the Army may need a Level III+ or perhaps a Level IV preventive medicine unit to provide these additional services in a modular manner. This unit may perhaps be assigned personnel from each 72-series AOC and be equipped with more advanced surveillance equipment, such as direct-reading toxic material analyzers, to provide more robust DNBI surveillance and control services. In fact, this unit may possibly be configured much like the US Navy's modular Forward-Deployed Preventive Medicine Unit.

Field Preventive Medicine Strategies and Future Prospects

Future field preventive medicine strategies are complex, and multiple parameters must be met to provide optimal results. These strategies must meet a balance between warfighter mission requirements, political requirements, and support requirements, with the ultimate focus on issues that would provide the greatest benefit to the warfighter in terms of reduced DNBI. The following sections identify some of these future field preventive medicine strategies and prospects:

1. Warfighters focus on mission accomplishment; therefore, efforts to reduce nonmission requirements are warranted. Future preventive medicine strategies for the warfighter must focus on essential capabilities that will result in warfighter mission accomplishment with minimal support requirements. Ideally, these solutions must be easy to use or require little or no effort from the Soldier or unit leaders, have high Soldier acceptance levels, be highly effective, have no or only minor side effects, be given or accomplished in advance or after a deployment, and require little planning, training, or resources to implement.

2. Materiel solutions must also focus on providing increased capabilities, while at the same time reducing equipment weight and volume. Efforts must be taken to consolidate 2 or more capabilities into a single, portable, lightweight, and easy to operate and maintain equipment item whenever possible. An example of this effort is RAE Systems' (3775 North First Street, San Jose, CA 95134, 408-952-8200) consolidation of a standalone photoionization detector (capable of detecting volatile organic compounds and other ionizable gases and vapors) with a standalone multigas analyzer (capable of measuring explosive gases and vapors, oxygen content, as well as carbon monoxide

and other toxic gases) in the design of the Multi-RAE Plus® Multiple Gas Monitor.

3. Political requirements, such as the health surveillance requirements mandated by Presidential Review Directive-5,[10] must be met. These requirements focus on the entire spectrum of medical support and require the warfighter and medical personnel to document medical treatment and preventive measures, as well as exposures to known hazards and environmental conditions. These hazards must be anticipated, identified, measured, assessed, and correlated to locations and Soldiers exposed. These data must then be linked to individual electronic health records for future review and use by medical personnel. This is an enormous task, and processes to efficiently collect, analyze, and correlate these data are needed. Roles and responsibilities must be established to ensure that the correct data are collected and to eliminate any duplication of effort. Materiel solutions are also needed to more effectively collect and assess health hazard exposure information, and creative information management solutions are required for data entry, correlation, archiving, and retrieval.

4. A number of medical research programs are already established to improve future field preventive medicine capabilities. Programs such as the Military Infectious Disease Research Program (MIDRP) and the Military Operational Medicine Program focus on preventing and treating disease, protecting warfighters' physical and mental health, enhancing their performance, and providing force health status. Each program will establish a set of parameters that will provide the best possible solution for the warfighter. For example, vaccines are a major research focus in the MIDRP. These meet warfighter requirements by preventing DNBI, and they can usually be administered prior to deployment to protect the warfighter against a particular disease. Additional vaccine parameters that will benefit the both the warfighter and the Army may include vaccines that provide protection soon after the initial vaccination; require only one dose to provide a high level of protection with no boosters, or a long time between boosters; are highly effective; have no or only minor side effects; are given in advance of a deployment; and require little planning and logistical support to implement. Furthermore, these vaccines should be low cost, have a long shelf life, are easily manufactured, easy to apply (oral or inhaled), easy to store, and have low dose regimens.

Conclusions

Army field preventive medicine must have command emphasis from the top down to include planning considerations, training emphasis, and adequate resourcing. Mechanisms are in place to support current and future field preventive medicine through doctrine, organization, and materiel processes, with each to be modified as new knowledge and technology improve or change the implementation of PMM.

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Deployment Occupational and Environmental Health Risk Management

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It is the Army's responsibility to ensure that Soldiers are protected during deployments (both domestic and overseas) against any hazards or threat agents, and to document potential or actual exposures to these harmful threat agents. The documentation database will allow health care providers to better treat and manage Soldiers if an illness occurs after deployment, or even after separation from the military. The record is permanent and always available to the Soldier. The Deployment Occupational and Environmental Health Risk Management (DOEHRM) Program will greatly assist in dealing with postconflict illnesses which have occurred following US major military engagements. This article presents a brief history of the DOEHRM program and existing or planned initiatives for program enhancement.

In the 1991 Gulf War, the number of coalition casualties was significantly low from an historical perspective. However, neither service personnel nor the American public were prepared to deal with significant health issues among returning veterans. Of particular impact were those veterans whose symptoms and conditions were not easily diagnosed or treated. To complicate matters, the military services soon became aware of 3 serious shortcomings;

1. the inability to track specific daily locations for deployed personnel and units, making it extremely difficult to cross reference locations with potentially dangerous occupational and environmental health exposures,
2. the health risk communications process was deficient, and
3. the lack of formal pre- and postdeployment screening processes (Note: screenings have since been implemented).

Several of the postwar health concerns centered on veterans' illnesses, mortality, hospitalizations, and reproductive outcome issues. For example, why were some veterans ill with unexplainable symptoms and were untreatable as well, leaving practitioners unable to explain diagnosis, prognosis and long term recovery issues to them? What were the acute, chronic, or delayed health relationships among pesticide exposures, vaccinations and antidotes, air/soil/water pollutants, chemical and biological warfare agents, stress, depleted uranium, and others? What exactly happened within a 50 km radius of Khamisiyah, Iraq when it was destroyed by coalition forces? What about potential exposures at other locations? Were veterans who deployed more likely to become ill and/or hospitalized versus those veterans who had not deployed? And what about birth defects among children born to Gulf War veterans—did the war experiences have anything to do with that?

To address the shortcomings during subsequent deployments, the Presidential Advisory Committee

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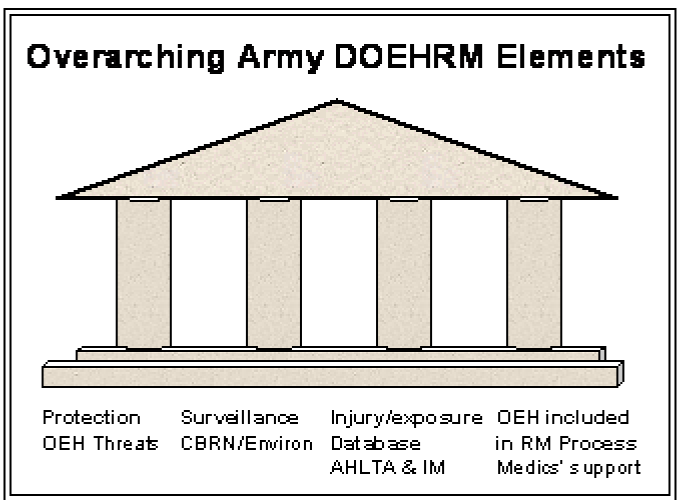
Army DOEHRM policy objectives:

1. Protect Army personnel, including Dept of the Army civilians and Army contractors, from potential and actual exposures on the battlefield. These exposures include chemical, biological, radiological, and nuclear (CBRN) warfare agents; endemic communicable diseases; food, water, and vector borne diseases; ionizing and nonionizing radiation; combat and operational stress; heat, cold, and altitude extremes; environmental and occupational hazards; toxic industrial materials and other physical agents.
2. Reduce occupational and environmental hazard potential and actual exposures during Army operations to as low as practicable to minimize acute, chronic, and delayed health effects within the context of mission parameters and Army risk management (RM) principles.
3. Make informed risk decisions regarding occupational and environmental health (OEH) threats during Army operations, using the RM process to manage such threats and minimize total risk to Army personnel.
4. Ensure that commanders are aware of and consider acute, chronic, and delayed health risks associated with occupational and environmental potential and actual exposures during all phases of Army operations and activities.
5. Comply with federal, state, local or host nation statutes, regulations, directives, and guidance governing OEH except for uniquely military equipment, systems, and operations while in garrison or during training exercises.
6. During deployments, comply with US, Army-unique, or host nation OEH standards, whichever are more restrictive.
7. Implement health surveillance and readiness programs during Army operations.
8. Collect, document, evaluate, report, and archive OEH sampling data from Army operations, integrating all relevant OEH data with potential and actual exposures and exposure scenarios to individual Army personnel, in their longitudinal health records.
9. Ensure necessary healthcare intervention and followup for potentially exposed Army personnel.
10. Deploy in such a way that DOEHRM supports modular and interoperable joint forces capabilities provided by the services.
11. Communicate OEH risks from military operations to all Army personnel and share OEH risk management lessons learned during unit rotations.
12. Provide commanders with the capabilities and tools for conducting RM assessments and communicating risks.
13. Provide access to all needed intelligence sources, deployable computer systems with environmental exposure data, unit locations, and movement information.

(PAC) on Gulf War Veterans' Illnesses was established. In its final report issued on Dec 31, 1996, the PAC recommended that the National Science and Technology Council (NSTC) develop an interagency plan to address health preparedness for, and readjustment of, veterans and their families after future conflicts and related military missions. The NSTC recommendation resulted in Presidential Review Directive-5 (PRD-5), *A National Obligation-Improving the Health of Our Military, Veterans, and Their Families* issued in August 1998.* The Deputy Assistant Secretary of the Army (Environment, Safety and Occupational Health) (DASA[ESOH]) directed implementation of the recommendations contained in PRD-5 in the memorandum *Force Health Protection: Occupational and Environmental Health Threats* dated 27 June 2001.

With encouragement and support from the Army Surgeon General, LTG James Peake, the Army Deputy Chief of Staff (DCS), G-3/5/7 took the lead responsibilities for implementation. The program was renamed Deployment Occupational and Environmental Health Risk Management to better describe the intent of the DASA(ESOH) memo. As part of the program, a governing Army regulation in the 11 series is in final staffing as the source document for DOEHRM. The 11 series (Army Programs) of regulations was chosen as the appropriate location for the DOEHRM regulation since it represents much more than a medical issue. DOEHRM is an Army issue to be executed by commanders and the Army leadership.



Available at: http://fas.org/irp/offdocs/prd-5-report.htm.

In addition to the impending Army regulation, an implementation plan for DOEHRM has been authored, directing numerous organizations within the Army to incorporate DOEHRM into their respective areas of responsibility. With finalization of the DOEHRM regulation and publication of the implementation plan, major commands (MACOMs) and Special Staff will be tasked to author their own implementation plans and identify requirements for the program. The DCS, G-3/5/7 will then assemble and validate all MACOM requirements as identified in the MACOM and Special Staff implementation plans, and staff DOEHRM through the Program Objective Memorandum process for implementation throughout the Army.

With the guidance as provided by the Army regulation and the specific instructions of the DOEHRM implementation plan, MACOMs and Army staff offices will be responsible for DOEHRM integration into their respective areas of responsibility. For example, the following are representative lead responsibilities of several major Army organizations:

1. The DCS, G-3/5/7 will
   - ensure all relevant Army publications are modified to include DOEHRM;
   - review modified tables of organization and equipment to ensure DOEHRM equipment requirements are properly included;
   - integrate the DOEHRM implementation plan with current and future CBRN and high explosive surveillance and bioanalysis systems;
   - identify, track and review DOEHRM issues, resolution and assessments.
2. The Training and Doctrine Command will
   - develop and publish DOEHRM doctrine in accordance with doctrine, organization, training, materiel, leadership, personnel, and facility (DOTMLPF) domains;
   - develop consistent operational guidance that allows appropriate personnel to assist commanders in managing risks from deployment occupational and environmental health hazards and incorporating same into the Army DOTMLPF process;
   - as DOEHRM requirements are identified, examine force structure to ensure said

requirements are defined and addressed by appropriate organizations;

- review current training practices to ensure appropriate risk is being communicated to those having DOEHRM responsibilities;
- develop exportable leader and Soldier training packets on sustainment DOEHRM training for all components after doctrine is approved;
- develop unit/organization training programs.

3. The DCS, G1 will
   - review and identify modifications to or expansion of Chapter 7 (Medical and Dental) of the *Department of the Army Personnel Policy Guidance for Contingency Operations in Support of GWOT** (global war on terror) to accommodate DOEHRM;
   - review and/or develop personnel policies to support integration and direct access of daily personnel and unit location cross-referenced data in DOEHRM information management/ information technology (IM/IT) systems in coordination and linkage with other IM/IT systems.
4. The Medical Command will
   - develop, improve, and disseminate criteria and guidance to include, but not be limited to, chemical, biological, radiological, nuclear, high explosive, physical, entomological, combat and operational stress health risks, endemic diseases, and preventive measures throughout the range of exposure levels for acute, chronic, and delayed health effects;
   - examine medical technology transition projects and processes for potential DOEHRM applicability and priority;
   - conduct reviews of existing medical research and development programs to determine DOEHRM applicability and opportunities for integration.
5. The Combat Readiness Center (CRC) will integrate the DOEHRM implementation plan with the CRC strategic plan and into RM doctrine.
6. Forces Command will incorporate procedures in the DOEHRM implementation plan into all mission training plans and deployment training exercises for both line and medical units.

Other MACOMs and staff offices have additional responsibilities outlined in the implementation plan.

The Surgeon General is confident that, under the leadership of the Deputy Chief of Staff, G-3/5/7, the DOEHRM program will enable commanders to better manage their war-fighting responsibilities and, at the same time minimize harmful occupational and environmental health threat exposures to the Soldier, Dept of the Army civilian, and Army contractor.

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Deployment Occupational and Environmental Health Surveillance: Enhancing the Warfighter's Force Health Protection and Readiness

Jeffrey S. Kirkpatrick
LTC Christine Moser, MS, USA
Brad E. Hutchens, PE

In 1996, the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) formed the Deployment Environmental Surveillance Program (DESP). This program was formed to fulfill the USACHPPM role as the Department of Defense (DoD) executive agent for deployment occupational and environmental health (OEH) surveillance measures, databases, data analysis, and support items. The program greatly assisted in implementation of preventive medicine lessons learned following the 1991 Gulf War by focusing deployment OEH surveillance measures and archive data, reports, and assessments. An overview of USACHPPM deployment support of major US military deployments since 1991 is presented in Figure 1.

At the behest of the Army Surgeon General, the Directorate of Health Risk Management (DHRM) was formed in 2001 to enhance the readiness of the US Army. The DESP and two existing USACHPPM programs were realigned under the DHRM. The Directorate is staffed by professional scientists, engineers, and technicians who provide a wide variety of services supporting health risk management. These services enable the Army and DoD leadership to incorporate informed risk management decisions into all Army and DoD activities.

The DESP workload expanded exponentially with the increased operational tempo of the worldwide deployment of forces for Operations Enduring Freedom and Iraqi Freedom, and the global war on terrorism. This expansion included USACHPPM's designation as the DoD repository for archives of deployment OEH surveillance data. In addition, the increased workload included deployment OEH surveillance training and coordination with the Army, Navy, Air Force, and Marine Corps, and collaboration with Coalition Forces.

USACHPPM restructured the DESP in 2004 to enhance the mission focus on warfighters' readiness, support the USACHPPM strategic vision, and respond to the increased workload of worldwide deployments. The restructuring added 2 new programs under the Directorate of Health Risk Management, appropriately named the Global Threat Assessment Program and the Deployment Data Archive and Policy Integration Program. The DESP was maintained for current deployment OEH surveillance support measures. The 3 programs provide comprehensive deployment OEH surveillance measures (Figure 2) and preventive medicine support as outlined in DoD and Joint Chiefs of Staff (JCS) surveillance requirements.

The 3 restructured DHRM programs ensure timely comprehensive deployment OEH surveillance support to their broad customer base, which includes deployed preventive medicine units of the Army, Navy, and Air Force; Combatant Commands (COCOM); Component Commands; Joint Task Forces (JTF); DoD; Departments of the Army, Navy, and Air Force; Department of Veteran Affairs; Joint Staff (J4-Health Service Support Division); Office of the Assistant Secretary of Defense for Health Affairs; Office of the Deputy Under Secretary of Defense, Installations and Environment; and the Army Surgeon General.

NOTE: The remainder of this article is organized into three major sections detailing the Global Threat Assessment Program, the Deployment Environmental Surveillance Program, and the Deployment Data Archive and Policy Integration Program respectively. The references and author information for all sections are consolidated at the end of the article.

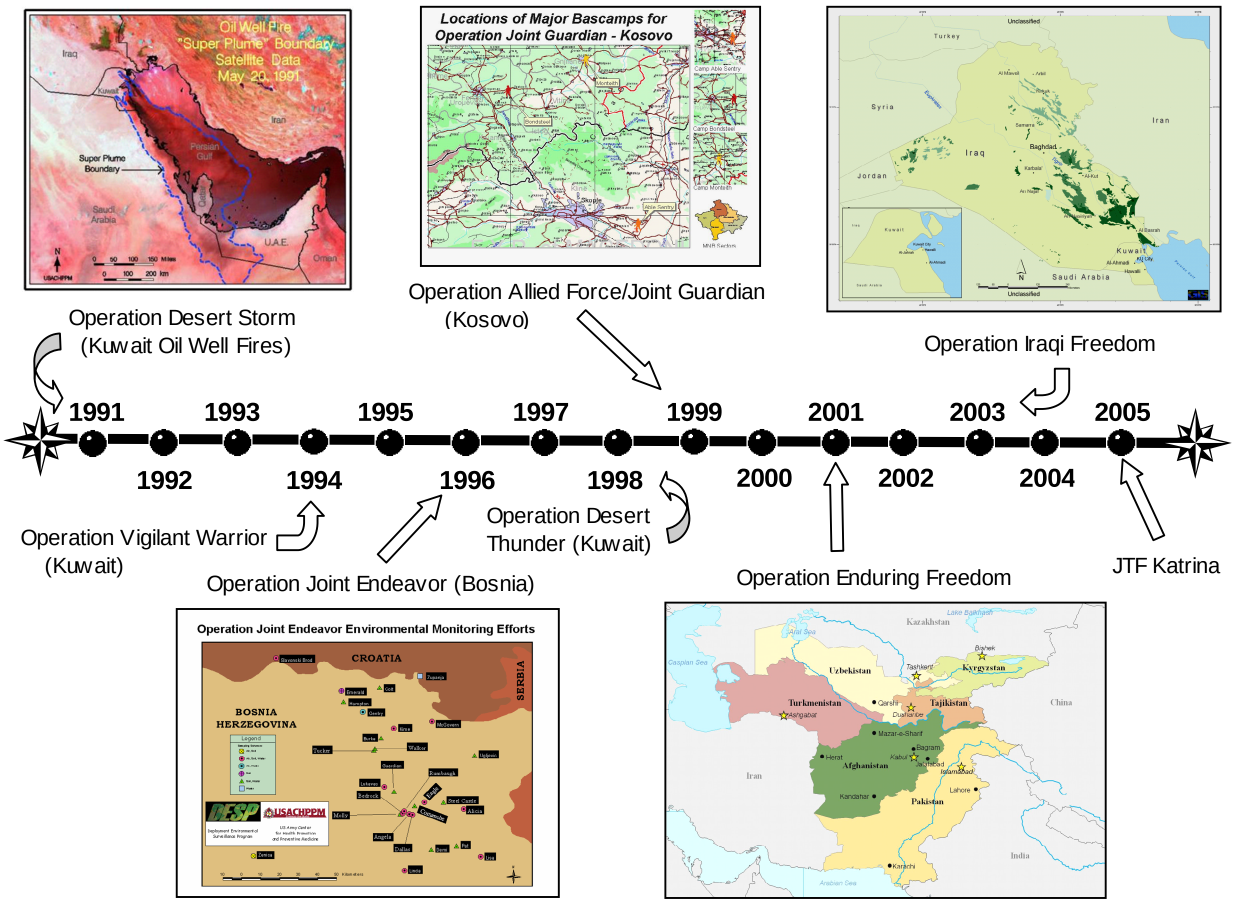

Figure 1. Overview of major US military deployments since 1991 for which USACHPPM provided deployment occupational and environmental health surveillance measures.

Global Threat Assessment Program

Jeffrey S. Kirkpatrick

Overview

The Global Threat Assessment Program (GTAP) was preceded by the Global Threat Assessment Team, which functioned from September 2003 through September 2004. Prior to that (1996 to 2002), predeployment OEH functions were performed exclusively under the DESP.

The GTAP was created to identify and assess deployment OEH hazards and threats for worldwide COCOM, Component Command, Joint Task Force, and the military services' priority deployment areas, both existing and planned. These assessments are used by the OEH surveillance activities that support the intelligence preparation of the environment during operational planning.

The GTAP works with US intelligence activities, including the Defense Intelligence Agency's Armed Forces Medical Intelligence Center, the National Geospatial-Intelligence Agency, the Army's National Ground Intelligence Center, and other domestic and overseas resources to obtain pertinent intelligence data and other products to support the USACHPPM mission.

The GTAP coordinates with theater customers to ensure that all predeployment (phase I) OEH surveillance products are expeditiously requested, produced, and disseminated. GTAP production priorities are based on the following ongoing DoD campaigns and missions:

- Global War on Terrorism
- Operation Iraqi Freedom
- Operation Enduring Freedom
- Theater transformation
- Peacekeeping/humanitarian missions

In addition, any products that are required to support a USACHPPM-based mission (eg, special medical augmentation response team – preventive medicine) are integrated with and managed against current production priorities. Finally, all products are coordinated with and validated by the requesting agency, activity, or unit, including COCOM, Component Command, and/or the military service.

The GTAP produces comprehensive, all-source (ie, information derived from all intelligence disciplines, including human, signal, imagery, and open sources) technical assessments of deployment hazards and threats to deployed and deploying US armed forces. Normally classified, the deployment hazards and threats in an assessment include:

- industrial chemicals
- historical contamination
- radiation
- infectious disease
- entomological risks
- weapons of mass destruction (chemical, biological, radiological, nuclear)
- unexploded ordnance
- specific threats identified by requirements (eg, oil infrastructure sabotage)

Both specific hazard and threat operational risk management (ORM) estimates and an integrated deployment based ORM estimate are generated using methods and procedures outlined in USACHPPM *Technical Guides 230* and *248*.[1,2]

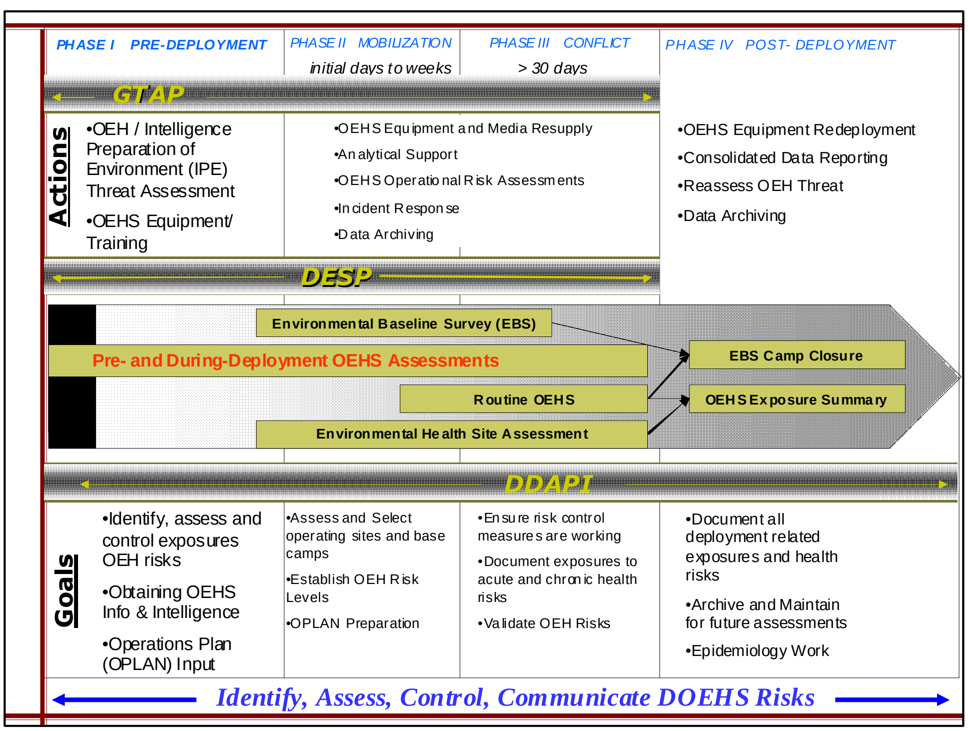

Figure 2. Tasks and goals of the deployment OEH surveillance process by phase, including the timeline of involvement of the Global Threat Assessment Program, the Deployment Environmental Surveillance Program, and the Deployment Data Archive and Policy Integration Program.

The GTAP develops pertinent input and subsections (tabs) for the medical services annex (Annex Q) of COCOM and Component Command operations plans. A recent example: tabs dealing with oil sabotage developed for the USCENTCOM Surgeon in support of operational planning for Operation Iraqi Freedom.

In addition to its forecasting and planning responsibilities, the GTAP develops and coordinates deployment OEH surveillance sample summary assessments for current military operations. The assessments help update the operational risk management estimates based on collected and analyzed deployment samples and assist in refining information on deployment hazards and threats for current and future use. The GTAP also maintains and populates the USACHPPM classified website and interactive map server on the SIPRNET (secure internet protocol router network).

Activities

As illustrated in Figure 1, from 1996 to 2002 the DESP produced and disseminated numerous predeployment OEH products in support of the planning and execution of military operations and exercises in Europe—including Bosnia and Kosovo—and southwest, central, and southeast Asia. OEH products supported Operation Enduring Freedom/Joint Forge (Bosnia); Operation Allied Force/Joint Guardian (Kosovo); Operation Southern Watch (Kuwait, Saudi Arabia); and Operation Enduring Freedom (Afghanistan, Pakistan, Uzbekistan, Kyrgyzstan, Philippines).

Since early 2003, the GTAP has provided predeployment support to COCOM, Component Commands, Joint Task Forces, various DoD secretariats, and deploying armed forces in accordance with DoD directives and JCS guidelines. The support efforts provided the deploying forces with pertinent deployment OEH surveillance assessments and information on known and potential health threats, risks, and enhanced sampling requirements for main operating bases, forward operating sites, cooperative security locations, and other known and planned locations of military interest. Commanders and staff sections (surgeon, intelligence, engineer, planners, operations, preventive medicine) use the assessments and information to plan and implement comprehensive force health protection for deploying forces. When needed, the GTAP ensures that all appropriate security classification measures are identified and coordinated with all concerned organizations.

The GTAP supports other government and allied organizations with predeployment OEH information. These organizations include the Office of the Deputy Under Secretary of Defense (Installations & Environment); the Department of State; and coalition partners (ie, Australia, Canada, and the United Kingdom).

The GTAP continues to support the worldwide military deployment operations for the global war on terrorism. Currently, the US Special Operations Command is the lead COCOM in the prosecution of this major, long term commitment. The 5 major geographic combatant commands are identifying known and potential locations of interest in their respective areas of responsibility. This includes planning for overseas bases, personnel, infrastructure, and equipment to better position US forces to strengthen allied and partner nation relationships to defeat terrorism and meet future challenges.

Concurrent with ongoing worldwide deployment planning and operations, DoD is actively engaged in global posture efforts, which focus on the restructuring of the US global defense posture. GTAP supports the DoD Integrated Global Presence and Basing Strategy which outlines the long term, comprehensive, integrated overseas strategy. In all, the locations will be identified as a cooperative security location (a host-nation facility with little or no permanent US presence), a forward operating site (an expandable host-nation site with limited US military support presence and possibly prepositioned equipment), or a main operating base (an enduring strategic base established in friendly territory with permanently stationed combat forces, command and control structures, and family support facilities). The GTAP will produce phase I assessments or deployment OEH surveillance summary assessments for identified sites as tasked.

Domestically, the US Northern Command (USNORTHCOM), established in 2002, is heavily involved with homeland defense efforts, providing military assistance to civil authorities (including consequence management operations), and maintaining theater security cooperation within their area of responsibility (mainly Canada and Mexico). The Hurricane Katrina response (2005) by DoD's Joint Task Force Katrina (under USNORTHCOM) highlighted the need for development, expansion, and integration of more comprehensive force (and public) health protection items in planning activities.

Finally, as discussed in detail in an accompanying article (page 46), the Department of the Army's Deployment Occupational and Environmental Health Risk Management (DOEHRM) program policy has 13 major elements that enable commanders to better manage their responsibilities to minimize both known and potential deployment OEH exposures to Soldiers, Department of the Army (DA) civilians, and Army contractors. The first major element identified in this policy is the protection of Army personnel, including DA civilians and Army contractors, from potential and actual exposures on the battlefield. In addition, the policy also discusses the use of operational risk management practices and ensuring that commanders are aware of and consider acute, chronic, and delayed health risks associated with occupational and environmental potential and actual exposures during all phases of Army operations and activities. The current efforts of the GTAP are in line with the overall intent of this policy. However, not all identified elements are in complete compliance, and additional resourcing efforts are necessary to realize the comprehensive intent of the DOEHRM policy.

Acknowledgement: Mumtaz Ali, Louis G. Boomsma, Mari Robinette-Deasel, Suhale M. Fathimulla, Farhana Lotlikar, and Sherri C. Whiteman contributed in the preparation of this section.

DEPLOYMENT ENVIRONMENTAL SURVEILLANCE PROGRAM

LTC Christine Moser, MC,USA

The Deployment Environmental Surveillance Program (DESP) provides coordination of technical consultative "reach-back" assistance concerning deployment occupational and environmental health (OEH) surveillance issues, operational risk management estimate assessments, and coordination of sample collection equipment. These efforts supply commanders and decision makers with pertinent deployment OEH surveillance information needed to detect, assess, and counter threats and hazards as part of the Comprehensive Military Medical Surveillance Program required by the DoD.[3]

The existing DESP mission supports the Army Deployment Occupational and Environmental Health Risk Management (DOEHRM) program (see accompanying article, page 46) by championing the collection, documentation, evaluation, and reporting of OEH sampling data in the standard operational risk management (ORM) principle format. The DESP informs commanders and decision makers, through their respective preventive medicine personnel, of the health risks associated with occupational and environmental potential and actual exposures during all phases of Army operations and activities. Armed with this OEH operational risk estimate, commanders can make informed decisions about properly mitigating the OEH risks while balancing the operational requirements of the mission.

The DESP provides coordination of technical consultative reach-back assistance concerning deployment OEH issues, sample collection equipment, media, and shipping coordination. Each discrete sampling event is interpreted and synthesized into a deployment OEH risk characterization report by utilizing the operational risk management model. The report assists commanders and preventive medicine professionals with identification, reduction, and prevention of potential OEH hazards. DESP personnel provide training assistance with regard to OEH-unique equipment and the ORM process.

The DESP is the central point of contact to coordinate and answer deployment OEH questions from personnel in both predeployment and deployed phases. DESP personnel collaborate with the technical experts within USACHPPM or other organizations as necessary to link customers with the correct answers, or the technical experts best suited to provide the answers.

Currently, the Army preventive medicine assets assigned to brigade combat teams, division headquarters, special forces groups, and preventive medicine detachments do not possess the type of equipment required to perform extensive ambient air, water, or soil sampling as part of their organic military authorized equipment. The US Central Command (USCENTCOM) developed an operating concept for theater force health protection of joint and interoperable preventive medicine support. Under that concept, the Air Force Expeditionary Medical Support units and Preventive Medicine Teams, the Navy Forward Deployed Preventive Medicine Units, and Marine Expeditionary Forces perform the OEH

Table 1. Equipment, Media, and Accessories Supplied by the Deployment Environmental Surveillance Program

Equipment	Intended Parameters
Deployment soil kits	Metals, pesticides, polychlorinated biphenyls, herbicides, semi-volatile organic compounds (SVOCs)
Deployment water kits	Metals, volatile organic compounds (VOCs), pesticides, inorganics, radionuclides
Airmetrics® Mini-Vol Particulate Sampler	Particulate matter with a diameter less than 50 μm, 10 μm, and 2.5 μm and heavy metals
SKC® pumps	VOCs
SUMMA® Canisters	VOCs
PS-1 high volume ambient air sampler	Dioxins, furans, SVOCs, pesticides, Polycylic aromatic hydrocarbons

surveillance mission. Table 1 presents the variety of deployment sampling equipment, media, and administrative accessories supplied to the tri-Sservice preventive medicine assets by DESP.

Additionally, the DESP supplies sampling media and supplies including preservatives, gloves, coolers, small tools, barometers, thermometers, etc. Although many preventive medicine units possess global positioning systems (GPS), DESP provides GPS equipment that is dedicated to tracking the location of air, water, and soil samples for future geospatial mapping. DESP personnel can also assist with developing a site-specific sampling plan.

As detailed in Table 2, between May 1991 and April 2006, the DESP provided worldwide equipment and lab analysis interpretation of approximately 17,000 deployment samples. It should be noted that although the USCENTCOM theater of operations sample numbers are themselves robust, DESP OEH surveillance responsibilities extend to the European Command, the Pacific Command, the Southern Command, USNORTHCOM, and the Army Special Forces Command. For example, between 1999 and 2006, a total of 120 air, water, and soil samples were collected from the Dominican Republic, El Salvador, Honduras, Nicaragua, Dominica, Guatemala, Guyana, Haiti, and Panama.

The deployment OEH risk assessment reports for the samples listed in Table 2 are created using the operational risk management doctrine included in Army *Field Manual 100-14*[4] and the relatively conservative (protective) assumptions and methods contained in the USACHPPM *Technical Guide 230*[1] to facilitate decision-making that can minimize the likelihood of significant risks. The DESP facilitates integration of medical threats into mission risk assessments as described in the USACHPPM *Technical Guide 248*.[2]

DESP supplies sandfly and mosquito surveillance equipment and media to the tri-Service preventive medicine resources involved in Operations Iraqi Freedom and Enduring Freedom. Mosquito and sandfly surveillance is performed by USACHPPM laboratories to analyze vectors that significantly impact readiness by transmitting disease (malaria and lieshmaniasis, respectively), analyze specimens for infectivity of the organism, and impact the outcome of the operational chemoprophylaxis policy.

Tri-Service preventive medicine personnel typically perform the air, water, soil, and vector surveillance functions in deployed settings. However, the USACHPPM can deploy a Special Medical Augmentation Response Team – Preventive Medicine (SMART–PM) upon request and validation by the corresponding component command surgeon's office for an identified deployment OEH surveillance mission requiring subject matter expertise, intense time commitment, and dedicated focus. The scope of the team's expertise is tailored to meet the mission requirements. The DESP civilian OEH surveillance subject

Air sampling in Kuwait

Table 2. Deployment Occupational and Environmental Health Surveillance Samples for the period May 1991 Through April 2006

Operation or Exercise	Time Period	Deployment Samples	Geographic Area (Type Samples)
Desert Storm	1991	5,000	Kuwait and Saudi Arabia; Kuwait Oil Well Fires (air, soil, industrial hygiene)
Southern Watch	1992–2002	650	Kuwait, Qatar, Saudi Arabia (air, water, soil, industrial hygiene, bulk, asbestos)
Vigilant Warrior	1994	125	Kuwait, Saudi Arabia (air, water, soil, industrial hygiene)
Desert Focus	1996	250	Saudi Arabia (air, water, soil, industrial hygiene, asbestos)
Joint Endeavor Joint Forge	1996–2005	2,250	Bosnia (air, soil, water)
Desert Thunder	1998	225	Kuwait (air, water, soil)
Allied Force	1999	25	Albania, Macedonia (water, noise)
Joint Guardian	1999–2005	840	Kosovo (air, soil, water, other)
Native Atlas	1999	100	Kuwait (air, soil, industrial hygiene)
Eastern Castle	2000	25	Jordan (soil)
New Horizons	1999–2006	120	Dominican Republic, El Salvador, Honduras, Nicaragua, Dominica, Guatemala, Guyana, Haiti, Panama (air, water, soil)
Joint Interagency Task Force (Drug Interdiction)	1999–2006	131	Colombia, Ecuador, El Salvador, Netherland Antilles, Antigua, Belize, Bolivia, Costa Rica, Guatemala, Nicaragua, Panama, Peru (air, water, soil)
Tradewinds	1999–2006	19	Antigua and Barbuda, Barbados, Dominican Republic, Ecuador, Jamaica, St Kitts and Nevis (water, soil)
Joint Task Force Bravo	1999–2006	125	Soto Cano Air Base, Honduras (air, water, soil)
Enduring Freedom	2001–2006	1,590	Afghanistan, Pakistan, Uzbekistan, Kuwait, Philippines, Cuba, Ethiopia, Kenya, Kyrgyzstan, Pakistan, Saudi Arabia, Uganda, Uzbekistan (air, water, soil, industrial hygiene)
Iraqi Freedom	2003–2006	5,503	Iraq, Kuwait, UAE, Qatar (air, water, soil, industrial hygiene)
Joint Task Force Katrina/Rita	2005	164	Louisiana, Mississippi (air, water, soil)
Total		17,142	

Water sampling in Iraq

matter experts have often augmented the SMART–PMs, including recent missions to Afghanistan, El Salvador, Haiti, Hurricane Katrina, Iraq, Kosovo, Kuwait, and Uzbekistan.

In portions of USCENTCOM's area of responsibility, concentrations of airborne particulate matter less than 10 µm in diameter are predominantly at levels much higher than normally encountered in the United States. The primary source of this particulate appears to be windblown dust and sand. Not enough information is currently known about the chemical and physical characteristics to determine whether short- or long-term health effects could be expected from exposure to these high particulate concentrations. Therefore, DESP partnered with the National Oceanic and Atmospheric Administration, Natural Environmental Test Office,* USCENTCOM, and the Desert Research Institute (DRI) for a year-long study to better distinguish the particulate matter by both physical (size, shape, geomorphology) and chemical (metals, elements, carbon ratios, silica content) characterization. The DRI will compare this data to existing desert research data from Operation Desert Storm (1991) and other US and worldwide locations.

For deployment locations requiring more intensive, continuous surveillance, the Mobile Ambient Air Monitoring Station provides continuous surveillance of US Environmental Protection Agency criteria pollutants, including carbon monoxide, sulfur dioxide, nitrogen oxides, ozone and particulate matter less than 10 µm in diameter. This suite of equipment transmits near-real-time data over the internet, allowing remotely located DESP personnel to compile operational risk management estimates. DESP and Air Quality Program personnel provide periodic onsite service in deployment settings to train personnel, install upgraded equipment, reposition the station to a new location, and establish real-time deployment OEH surveillance data connectivity. Currently, one station is located in a USCENTCOM operating location. Other stations are available for deployment as required.

Mobile Ambient Air Monitoring Station in Kuwait

In summary, the ongoing DESP mission remains operationally relevant by augmenting tactical preventive medicine assets with deployment OEH surveillance-unique collection equipment, shipping, lab analysis coordination, and interpretation. The subsequent OEH ORM estimate upholds the Army DOEHRM program, in which commanders make informed decisions about identification of deployment OEH health hazards and risk mitigation measures. Armed with this knowledge, decision makers can successfully execute their operational mission while protecting the health of deployed forces during the entire spectrum of the military operations.

Soil sampling during deployment in Louisiana (Joint Task Force Katrina)

*Activity of the US Army Developmental Test Command (http://www.dtc.army.mil/capabilities/enviro.html)

Acknowledgement: John Kolivosky, Chris Weir, and James Sheehy contributed in the preparation of this section.

DEPLOYMENT DATA ARCHIVING AND POLICY INTEGRATION

Brad E. Hutchens

Prior to the reorganization of the Deployment Environmental Surveillance Program (DESP) in 2004, information technology development and policy integration were the responsibility of DESP. As a part of the restructuring, the Deployment Data Archiving And Policy Integration (DDAPI) Program was established to develop an information technology system capable of capturing and archiving occupational and environmental health (OEH) data, as part of a Comprehensive Military Medical Surveillance Program. This program, illustrated schematically in Figure 3, is mandated by Department of Defense (DoD) directives, Department of the Army Policy, and Joint Staff Memorandum to ensure the effective analysis and dissemination of data. The DDAPI is responsible as an agent of the Army to "Provide for the assembling and archiving of all DoD deployment and environmental health surveillance data and reports." as required by DoD directive.[4(p5)]

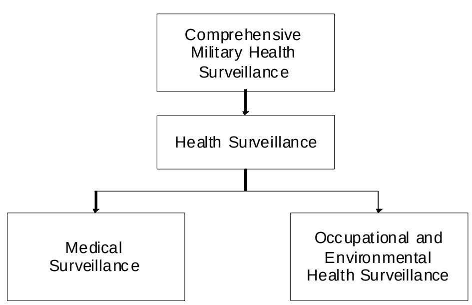

Figure 3. The Comprehensive Military Health Surveillance Program

In addition, the DDAPI Program is responsible for integrating OEH into Army Preventive Medicine through the Doctrine, Organization, Training, Logistics, Materiel, Personnel and Facilities model, with primary emphasis on the Doctrine, Training and Materiel aspects.

To meet this responsibility, the DDAPI, in coordination with the Defense Occupational and Environmental Health Readiness System (DOEHRS) has developed the Occupational and Environmental Health Data Portal (OEH-DP).[5] The OEH-DP is a password protected internet site that allows registered users to submit and retrieve documents and other electronic files associated with OEH activities.

In addition to maintaining the OEH-DP, the DDAPI Program is responsible for developing an information technology system to capture, process, analyze, interpret, and report all OEH data. Examples of this data include, but are not limited to, environmental samples (air, water, soil), entomological data, sanitation surveys, and waste management surveys. To accomplish this, DoD is expanding the current capabilities of DOEHRS Industrial Hygiene (DOEHRS-IH) to capture and manage the types of data outlined above. The DDAPI, in conjunction wit the other armed services, is developing the system requirements needed to expand the capability of DOEHRS-IH. The goal is to have a single system for environmental and occupational health surveillance data for both deployment and garrison conditions.

The DOEHRS-IH is only one part of comprehensive medical surveillance and will be linked to other military health systems such as the Armed Forces Health Longitudinal Technology Application.[6] These systems will work together to provided a longitudinal health record for all military personnel from the time they enter military service until they separate.

In addition, the DDAPI is assisting in the development and integration of doctrine, training, and material requirements for OEH for the Army. The program, along with the Navy and Air Force, worked to develop ASTM E2318-03,[7] which standardizes the process to evaluate sites used by US military personnel. The DDAPI is the proponent for US Army Center for Health Promotion and Preventive Medicine (USACHPPM) *Technical Guides 230* and *248*.[1,2]

The DDAPI provides OEH training to a wide variety of DoD agencies and personnel. The training includes sampling techniques, operational risk management, entomological surveillance, radiation protection, risk communication, and situational training exercises. The training is conducted using a wide variety of USACHPPM subject matter experts and is coordinated with other agencies and armed services for consistency across the Department of the Army and DoD.

Material solutions are developed to assist preventive medicine personnel in the collection of OEH samples. The DDAPI personnel are constantly investigating commercial-off-the-shelf equipment that can provide more effective and efficient ways to acquire OEH data. Also, existing sampling methods are reengineered to meet the needs of a deployed military force by making existing equipment and sampling media lighter, smaller, simpler to operate, and more rugged. Examples of this include the deployment water and soil sampling kits (Figures 4 and 5) and the Deployment Environmental Surveillance Backpack (Figure 6).

Figure 6. Environmental Surveillance Sampling Backpack

DDAPI personnel also participate in several DoD and international work groups. This participation allows

Figure 4. Deployment Potable Water Sampling Kit

Figure 5. Deployment Soil Sampling Kit

technology to be leveraged across the DoD and the international community, bringing together OEH surveillance data from throughout the Armed Services and International coalitional partners.

As discussed in detail in an accompanying article (page 46), the Department of the Army's Deployment Occupational and Environmental Health Risk Management program policy has 13 major elements that enable commanders to better manage their responsibilities to minimize both known and potential deployment OEH exposures to Soldiers, Department of the Army civilians, and Army contractors. All of the elements require OEH data to be captured, processed, analyzed, interpreted, and reported, which is the mission of the DDAPI program.

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THE US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE

Making the Modern Army Public Health Nurse: Establishing Essential Service Skills

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As times change, the defined roles for some military occupations must also change. One field where this has become evident is in the field of Army Public Health Nursing, Area of Concentration (AOC) designation 66B. The need for transformation is apparent from the recent name change for the 66B (Public Health Nurse), previously Community Health Nurse. Traditionally, the role of the Army Public Health Nurse (APHN) has been defined in terms of program management sets. The AOC was originally created in 1949 to run a planned program geared to assist new parents adjust to family life, with the overall goal of decreasing emergency room utilization. The scope of practice quickly widened to programs focusing on family-centered services and communicable disease case management.[1] Over time, the AOC 66B incorporated many more programs, including the identification or labeling as the Latent TB Infection (LTBI) program manager, the Sexually Transmitted Infection (STI) clinic director, the HIV/AIDS program administrator, the health consultant to the Child and Youth Services, or the Health Promotion Center manager. Other more local program titles might be In-Out Processing Center manager, Pregnant Soldier Physical Training Program director, or the Smallpox Vaccination coordinator. Sometimes one might wonder if the APHN is being asked to function as a specialty practicing nurse or as a nurse program administrator.

The incorporation of the previously mentioned programs as responsibilities of the AOC is not really the issue. The APHN can certainly function in those areas, and should maintain those duties. However, they have found themselves pigeon-holed into those program roles. Many of those responsibilities are not required during deployment, or at the least in a full time capacity. The APHN could be deployed being completely unsure of what will be expected. This uncertainty is understandable since much of the previous training and job descriptions have been geared towards running those programs.

A medical command group will naturally attempt to optimize use of their assets in a deployed setting. In the case of the Army Public Health Nurse, they must consider any value that is realized when this resource is assigned those traditional programs of the APHN in garrison. They know there is no need for a child and youth health consultant because there are no Child Development Centers. They are not interested in the establishment of an HIV/AIDS program. They probably do not see the need for in and out processing of Soldiers through the medical treatment facility. STI and LTBI can be followed in the acute care setting in a combat support hospital or a battalion aid station under established standard operating procedures. The environment of deployment probably explains why the deployed APHN is often tasked to function within the scope of the general medical-surgical nurse AOC on the intermediate or the minimal care ward. The command often sees that task as the most appropriate use of a nurse in a deployed environment. However, in making such assignments, commanders fail to fully exploit the valuable skills of the Public Health Nurse.

The role of the APHN in the increasing involvement of the Army in humanitarian efforts and civil-military operations is another factor to consider in Army Public Health Nurse training. The AOC 66B has been proposed to fill two slots within a civil affairs (CA) section of the Medical Deployment Support Command. Under the responsibilities expected of the CA section, there is little need for the APHN to function within the traditional roles or programs of that AOC. Instead, the Army Public Health Nurses will be expected to apply their skills as public health officials.

It is within this evolving environment that the APHN basic skill set must change to meet the changing needs of the Army, but at the same time maintain familiarization with the traditional programs still expected of the APHN in garrison. To accomplish this, it is important that we start looking at the APHN profession, not as program managers, but as skilled professionals that have much to bring to Preventive Medicine, Force Health Protection, and military operations. Recently, leadership in the APHN field has identified the direction to take regarding the APHN future practice.[2] They have established a vision of ready and fit Soldiers prospering in healthy military communities. The overall goal is to realize this vision and to align the 66B AOC with the American Nursing Association's (ANA) understanding of the skill sets required by a public health nurse to accomplish the job. For the APHN, this skill set should be used under any number of situations, including garrison, deployed settings, civil-military operations, and even local emergency response conditions.

The knowledge-based skill set recognized as the base foundation to practice as an Army Public Health Nurse has come to be known as the APHN-Public Health Essential Services. The 10 services are built directly around the work of the National Public Health Performance Standards Program.[3] It supports the 3 core public health functions (assessment, policy development, and assurance) modeled by the Association of State and Territorial Directors of Nursing Public Health Nursing Practice Model,[4] with the intent to standardize practice according to the ANA. The essential services, listed below, are those that the APHN is expected to perform under any situation requiring community-based health interventions and public health nursing efforts:

1. Monitor health status to identify community health problems.
2. Diagnose and investigate health problems and health hazards in the community.
3. Inform educate and empower people about health issues.
4. Mobilize community partnerships to identify and solve health problems.
5. Develop policies and plans that support individual and community health efforts.
6. Enforce laws and regulations that protect health and ensure safety.
7. Link people to needed personal health services and assure the provision of health care when otherwise unavailable.
8. Assure a competent public and personal health care workforce.
9. Evaluate effectiveness, accessibility, and quality of personal and population-based health services.
10. Research new insights and innovative solutions to health problems.

Health fairs are perfect examples of how Army Public Health Nurses can educate and inform the public and mobilize community partnerships. During their training in course 6A- F5, the APHNs are deeply immersed in the development and presentation of a health fair which will typically host 200 to 300 clients with 12 to 15 vendors.

To implement these skills, it is imperative that the initial training for the Army Public Health Nurse includes fundamental development and understanding of these essential service expectations. Presently, to become an Army Public Health Nurse, a Registered Nurse is required to attend the Principles of Military Preventive Medicine (6A−F5) course within the Army Medical Department (AMEDD) Center and School. Adjustments have been and continue to be made to the skill sets training in the 6A−F5 course, especially the nurse track phase, to accommodate this paradigm shift in Army Public Health Nursing.

The greatest change came in 2003, when a number of hours in the HIV/AIDS certification material were removed from the program. Though the topic is relevant to the 66B AOC, the depth was much greater than necessary when viewed in light of practical expectation of future application as an APHN. Though 6 hours of HIV/AIDS material are still provided, elimination of this and some other material freed up nearly 30 hours for additional course work.

During the 6A-F5 course, Army Public Health Nurses work with other Preventive Medicine Officers on issues that today's Soldier may face in a deployed setting. Cross-training, thorough investigations, and command briefings are emphasized during the training period.

The available time is used to focus on the essential skill sets and projected roles of the APHN in a deployed setting. Along with introduction to some other programs, classes that focused on developing skills applicable to public health nursing were incorporated into the curriculum. Training in many skills was expanded. Classes on the Planned Approach To Community Health and the PRECEDE/PROCEED models[5] were introduced as tools for community assessments and setting health objectives for the community. Conducting a community health assessment is the primary skill that the APHN will need. The skill set includes collection of data, analysis of information, and determining risks and resources within the population. The assessment establishes the foundation of all the other APHN responsibilities. The assessment must not only consider the health of the population, but also recreation, education, safety, and economics. The professional skills background in nursing and the ability of nurses to build partnerships and mobilize the community make the APHN assessment different from other Preventive Medicine assessments.

Additional courses on etiology and epidemiology on many of the newer diseases of military importance are now included to improve competence in this critical area. A sample of these useful topics includes emerging infectious diseases, such as West Nile virus, avian influenza, and leishmaniasis. Another contemporary issue is exposure to biological agents and environmental hazards during deployment. It is important that the APHN is able to discuss these issues in the military context, and also have an awareness of the concerns of individuals who face potential exposure, as well as those of family members worried about their Soldiers.

To facilitate the changing role of the APHN, completely new material was introduced into the curriculum. The APHN now receives 12 hours in civil affairs, rapid health assessments, nutritional considerations in disaster relief, preventive medicine support in contingency operations, and PM operations with detainees. This course material was added to help the APHN incorporate the essential services and public health core functions into military operations other then war, in particular humanitarian assistance and disaster relief. The material is there to stimulate student thinking about the APHN role in a deployed setting. The student must understand that although the responsibilities during deployments are different in many ways from those in garrison, basic skills are applied the same way. The APHN must assess the deployment setting for risk and potential health concerns, and identify resources. Interventions, programs, and policies must then be instituted to decrease the risks and to link specific populations with the proper programs and resources in the area of concern. Lastly, the setting must be evaluated for the effectiveness of efforts and changes in the community. The population might be different, but the essential service skill set does not change.

Army Public Health Nurse training often includes understanding responsibilities not traditionally nursing in nature. Here, two student APHNs identify mosquitoes in an effort to manage a notional malaria threat.

Good presentation skills are necessary for the APHN to inform, educate, and empower people. Public speaking is vital to informing commanders of current issues, instructing personnel to insure a competent public health system, and supporting regulations. The presentations of medical threat briefs and aggregate health promotion education are the principal means for the prevention of disease and nonbattle injury in the Army. The APHN exposure to public speaking skill development has nearly doubled with recent changes in the nurse track of the 6A−F5 course.

Public speaking as a means of informing and educating the community and assuring competency among other health care workers is essential in the development of the Army Public Health Nurse.

Another increasing role for preventive medicine is in homeland security and local disaster response plans. The APHN is now given exposure to the issue and made aware of the potential need for public health nurse involvement in response plan development and postevent action. They are taught this with a special emphasis on biological threat responses, communicable disease outbreak responses, and preventive medicine support. Once again, in this environment, the APHN must be able to incorporate the essential service skills to manage the community under any of the potential situations.

There are, of course, many previous topics in the 6A−F5 course which are still integral parts of the training of the APHN. Some of these broad topics include epidemiology, outbreak investigations, occupational and radiological exposures, environmental quality, medical entomology, data management, and risk communication. No modifications have specifically been made to this material, but the nurses are challenged to see how this material is applicable within their scope of practice, and how it relates to the essential service skill set they are assimilating. The APHN also participates in a Preventive Medicine Operation and Field Training Exercise at the end of the course. They are immersed in a simulated deployed setting with other preventive medicine disciplines and are expected to incorporate their proficiency in issues that might occur in a field environment.

The modifications to update the role of the APHN also come at a critically vital time for the AMEDD. The capabilities of officers in other professional AOCs within Army Preventive Medicine are enhanced by the deployment of the skilled APHN in the operational setting. Whether at a combat support hospital or within a civil affairs unit, the assessment skills of the APHN can be invaluable to other nurses, physicians, physician assistants, and other AOCs, including Environmental Science Officers (ESOs), Environmental Engineers, Audiologists, Nuclear Medicine Science Officers, and Medical Entomologists. Greater numbers of ESOs are now assigned at the brigade level to enhance surveillance capabilities within a division. The APHN can now work hand in hand with ESOs at the brigade level and with preventive medicine physicians who are often assigned to the division surgeon section. This allows the APHN to act as an effective force multiplier for preventive medicine in this setting.

The changes in the program have been geared toward the modernization of the Army Public Health Nurse. The APHN brings educational expertise and professional nursing skills into the Army Preventive Medicine arena. Their background in the holistic nursing process helps fuse the environmental aspects with the individual factors associated with public health. They understand human responses to exposures and to the diseases that might occur. They can bridge the gap between data availability and practical utilization of these data. The public tends to trust the nurse in situations where they might be reluctant to accept words and messages from someone else. Therefore, the Army Public Health Nurses find themselves well placed in situations to bring public health education, compliance, and agreement on the focus of preventive medicine to benefit our most important asset – the Soldier.

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The new logo emphasizes the modern paradigm of today's Army Public Health Nurse as a specialty practicing nurse, not a program manager.

Force Health Protection Through Laboratory Analysis and Health Risk Assessment

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INTRODUCTION

The US Army's 1st and 9th Area Medical Laboratories (AMLs) provide the Department of Defense (DoD) with a Force Health Protection (FHP) capability. FHP is a strategy using preventive health techniques and emerging technologies in environmental surveillance and combat medicine to protect all service members before, during and after deployment.[1] The mission of the AML:

> On order, deploy worldwide and conduct health hazard surveillance for biological, chemical, nuclear, radiological, occupational/environmental health, and endemic disease threats at the theater level to protect and sustain the health of the force across the full spectrum of military and domestic support operations.

Through the use of sophisticated analytical instrumentation combined with health risk assessment by medical and scientific professionals, the AML performs field confirmation of environmental exposures associated with the contemporary operating environment. The execution of this mission provides the warfighting commander with the critical information requirements needed to mitigate or eliminate health threats during the operational risk management process.

The 1st and 9th AMLs are the only deployable laboratories in the US Army's inventory capable of providing health hazard surveillance through a robust analytical capability. Both AMLs are an Echelon Above Corps level asset assigned to 44th Medical Command and XVIII Airborne Corps. This relationship exists primarily to provide command and control, however, both AMLs can provide FHP support to Army, joint, or combined forces. The AML is authorized 43 personnel, however, only 30 personnel are required by the Modified Table of Personnel and Equipment and are available at all times. The 13 personnel not permanently assigned to the unit are PROFIS (Professional Filler System) assigned to US Army Medical Command (MEDCOM) organizations. The organizational structure of the AML consists of the Headquarters, Occupational/Environmental Health, Nuclear/Biological/Chemical, and Endemic Disease Sections. The unit personnel represent a wide range of scientific military occupational specialties, therefore, both the 1st and 9th AMLs are capable of providing the comprehensive health hazard surveillance typically associated with MEDCOM's fixed facilities.

The home station of the AMLs is Edgewood Area, Aberdeen Proving Ground, Maryland. This location was chosen due to the reliance of the 1st and 9th AMLs on MEDCOM for sustaining Soldier technical proficiency. The AMLs draw upon the following organizations for the scientific expertise, technical training, assistance, and consultation:

- US Army Center for Health Promotion and Preventative Medicine (USACHPPM),
- US Army Medical Research Institute for Chemical Defense (USAMRICD)
- Walter Reed Army Institute for Research (WRAIR)

Due to the proximate location to these organizations, the AMLs can easily leverage and stay current with the emerging technologies necessary to perform their FHP mission.

HISTORY

The Army has activated and inactivated both the 1st and 9th AMLs several times. Both laboratories supported campaigns in World War II. The 1st AML participated in investigations in North Africa and the European Theaters of Operation. The 1st AML also participated in campaigns of the Korean War and the Vietnam War. The 9th AML participated in the China-Burma-India Theater during World War II and participated in 15 campaigns in the Vietnam War. The Army activated the current version of the 1st and 9th AMLs in September 2004. The Army based both AMLs on the structure of the 520th Theater Army Medical Laboratory (TAML) which was inactivated on the same day. The history of the 520th TAML is similar to the AMLs with participation credit for Vietnam, Bosnia, and Operation Iraqi Freedom.

Transformation of the 520th TAML to the 1st and 9th AMLs did little to change the mission. The Army expects both units to execute the same level of surveillance as the 520th TAML performed in support of Operation Iraqi Freedom. The chain of command for both the 1st and 9th AMLs runs through the 44th Medical Command, the XVIII Airborne Corps, and the US Army Forces Command. The Army preserved this chain of command during the conversion from the 520th TAML. The personnel of both units are largely enlisted Soldiers of the 91 (now changed to 68) military occupation specialty series and a sergeant major is the highest ranking noncommissioned officer. In addition to the commander, 5 officers provide leadership to the AML. The Army equips both AMLs with tactical equipment that enable the units to move and survive in a tactical environment. Each AML has organic transportation assets including 5-ton trucks, FMTVs (Family of Medium Tactical Vehicles), and HMMWVs (High Mobility Multipurpose Wheeled Vehicles). The AML conducts laboratory operations in TEMPERs (Tent, Extendable, Modular, Personnel), and Isolation Facilities. Each AML can supply all the power needed for its own continuous operations.

Both AMLs retained headquarters at Aberdeen Proving Ground, the location of the former 520th TAML's headquarters. Since the endemic disease section has a close relationship with US Army Medical Research Institute for Infectious Disease (USAMRIID), both AMLs stationed this section of their units at Fort Detrick, Maryland. The AMLs retained the same close relationship that the 520th TAML established with USACHPPM, USAMRICD and USAMRIID. Combined, these centers provide most of the technical training needed by each AML. These centers also provide PROFIS personnel and controller/observers to evaluate the performance of each AML on field exercises.

CAPABILITIES

The personnel and equipment organizational structure of the AML places great challenges upon the AML to perform logistical and maintenance operations. Based upon the Modified Table of Organization and Equipment (MTOE), the AML is approximately 35% mobile. If and when called upon to provide support in a theater of operation, the AML would require transportation assets to move all assigned equipment and personnel. Under the new MTOE following the Medical Reengineering Initiative, the AML lost key support military occupational specialties (MOS) formerly available in the 520th TAML. The most significant losses were the Supply Sergeant (MOS 92Y20), Utilities Equipment Repairman (52C10), and the Medical Equipment Repairman (91A20).

The AML Headquarters provides command and control functions, operational planning, administrative and logistics support to the unit. The headquarters is staffed by the commander, executive officer, sergeant major, medical operations officer, medical supply sergeant, administrative specialist, wheeled vehicle mechanic, and a cook.

Occupational and Environmental Health Section

The Occupational and Environmental Health (OEH) Section of the AML provides comprehensive environmental health threat assessments by conducting air, water, soil, entomological, epidemiological, and radiological surveillance and laboratory analyses. In support of this mission, the OEH Section conducts analysis in 4 areas: environmental health, industrial hygiene, radiological assessment, and entomology.[2-4]

The OEH Section monitors air quality for particulate, inorganic, and organic contaminants. The Section employs high volume, mid volume and low volume air sampling equipment capable of collecting particulate samples PM-10 (Particulate Matter 10 μm), PM-2.5 (2.5 μm), TSP (Total Suspended Particulates), and inorganics (ie, heavy metals). Sorbent tubes and polyurethane foam sampling systems are utilized to collect ambient and breathing-zone samples of volatile and semivolatile organics. The OEH Section presumptively determines particulate samples and sends these and inorganic samples to a laboratory in the United States for confirmatory analysis. The NBC Section receives the sorbent tubes collected by OEH Soldiers and analyzes the tubes using gas chromatography coupled with either mass selective detector, electron capture detector (ECD) or flame photometric detector (FPD).

The OEH Section executes comprehensive water quality surveillance. The OEH Section conducts inorganic analysis using ultraviolet and visible light spectroscopy and measures most inorganic water contaminants absorbance readings taken after addition of applicable reagents or in conjunction with other isolation and extraction procedures and reagent kits. The OEH Section detects, identifies, and measures concentrations of lead and copper in potable water with an electrochemical device which utilizes anodic stripping voltammetry. The method is specific for lead and copper and is free from all known interferences typically found in potable water. Organic analysis is conducted using either a portable gas chromatograph/ mass spectrometer (GC/MS) or a benchtop GC/MS/ ECD/FPD. To detect bacteriological contamination in water, the OEH Section utilizes presence/absence techniques, membrane filtration, most probable number, and heterotrophic plate counts. To further identify nonfecal coliforms or other problematic bacteria, the Section can forward collected samples to the Endemic Disease Section for analysis.

Soil sampling and analysis for the detection of volatiles, semivolatiles, inorganics, metals, and biologicals is also possible. The OEH Section uses traditional soil sampling equipment and techniques to obtain surface and subsurface soil samples. The Section has the capability to conduct some limited, on-the-spot colorimetric and electrochemical testing for PCBs (polychlorinated biphenyls) and PAH (polycyclic aromatic hydrocarbons), but most chemical soil analysis is conducted by the NBC Section using head-space analysis with the portable GC/MS or solvent extraction with analysis on the benchtop GC/ MS/ECD/FPD.

The OEH Section deploys a robust radiological surveillance capability. The Section uses numerous high volume particulate samplers and collects filters for radiological analysis. The Soldiers analyze these samples and collected soil samples using multichannel scaling spectroscopy. The Section also has a handheld radiation spectrometer/identifier, dose-ratemeter, and nuclide finder in addition to multiple radiac meters with probes for measuring alpha, beta, and gamma radiation. The Section analyzes wipe samples and water samples using a liquid scintillation counter. The Soldiers also employ dosimeters to manage their own exposures as well as occupational exposures of those working in and around radiation hazards. Further, besides detecting, identifying, and measuring ionizing radiation, the Section also has the capability to detect and measure nonionizing radiation hazards.

The OEH Section conducts industrial hygiene surveys. Using multigas electrochemical analyzers, photoionization detectors, infrared gas analyzers, and sampling pumps with filters and/or sorbent tubes, the Section identifies potential chemical hazards in the workplace. Noise meters, noise dosimeters, thermal environment monitors, ventilation meters, and particle counters help to characterize the physical environment and indoor air quality. Utilizing portable GC/MS and portable Fourier Transform Infrared Spectroscopy technology, the OEH Section responds and qualitatively identifies many unknown solids, liquids and gases.

The OEH Section contributes expertise in medical entomology, another vital discipline. The Section collects and identifies arthropods, rodents, and poisonous plants of military importance, and also raises mosquito larvae for accurate species identification or potential insecticide resistance studies. The Section prepares and forwards specimens to the Endemic Disease Section for real-time or traditional polymerase chain reaction analysis to detect and identify medically relevant vector-borne diseases.

The OEH Section's strength is the ability to conduct complete worksite and ambient environment evaluations to detect and identify the hazards present in the full spectrum of media, air, soil, water, physical environment, arthropods and rodents. These comprehensive evaluations provide the data necessary to conduct accurate and thorough environmental health site assessments.

Nuclear Biological and Chemical Section

The capabilities of the Nuclear/Biological/Chemical (NBC) Section include cholinesterase activity measurement, microbial identification, GC/MS/ECD/ FPD, a mobile laboratory and telechemistry. These capabilities allow the Section to monitor for chemical weapons of mass destruction and a wide variety of toxic industrial chemicals, as well as to conduct microbial identification using an independent method that compliments the capabilities of the Endemic Disease Section. The NBC Section works closely with both the OEH and Endemic Disease Sections. The NBC Section analyzes many samples collected by the OEH Section. Similarly, the NBC Section analyzes microbes cultured and incubated by the Endemic Disease Section. The technicians of the NBC Section execute all of the capabilities in an isolation facility (ISOFAC). The Soldiers set up the ISOFAC using an expandable, 2-sided shelter attached to 2 sections of TEMPER. Some of the capabilities can be executed in the mobile laboratory mounted in a shelter unit on the back of a M1097 HMMWV.

The NBC Section provides confirmatory analysis of exposure to nerve agents and toxic industrial compounds (organophosphorus pesticides) by measuring acetylcholinesterase (AChE) activity in Soldier blood samples. Technicians use the Test-mate ChE Test System (EQM Research, Inc, 2814 Urwiler Ave, Cincinnati, Ohio, 513-661-0560) to perform the tests for AChE. The ability of the Test-mate ChE Test System to determine AChE activity under field conditions was evaluated several years ago by the 520th TAML in conjunction with USAMRICD. To mimic nerve agent exposure, USAMRICD spiked blood samples with variable amounts of soman. Blinded to the identity of the samples, the 520th TAML tested the samples during a field training exercise. The technicians accurately identified all of the samples and quantified the AChE activity.[5]

The NBC Section provides confirmatory analysis of microorganisms including aerobic bacteria anaerobic bacteria and yeasts using the MIDI Sherlock Microbial Identification System (MIDI, Inc, 125 Sandy Drive Newark, Delaware, 800-276-8068). The MIDI analysis system is based on fatty acid profiles and contains reference profiles for thousands of microorganisms. This technique provides an identification that is independent from other techniques used by the Endemic Disease Section.

The NBC Section provides confirmatory analysis of air, water, wipe, and soil samples using an Agilent 6890N GC (Agilent Technologies, Inc, 395 Page Mill Road, Palo Alto, California, 650 752 5303). The technicians extract water, wipe, and soil samples. Mass spectra frequently provide a unique fingerprint identification of chemicals. Using the retention time and the mass spectrum, technicians can often identify a chemical based solely on the results of GC-MS. The other detectors, the ECD and FPD, provide analysis for much lower concentrations of threat chemicals. The ECD detects compounds containing halogens and other electrons withdrawing groups at levels much lower than the mass selective detector (MSD). The FPD provides much greater sensitivity for compounds containing sulfur and phosphorous than the MSD. Soldiers of the NBC Section also conduct GC-MS with a portable instrument called HAPSITE (Inficon, Inc, Two Technology Place, East Syracuse, New York, 315-434-1100). Using the HAPSITE, Soldiers can commence analysis with less than an hour setup time

The 520th TAML constructed a mobile NBC laboratory from a shelter unit mounted on a M1097 HMMWV, equipped with a GC-MS, glovebox and Ruggedized Advanced Pathogen Identification Device® (Idaho Technology Inc, 390 Wakara Way, Salt Lake City, Utah, 801 736-6354) thermal cycler.[6] The M1097 HMMWV pulls a trailer with a mounted generator that supplies all the power needed to conduct sample preparation and GC-MS analysis. A full tank of fuel is sufficient to power the generator in nearly a week of continuous use. The mobile laboratory platform gives the commander of the AML more flexibility in responding to a volatile environment. The AML mobile lab can conduct sample analysis more rapidly upon arrival in an area of operations, usually within 3 hours of arrival, and can perform initial analysis at a remote location instead of waiting for collected samples to arrive at the ISOFAC. The mobile laboratory provides the commander of the AML with the ability to test for chemical and biological agents, endemic diseases and to monitor cholinesterase activity in Soldiers with potential field exposures.

Through a joint venture with USAMRICD, the AMLs have developed the capability to conduct telechemistry. Through a satellite link, senior scientists at USAMRICD can control the computers that run the AMLs gas chromatographs, conduct data analysis, tune the MSD, troubleshoot, and even run samples. Through a video link, USAMRICD scientists can inspect sample preparation and identify other problems that require visual inspection. Telechemistry provides the AMLs in a deployed environment with unprecedented access to scientists with years of experience in analytical chemistry.[7]

Endemic Disease Section

Upon request, the Endemic Disease Section deploys worldwide to conduct health threat surveillance for biological warfare agents and endemic disease threats at the theater level and provides and sustains FHP. The Endemic Disease Section is composed of an officer-in-charge (captain or major, microbiologist [MOS 71A]), a noncommissioned officer-in-charge (staff sergeant [91K30]), and 4 medical laboratory technicians (MOS 91K). The Section sets up its laboratory in an ISOFAC that is nearly identical to that used by the NBC Section. The Section is self-supporting, with the capacity to transport tactical and technical equipment, provide environmental control and power generation equipment in order to complete any assigned mission. The Endemic Disease Section relies primarily on nucleic acid and antigen detection based technologies, along with basic microbiological techniques in order to detect, identify, and analyze naturally occurring infections and biological warfare (BW) agents that may be encountered during deployments. The Section can also conduct laboratory diagnosis of military relevant infectious diseases which are endemic within the theater. However, in order to enhance the capabilities of the section, PROFIS personnel are assigned, including a veterinary pathologist, veterinary microbiologist, preventative medicine physician, and an infectious disease physician. With the PROFIS personnel, the Section serves as the local joint task force commander's subject matter experts on matters regarding infectious disease and BW agents, providing laboratory support for in-theater infectious disease outbreak investigations, and processing and analyzing potentially dangerous infectious specimens.

Currently, the nucleic acid identification capabilities/ technology relies on the Ruggedized Advanced Pathogen Identification Device (R.A.P.I.D®). The system utilizes quantitative real-time polymerase chain reaction technology and provides both presumptive and confirmatory analysis of potential BW and endemic disease agents. The system consists of the R.A.P.I.D. analyzer, a laptop computer for programming the analyzer, and backpack for efficient storage and ease of transport. Associated durable equipment consists of the nucleic acid extraction kits, a microcentrifuge for centrifugation of 1.5 ml snap-cap tubes, and a standard color printer. The technology is based on the detection of a fluorescent reporter fluorochrome attached to an internal primer that hybridizes to the target sequence between traditional forward and reverse primers. Presently, our BW nucleic acid confirmatory detection capabilities are limited to approximately 8 to 10 agents. Reagents are selected based on the disease causing agents endemic to a particular region and what is available through supporting research institutions, such as USAMRIID.

For antigen detection based capabilities, the Endemic Disease Section employs the M-Series® M1M analyzer (BioVeris™ Corp, 16020 Industrial Drive, Gaithersburg, Maryland 20877, 800-336-4436), an antibody-antigen based identification system (sandwich immunoassay) developed for the detection of a variety of antigens/analytes from small molecules, proteins, and microorganisms. The system is capable of analyzing raw liquid samples such as blood, serum, and liquid buffers from a joint biological point detection system or biological integrated detection system unit. The technology is based on electrochemiluminescence. Sample preparation tags the target to emit light when electrochemically stimulated. Presently, BW antigen confirmatory detection capabilities are limited to approximately 9 agents using the M1M analyzer, with expanded capabilities using an Enzyme Linked Immunosorbent Assay (ELISA).

The Endemic Disease Section is also capable of providing basic laboratory support for weaponized and endemic bacterial agents and parasitic organisms. Limited culture capabilities include the ability to generate ambient air, microaerophilic, and anaerobic culture environments. Basic biochemical identification of many human pathogens and environmental organisms can be performed. To enhance this capability the Dade Behring Microscan® autoSCAN® system (Dade Behring, Inc, 1717 Deerfield Road, Deerfield, Illinois 60015, 847-267-5300) is employed to provide definitive identification of gram positive and gram negative organisms. The antimicrobial susceptibilities of these organisms can also be determined with the autoSCAN®. Endemic parasite identification can be performed on fixed sample unknowns and other sample types, such as malarial smears and arthropod vectors. Fluorescent and light microscopy is available for pathogen analysis through variable staining methodologies, ie, Gram stain, Wright/Giemsa stain, and specialized fluorochrome stains for specific pathogens.

While in garrison and aside from technical and tactical training exercises, the Endemic Disease Section has had the opportunity to assist DoD as well as the local community with the present capabilities. During April-May of 2005, both the 1st and 9th AMLs were tasked by DoD to represent the Army in a multi-Service joint exercise during the initial operational test and evaluation of the Joint Biological Agent Identification and Diagnostic System (JBAIDS), at Brooks Air Base in San Antonio, Texas. The JBAIDS is a nucleic acid based laboratory instrument system that provides commanders with rapid and specific identification of biological threat agents. Following a 10 day training course, the AMLs were involved in a 10 day record test that evaluated 4 of 8 JBAIDS systems for network performance, survivability, interoperability, and logistical support. In August 2005, the 9th AML provided 5 Soldiers to assist USACHPPM for 2 weeks at Fort AP Hill, Virginia. The Soldiers assisted in the identification of Lone Star, Black-Legged (Deer), and American Dog ticks and used nucleic acid based technologies to screen for such arthropod-borne diseases as human monocytic ehrlichia, Lyme disease, human granulocytic ehrlichia, and Rocky Mountain spotted fever.

Discussion

Although neither AML has been deployed since activation in September 2004, both units maintain a high state of readiness by conducting realistic field training exercises and maintaining a robust intramural training program. One of the largest challenges in the current operating environment is the maintenance of a core of Soldiers highly trained with the requisite skills to operate and maintain the advanced technologies fielded by the AMLs. To this end, the AMLs invest considerable effort in arranging mission-specific technical training programs for individual Soldiers in cooperation with their fixed facility partners. Through participation in strategic working groups and scientific conferences, AML personnel stay abreast of current issues in Force Health Protection. Every effort is made to update unit equipment to reflect the latest developments in technology and provide a better product to their customers. They also work to establish relationships and investigate joint training opportunities with the Army National Guard and organizations of the other armed services that perform similar missions. In addition to the doctrinal theater support mission, the AMLs provide an untapped resource of essential capabilities to support civil authorities in homeland defense missions, consequence management, and disaster relief operations. Ready, relevant, and reliable, the 1st and 9th AMLs stand prepared to assist whenever and wherever they are needed.

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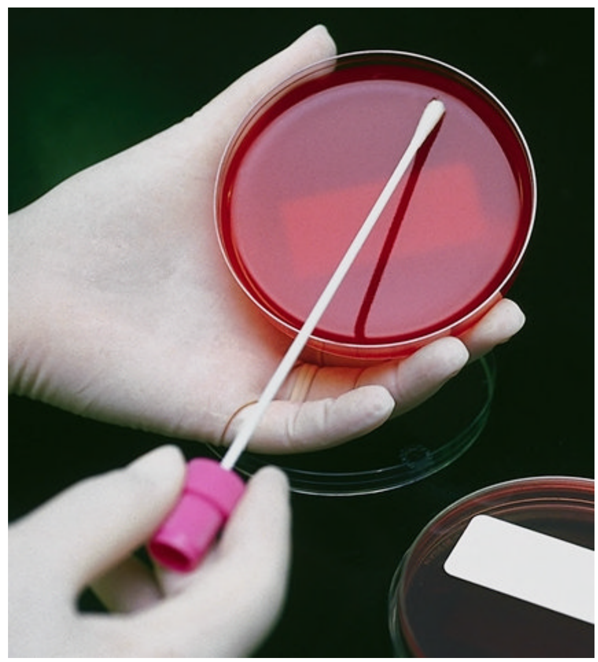

Bullis Fever: A Fleeting Epidemic of Unknown Etiology

LTC Michael J. Zapor, MC, USA

SUMMARY

Between 1941 and 1944, over 1,000 troops training at Camp Bullis, TX presented to the post hospital with concurrent fever, rash, adenopathy, and cytopenia. In each case, the physical examination was also notable for numerous tick bites, suggesting an arthropod-borne infection. The syndrome, coined "Bullis fever," was self-limiting, but convalescence was protracted. Investigations implicated the Lone Star tick (*Amblyomma americanum*) as vector, and an aggregate of signs consistent with Bullis fever was reproducible in volunteers and guinea pigs inoculated with emulsified tick extract. However, sera from inoculated subjects did not show cross-reactivity with known tick- borne pathogens, and workup of a solitary case presenting several years later was similarly nondiagnostic. The end of the war heralded a sharp decline in the number of troops training at Camp Bullis and also an abrupt end to the disease bearing its name.

Although highly speculated, the etiology of Bullis fever was never proven, and a definitive retrospective diagnosis is unlikely. The clinical specimens collected during the epidemic are no longer extant. Moreover, insecticide use, drought, and predation have decimated the region's tick population. Six decades after the epidemic, Bullis fever seems fated to remain enigmatic.

INTRODUCTION

In the spring of 1941, United States Army physicians assigned to Brooke General Hospital (presently Brooke Army Medical Center) at Fort Sam Houston, TX, encountered a number of "acutely ill Soldiers suffering from (an) obscure febrile disease" which "defied definite identification."[1] Invariably, each of these Soldiers had been training at nearby Camp Bullis (an adjunct field site for Fort Sam Houston) in preparation for deployment overseas. Coined "Bullis fever," the illness was characterized by the abrupt onset of fever and chills, leukopenia, headache, and lymphadenopathy. Eventually, over 1,000 cases (with one fatality) would be diagnosed. However, a cause was never proven and as recently as 1988 speculation appeared in the literature about its etiology.[2]

CLINICAL PRESENTATION

Bullis fever typically commenced with subjective chills and fever from 102°-105°F. Patients complained of postorbital or occipital headache, lassitude, prostration and, occasionally, nausea and vomiting; and weight loss was common (20 pounds in one patient). The fever persisted from 4 to 14 days (average 5 days) with abrupt defervescence. However, convalescence was protracted.[3]

On physical examination, patients presented with regional or generalized lymphadenopathy and a fleeting maculopapular rash similar to that of endemic typhus. Moreover, multiple tick bites were commonly evident. In severe cases, splenomegaly and subconjunctival hemorrhage were noted. A typical case description appeared in the medical literature in 1943:

> (The patient) was admitted to the Brooke General Hospital on June 25, 1942 complaining of severe generalized headache of four or five hours duration. His face was flushed as with fever, and he appeared acutely ill. The onset of illness was sudden with nausea, vomiting and severe headache...He had been at Camp Bullis, Texas, for one week, June 13 to June 20 inclusive, and had returned to Fort Sam Houston five days prior to the onset of symptoms. While at Camp Bullis, he suffered numerous tick and "chigger" bites. Physical examination revealed flushed skin and evidence of numerous insect bites on the abdomen and the legs. Moderate lymphadenopathy was found. Otherwise, physical examination gave negative results.[3]

A constant finding among patients with Bullis fever was leukopenia with associated neutropenia occurring on or about the second or third day of symptoms. The total white blood cell count frequently dropped to about 3,000/µl and occasionally as low as 1,750/µl. The leukopenia gradually resolved during convalescence, however, a relative lymphocytosis persisted beyond discharge. Several patients had trace albuminuria and none were anemic.[3]

Typically, patients with Bullis fever suffered a mild, self-limiting, febrile illness of 7–10 days duration. In some instances, however, the course was more severe, characterized by debilitation and protracted convalescence. One death occurred which was attributed to agranulocytic angina and sepsis. In about 10% of cases, a transient rash "resembling German measles, and at times, typhus"[3] appeared early in the disease. Treatment was mostly supportive and consisted of codeine, aspirin, ice, rest, and fluids.

The Army Medical Department Response

Faced with an epidemic of unknown etiology, the Brooke General Hospital commander, COL George C. Beach, petitioned the Surgeon General to dispatch specialists for consultation. Consequently, 3 members of the Board for the Investigation and Control of Influenza and Other Epidemic Diseases in the Army (Drs Kenneth E. Maxey, Norman H. Topping, and John C. Snyder) arrived at Fort Sam Houston on 8 July,1942. After a thorough examination of the patients and their medical records, these 3 investigators concluded that the evidence suggested an association with tick bites (thus garnering the tentative designation of "tick bite fever"), however, neither the causative agent nor the tick as vector had been proven.

Three successive papers were subsequently published describing the syndrome and reporting the results of preliminary laboratory investigations. One paper, authored by 3 clinicians at Brooke General Hospital, depicted the clinical presentation and implicated the Lone Star tick (*Amblyomma americanum*) as vector.[3] Another study, conducted by the Army's 8th Service Command Laboratory, described the induction of an illness resembling Bullis fever in animals inoculated with clinical specimens.[4] In this study, a consistent low-grade febrile reaction was observed in guinea pigs after intra-abdominal inoculation with blood or lymph tissue from infected patients. Biopsy specimens, taken both from patients and inoculated guinea pigs, demonstrated "small intracellular fuchsinophilic granules and rods, similar in morphology to Rickettsiae."

However, sera from inoculated animals showed no cross reactivity with the etiologic agents of Rocky Mounted Spotted fever (*Rickettsia rickettsii*) or Q fever (*Coxiella burnetii*), nor were these animals protected against challenge with *R rickettsii*. A third paper, an epidemiologic study published at about the same time, reiterated the likelihood of *A americanum* as the vector for Bullis fever.[5] Collectively, these studies suggested that Bullis fever represented a previously unknown rickettsial illness with the Lone Star tick as likely vector.

Pursuant to these findings, the Army scaled back the number of troops deployed to Camp Bullis for training with a consequent decrease in the incidence of disease. In 1944, for example, there were 47 patients admitted with Bullis fever to Brooke General Hospital, compared to more than 500 cases the preceding year.1 Interestingly, 13 of these patients were treated with penicillin without therapeutic benefit, further implicating a rickettsial etiology.

In 1946, Army researchers from the 8th Service Command Laboratory and Brooke General Hospital published the results of several human challenge experiments.[6] In these studies, volunteers were inoculated with either whole blood from natural cases of disease, whole blood from a natural case propagated through chick embryos, or an emulsion derived from the spleens of mice inoculated with emulsified *A americanum* ticks from Camp Bullis and serially passed through chick embryos. These researchers found that a syndrome resembling Bullis fever could be reproduced in humans by inoculation with either whole blood from natural cases or with emulsified *A americanum* ticks. Based on these findings, they determined Bullis fever to be a transmissible illness with a causative agent maintainable by serial passage.

Consigned to History

With the end of World War II, and a further reduction in the number of troops passing through Camp Bullis, the syndrome bearing its name became all but forgotten. In 1949, however, a case report of Bullis fever was published by physicians at Walter Reed Army Hospital in Washington, DC.[7] The patient, who had trained previously at Camp Bullis, presented with fever, leucopenia, and lymphadenopathy. Subsequent workup, which included complement fixation testing, excluded American Q fever, Rocky Mountain Spotted fever, rickettsialpox, Colorado Tick fever, lymphocytic choriomeningitis, and mumps. Interestingly, the patient failed to respond to sulfa drugs and penicillin but showed clinical improvement with para-aminobenzoic acid, an agent then used in the treatment of rickettsial diseases.

Subsequent to that case report, there was a dearth of references to Bullis fever in the literature until 1975, when Anigstein and Anigstein published a review of the subject and proposed the name *Rickettsia texiana* for the hitherto unnamed etiologic agent.[8] More recently, Goddard described an airman with a clinical syndrome resembling Bullis fever and positive serology for Ehrlichiosis canis, prompting him to speculate that human ehrlichiosis and Bullis fever might be the same disease.[2] In reply, however, Eng et al of the Centers for Disease Control disputed this conclusion, citing differences in clinical presentation, hematologic parameters, histopathology, and endemnicity.[2] Specifically, they noted:

1. the association of generalized lymphadenopathy with Bullis fever and its absence in human ehrlichiosis,
2. the neutropenia and lymphocytosis commonly seen with Bullis fever, contrasted with the thrombocytopenia and lymphopenia typical of human ehrlichiosis,
3. the differing appearance of intracytoplasmic inclusions in patients with each disease, and
4. the exclusive distribution of Bullis fever cases to Camp Bullis, TX.

Epilogue

Since it was established in 1917 as a training site for troops headed for the war in Europe, Camp Bullis has functioned as a tactical training area for the Army, Air Force, and Marine Corps, a prisoner of war camp, a reception center for inductees as well as a separation center for Soldiers upon completion of their military service, and even as the backdrop for several motion pictures (The Rough Riders, 1926 and Wings, 1927). The Army maintains a small cadre of assigned personnel, and there are several tenant units based at Camp Bullis. However, World War II, as with other conflicts, precipitated a massive influx of troops training there prior to deploying overseas. Perhaps the sudden proximity of a large human population and the presumed tick vector set the stage for the Bullis fever epidemic. Similarly, the abrupt disappearance of the disease may be due to the near abandonment of the camp at the end of the war. Moreover, there has been a notable decline in the tick population at Camp Bullis over the past 6 decades. This may derive from aggressive tick eradication by the cadre, a prolonged regional drought in the 1950s,[9] and the appearance in Texas of the fire ant, a predator of ticks.[10,11]

However, those conditions, which set the stage for the epidemic, may eventually recur, permitting the reemergence of Bullis fever. As a consequence of current and impending hostilities overseas, the tempo of training at military installations including Camp Bullis has intensified,[12] and much of this training is conducted in forested areas with dense underbrush, terrain favored by the Lone Star tick. Moreover, some researchers project resurgence in the Lone Star tick population as a consequence of rising populations of the mammalian host vectors (consider, for example, the fiftyfold increase in the number of white-tailed deer in the United States during the 20th century).[13] Collectively, these variables may contribute to the eventual recreation of those conditions which set the stage for the emergence of Bullis fever 6 decades ago. Until then, however, Bullis fever is consigned to history as an intriguing diagnosis sans known etiology.

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