THE UNITED STATES ARMY MEDICAL DEPARTMENT

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FORCE HEALTH PROTECTION: EVOLVING CHALLENGES AND SOLUTIONS

April – June 2010

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Perspectives

Commander's Introduction

MG David A. Rubenstein

It is with great personal pleasure that I present the first issue of the *AMEDD Journal* published during my tour as Commanding General, US Army Medical Department Center and School (AMEDDC&S). This publication exists for the specific purpose of enhancing and advancing the science of military medicine, the primary mission of which is maintaining the health and combat effectiveness of our military force. However, the vast majority of topics addressed in these pages also have direct corollaries in the practice of civilian healthcare. Indeed, the history of military medicine is replete with examples of the synergistic effect of efforts by both military and civilian resources producing results beneficial to both general populations and military mission accomplishment.

The *AMEDD Journal* is an invaluable forum for the presentation of and dialogue about the most current healthcare issues and combat experiences related to military medicine and doctrine development for the medical battlefield. The *Journal* receives manuscripts from across the spectrum of medical professionals, including highly-experienced medical and dental practitioners, accomplished research scientists, preventive medicine and public health specialists, veterinarians, healthcare support and service specialists, and non-medical professionals who contribute to healthcare delivery in various ways. The diversity of subject matter reflects the depth and breadth of functions in military medicine.

Likewise, the *AMEDD Journal* has a broad reach in readership. It is distributed throughout the Army, Navy, Air Force, and DoD, as well as to many civilian medical schools and libraries. It is also distributed to a number of foreign military medical schools and commands. The quality of the content and presentation of the *AMEDD Journal* was recognized by the National Library of Medicine, which, in November 2009, selected it to be included and indexed in MEDLINE, the nation's premier bibliographic database of life sciences and biomedical information from publications worldwide. The *Journal* is a superb presentation of who we are and what we do as healthcare professionals, both on the battlefield and in garrison. The topic of this edition also supports AMEDD Balanced Scorecard objective 3.0, "Improved Healthy and Protected Warriors."

For the fifth consecutive year, COL Mustapha Debboun, the senior medical and veterinary entomologist at the AMEDDC&S and Chairman of the *AMEDD Journal* Editorial Review Board, has organized and compiled an outstanding collection of articles addressing preventive medicine and public health in the context of force health protection. History has shown time and again that preventive medicine is the foundation for sustainable, effective combat capability.

Editors' Perspective

The US Army has long recognized the inestimable value of a Soldier's healthy mind and body to the combat readiness of the unit. The Army has continually sought improvements in effectiveness and efficiency in the methods and tools to ensure our Warriors remain healthy and fit, whether at home or in the theater of combat operations. The research, planning, application, and resources that are necessary to achieve this desired result are considerable. The recent establishment of the Army Public Health Command (APHC) is a significant step in the commitment to focus and optimize efforts among the various disciplines working towards that common goal. The leadoff article in this issue of the *Journal* is an account of the detailed planning and execution necessary to transition force health protection functions and responsibilities into the newly created APHC. The authors, Rosemarie Ugalde and John Resta, are key players in this ongoing process, and their article provides a detailed overview of the procedures involved, the schedule, and the ultimate organization of the APHC.

Unconventional warfare presents an almost indefinable array of challenges to those charged with anticipating and countering the threats. Usually, thoughts of guerilla-style attacks or use of chemical or biological agents come immediately to mind. However, in a timely, important article, CPT Derek Monthei and his coauthors discuss a potential threat that usually does not enter most discussions—the use of insects as attack weapons, for destruction of food sources, or as disease vectors. Use of stinging or toxic insects in warfare has

been chronicled throughout history, and the article explains how such a threat is not improbable today. However, the threats posed to food sources (agroterrorism) and as vectors of disease are of much greater concern. The article clearly and succinctly describes the threats represented, and the measures that have been, or should be, implemented to first detect and then control the outbreaks.

As long as humans have congregated in living and working areas, accumulation of trash and solid waste has been an inevitable byproduct of our activities. The health threat of such accumulation has long been recognized, and has been a serious concern for US military operations for well over a century. In her excellent article, Dr Colleen Weese presents a historical perspective of the problem, and then describes the situation as it exists today in the Iraq theater. Not only are modern societies, including military forces, faced with the expected hygiene and sanitation problems of accumulating waste, but we are also dealing with new categories of toxic (or potentially toxic) substances which pose additional problems in safe handling and disposal. Dr Weese focuses on the particularly troubling disposal method of burn pits, which is often the only method a commander may have to address the immediate situation. The article is a well-researched, detailed discussion of the environmental and health hazards posed by open burning of accumulated waste, and the measures taken by the US military to mitigate those problems. It provides an in-depth look into how the hazards associated with waste disposal should be addressed. This article is a must-read for those charged with planning and implementing waste disposal procedures for deployed forces.

Brian Zeichner and Sheila Adams have contributed an article describing a technological tool to assist preventive medicine and public health specialists in the collection and analysis of environmental data related to entomological threats in a given area. They demonstrate how readily-available geographic information system instruments can be used to define source areas of mosquito infestations, and then enable precise planning to attack those areas. They also illustrate identification of tick infestations, as well as agriculturally important beetle infestations. This is an interesting, easily understood article which presents sound, statistical evidence of the effectiveness of the techniques employed. The article should provide a stimulus for others to adopt the techniques for local, immediate applications addressing similar entomological threats.

We have all become accustomed to the use of radiation in diagnosis and treatment of various health conditions. Although we are aware of the hazards represented by the radiation, we trust that the professionals employing it are experts in their craft, and the threat is essentially nonexistent. Indeed, this is the case. It is so because of the continuous training, practice, and attention to every detail of the clinical use of radiation that is demanded of these professionals. The next 2 articles discuss various aspects of that attention to training and monitoring of their potentially hazardous tools. First, COL Mark Melanson and his coauthors discuss a workshop for Army Nuclear Medical Science Officers to expand their skills in working as a group in communicating information about a potentially hazardous situation which could be present following a radiation incident, with special emphasis given to dealing with potential victims, and then the media. The workshop presented training in the personal skills and techniques necessary for such situations, and then participants worked through a real-world case study to understand how it can either get quickly out of control, or handled correctly and sensitively for all concerned. In the second article, MAJ Christopher Pitcher and COL Melanson describe the concerns presented by the expanding use of fluoroscopy in interventional pain management (IPM), an increasingly important specialty which uses nerve blocks and other techniques for pain management. The Health Physics Office at Walter Reed Army Medical Center performed a measurement study and implemented a peer-based training program to reduce as much as possible the radiation doses experienced by staff, patients, and the public as a result of the operation of the IPM clinic. This is a well-developed, thoroughly researched article which demonstrates the correct way to evaluate and address potentially hazardous situations which may exist in our medical facilities.

The emotional and psychological toll on medical providers who treat casualties of war has been recognized for years, but was not directly addressed as a potentially serious condition until relatively recently. Over the last few years, the *AMEDD Journal* has published several articles discussing the evolving understanding of this condition, and the ongoing research and developing approaches to deal with it. LTC Sheila Adams and her coauthors present the latest article on this subject, describing the formal training course, Professional Provider Resiliency Program,

introduced by the AMEDD Center and School in May 2009. The article is a detailed discussion of the basis on which the training was developed, the training itself, and includes the results of a survey of the participants in a recent class who evaluated the training received. This is a valuable depiction of another of the increasingly more sophisticated approaches that the AMEDD is taking to answer the proverbial question, "who heals the healer?"

The military has dedicated considerable resources to research, training, and the development of equipment to mitigate environmental health threats, both endemic to the location and resulting from military operations. Unfortunately, the best of preventive measures and equipment are valueless if not diligently, continuously applied throughout all levels and locations of military units and facilities. CPT Elizabeth Wanja has contributed an important, revealing article that details her deployment experiences investigating and addressing a number of problems resulting from noncompliance with preventive medicine regulations and training, as well as the inconsistent distribution and availability of equipment. Such problems should be expected in the chaos and unpredictability of extensive, ongoing combat operations, but cannot be tolerated in a mature theater of fixed installations and reduced combat activity. Sadly, this is not a new situation. Commanders and other leaders must constantly balance priorities and resources—but the health and safety of their Soldiers must always be the first of those priorities. This article is must-reading for all who are charged with that responsibility, whether as leaders or providing preventive medicine support to units and facilities.

The Army Hearing Program was instituted in 2007 and has been implemented throughout Army installations in the United States. However, application of the Program elements in the deployed theaters has been problematic, in that available audiologists were necessarily focused on diagnostic care of injured Soldiers. The article by CPTs Kara Cave and Edward Price describe how the Program elements were implemented in Iraq as soon as the circumstances permitted. As the clinical role diminished, CPT Cave began training technicians, including classes in noise hazard evaluation in collaboration with CPT Price of the preventive medicine medical detachment. The arrangement expanded to proactive evaluations of noise hazards, and resulted in a fully developed model and process of identifying and mitigating noise hazards throughout the Iraq theater. This article is another excellent example of how the initiative and competence of our military medical professionals benefit the Warfighters who serve every day, everywhere in the world.

In their article, Todd Hoover and COL Kyle Campbell address a health problem that is completely preventable among healthy individuals, namely, excess body fat. They describe the collaboration between what is now the APHC (Provisional) – Europe and the Army Medical Department Activity, Heidelberg, to develop a weight reduction program designed around each individual's metabolic rate and other physiological factors. Using students over a year of training cycles at the Warrior Leader Course as the target population, the program achieved a 99% success in the body fat standards, and 6-month follow-on checks indicate that over 86% remain within the established standards. This approach could be applicable in similar environments throughout the Army.

Dr Wayne Austerman closes this issue with an excellent historical perspective on another completely preventable condition that not only damages the individual's health, but also, without question, severely degrades combat effectiveness. The abuse of alcohol has always been a part of human history, which includes a significant presence in military history. The article examines the role it played during the Texas War for Independence, highlighting the legendary battle of the Alamo where alcohol was a constant debilitating element, among both the men and some of their leadership. As Dr Austerman relates in fascinating detail, as the Mexican Army approached San Antonio, the majority of the Alamo garrison had been engaged in 2 days of revelry and drinking in town, rendering them virtually unable to mount a serious defense to any attack. Fortunately for Texas, bad weather and timid leadership delayed any action from the Mexicans. The article then postulates on how history may have changed had the Mexicans rolled up the defenders in the streets of town. Today's military leaders must still be alert to the appeal of alcohol, whether chronic or opportunistic, and ensure immediate, positive action always addresses its abuse. No individual's self-inflicted impairment can ever be allowed to jeopardize either the mission or his or her fellow Warriors.

The US Army Public Health Command Initiative: Transforming Public Health Services for the Army

Rosemarie M. Ugalde, BSPH
John J. Resta, PE

Introduction

The United States is at a healthcare crossroads. We spend more on healthcare than any other nation on the planet (in excess of $2 trillion ($10^{12}$) per year, or about 16% of gross domestic product) and yet our population's health is, at best, only average by most measures (life expectancy, chronic disease rates, access to healthcare, infant mortality, etc).[1] This problem is projected to worsen as the US population ages. The Army follows the overall US trends. Army medical beneficiaries (Active Duty, military retirees, their Families, and Army civilian employees) are as healthy or unhealthy as their civilian counterparts. Army beneficiaries suffer the same chronic disease rates, use tobacco and alcohol at equal or higher rates, and are as overweight and/or obese as their civilian counterparts, with 2 important exceptions: our Soldiers are fitter than their civilian counterparts due to mandatory physical fitness training and weight limits but suffer more injuries due to the physical nature of their duties, and our beneficiaries have universal access to quality medical care.[2,3]

Recognizing that more must be done, the Army Medical Command (MEDCOM) has begun to place an increased emphasis on improving beneficiary health by using a public health-centric approach to its overall strategy.[4] This approach uses such initiatives as:

- Creating incentives for Army medical treatment facilities (MTFs) to improve their beneficiaries' health via enhanced preventive health screenings measured by the Healthcare Effectiveness Data and Information Set (HEDIS*) metrics[5] and outcome based care measured with ORYX† metrics[6] The MEDCOM has established an enterprise goal that Army MTFs will exceed 90% for 8 different preventive health screening HEDIS measures and 4 additional ORYX measures.
- Reducing the rates of workplace injuries in Army MTFs by providing MTF commanders with data about the rates and types of injuries suffered by their employees, and testing various safe patient-handling practices to identify which techniques best reduce workplace injuries.
- Decreasing the rate of overweight and obese Family members and retirees by adopting the Healthy Population 2010[7] goals for overweight and obesity and implementing a standardized weight management program developed by the Department of Veterans Affairs.[8]

A key component of this increased emphasis on public health is the creation of an Army Public Health Command as part of the overall MEDCOM reorganization. This article describes the Army Public Health Command (APHC), its objectives, and current status.

Background

In July 2008, the MEDCOM Chief of Staff formed an APHC Workgroup to conduct a staff analysis and provide recommendations to the Commander, MEDCOM on the feasibility of a command focused on public health. The Workgroup members consisted of representatives from the Army Center for Health

*HEDIS is a tool used by more than 90% of America's health plans to measure performance on important dimensions of care and service. HEDIS was developed and implemented by The National Committee for Quality Assurance, a private sector, US-based, not-for-profit organization offering accreditation to health plans throughout the United States and Puerto Rico.

†ORYX is the performance measurement and improvement initiative of the Joint Commission (One Renaissance Blvd, Oakbrook Terrace, Illinois 60181), a private sector, US-based, not-for-profit organization founded in 1951. The Joint Commission operates accreditation programs for a fee to subscriber hospitals and other healthcare organizations.

Promotion and Preventive Medicine (CHPPM), the Army Veterinary Command, the Proponency Office for Preventive Medicine, the Department of Defense (DoD) Veterinary Service Activity, and the 6 MEDCOM regional medical commands. John Resta [coauthor], was chosen to lead this effort and served as the chair of the Workgroup.

The APHC Workgroup followed a military decision-making process: conducting a mission analysis, developing courses of action (COAs), analyzing and comparing the COAs, and ultimately recommending a COA for approval.[9] The workgroup completed an Enterprise Risk Assessment of the final COAs to ensure that the final decisions were fully informed.[10] Enterprise Risk Assessments are designed to identify and assess risks across 7 dimensions: scope, people, strategy, technology, contracting, process, and external factors.[11] Typically, the risk assessments are done to support major acquisition efforts but have been used to support organizational studies in the private sector. As a direct result of the efforts and analyses conducted by the Workgroup, in July 2009, the Commander, MEDCOM directed the establishment of the APHC, comprised of missions and resources from the CHPPM and the Army Veterinary Command. The Commander, CHPPM was tasked to lead the reorganization effort.

Structured Approach to Transformation

A structured approach was developed to engage the challenge of establishing the APHC. On August 28, 2009, the Commander, CHPPM signed a charter to form an APHC Transition Team consisting of an executive board, steering committee, and a core team to serve as an advisory team and conduct the necessary staff analyses to fully establish the APHC. John Resta and COL Gary Vroegindewey, Assistant Chief, Army Veterinary Corps, serve as cochairs in leading this effort. The Transition Team adopted the "A3 Thinking" methodology to employ a systematic, structured means of analyzing the various complexities involved in the APHC transition and identifying solutions.

A3 Thinking is a Toyota-developed, "lean" method of problem solving or performance improvement.[12] There are 9 steps in the method:

1. Reason for action
2. Initial state
3. Target state
4. Gap analysis
5. Solution approach
6. Rapid experiments
7. Completion plan
8. Confirmed state
9. Insights

All 9 steps can be represented in a 9 box format on an 11 in by 17 in (international standard A3) sheet of paper.

A3 working groups have been established to review, revise, and republish all policies, regulations, and procedures needed to govern the operations of the APHC; develop the appropriate procedures and agreements to conduct enterprise oversight of installation level public health services; and, in conjunction with the regional medical commands, consolidate installation public health assets under the command and control of the medical treatment facility commander. These working groups are being led by senior personnel from throughout CHPPM and the Army Veterinary Command.

Mission

The mission of the APHC is to promote health and prevent disease, injury, and disability to Soldiers and military retirees, their Families, and Army civilian employees; and assure effective execution of full spectrum veterinary services for Army and DoD Veterinary missions (Figure 1). This mission is significantly broadened because it commits the Army Medical Department to providing public health services to military Family members, military retirees and their Families, as well as to Soldiers and Army civilian employees. Previously, Army public health programs were focused on Soldiers and Army civilian employees. The APHC will sustain the Veterinary Command's unique mission as the sole provider of veterinary services to the Department of Defense and all military services. Those missions include medical care for government-owned animals; zoonotic disease surveillance and control; food safety and quality assurance; food defense; and medical care for beneficiary-owned pets.

Command Composition

The APHC is being formed by integrating missions and personnel from CHPPM and the Veterinary Command. Its headquarters will be organized as a distinct headquarters element with command and

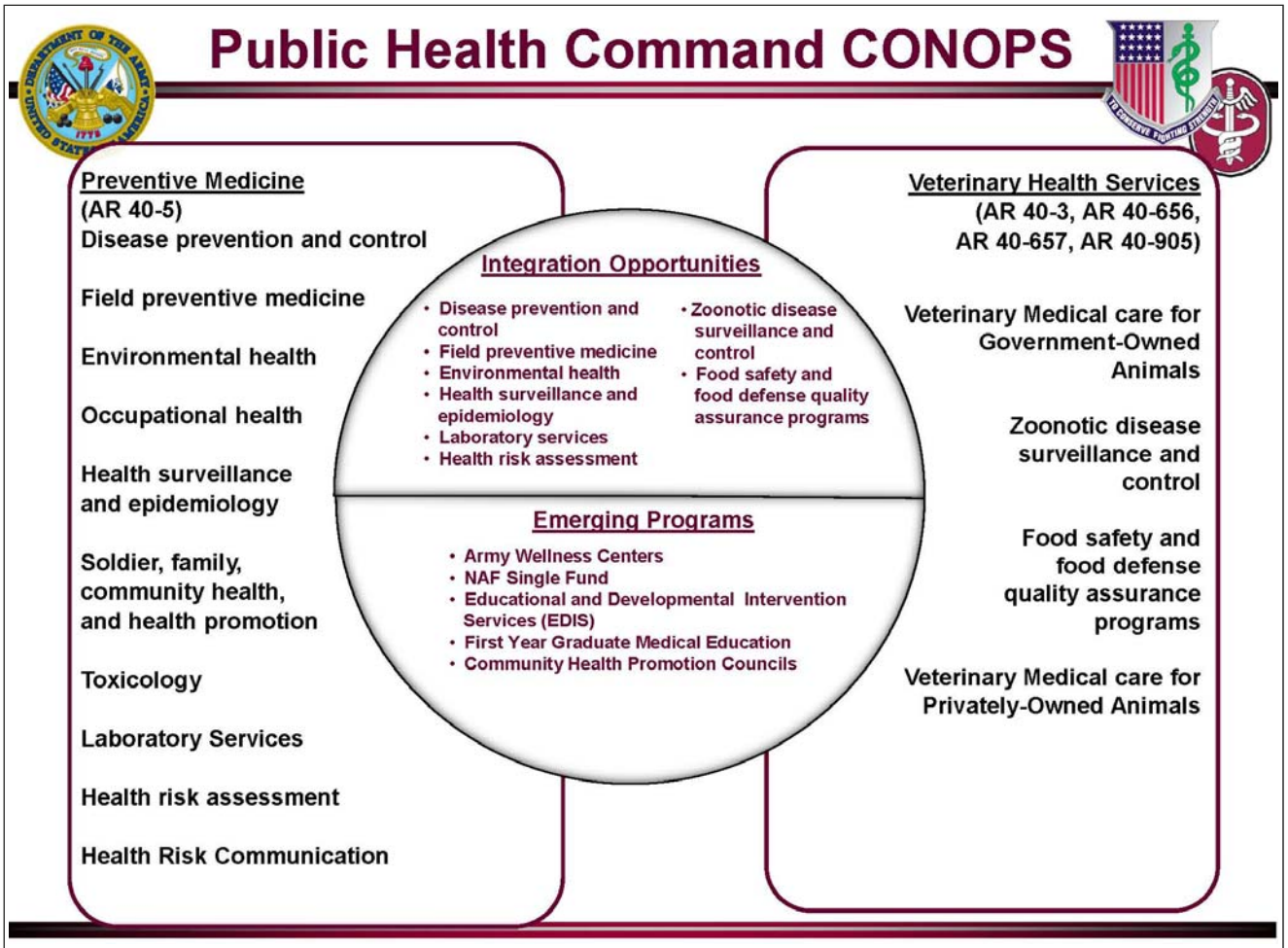

Figure 1. The respective missions and functions of CHPPM and the Veterinary Command which will be the responsibility of the APHC as of October 1, 2011.

Glossary

CONOPS: Concept of operations
AR 40-3: *Army Regulation 40-3* [13]
AR 40-5: *Army Regulation 40-5* [14]
AR 40-656: *Army Regulation 40-656* [15]
AR 40-657: *Army Regulation 40-657* [16]
AR 40-905: *Army Regulation 40-905* [17]
NAF: Nonappropriated funds

control, policy development, and oversight responsibilities. The headquarters will be located at Fort Sam Houston, Texas.

Five public health command regions (Figure 2) will report to the headquarters. These regional commands will initially be at the current locations of CHPPM or Veterinary Command regional subordinate commands. They will be responsible for monitoring the public health programs of MTFs and providing technical consultation and support to public health programs at MTFs, installations, and operational units. A primary goal of the APHC transformation is to collocate these regions with the corresponding regional medical command headquarters to encourage collaboration. Fourteen public health command districts (Figure 2) will report to the various regional public health commands.

What was formerly known as CHPPM-Main at Aberdeen Proving Ground, Maryland, will become the US Army Institute of Public Health, reporting directly to the APHC headquarters. The institute will deliver unique, low-density public health services to MTFs, installations, and operational units; provide consultative assistance to public health regions and districts; develop Armywide public health programs; and oversee public health program process improvement and quality assurance.

The DoD Military Working Dog Center at Lackland Air Force Base, Texas, will remain as is, and report directly to the APHC headquarters.

Installation-level public health teams will be created by combining installation veterinary services missions and personnel from the Veterinary Command with preventive medicine missions and personnel from the installation MTFs. These installation public health teams will be under the command and control of the MTF commander/director of health services. However, installation veterinary services delivered overseas will remain within the APHC under the command and control of the overseas (Europe, Pacific) APHC regions. This organizational structure is depicted in Figure 3.

The relationship between the APHC and the 6 regional medical commands (North Atlantic, Southeast, Great Plains, Western, Pacific, Europe) will change significantly. To ensure that public health programs across the Army are optimized and properly synchronized, the APHC will have enterprise oversight of all Army public health activities in accordance with Army Core Enterprise governance guidance. The Army's Core Enterprise initiative is an emerging Department of the Army business transformation effort that provides multiple stakeholders with the ability to synchronize efforts in a specific area while maintaining separate command and control structures.[18] This new approach to management will require preparation and revision of MEDCOM regulations and policies, as well as creation of management controls to ensure that public health activities throughout the Army are synchronized and achieving the program goals.

TIMELINE

The APHC will be established in 2 phases over a 2-year period (Figure 4). In the first phase (October 1, 2009 through September 30, 2010), the MEDCOM established an APHC (Provisional) to integrate the capabilities of CHPPM and the Veterinary Command, and continue the delivery of public health and veterinary medical services during the transition. This phase includes the development of a concept plan describing the APHC mission, roles, and responsibilities; policies that define an integrated Army public health program; and the assignment of enterprise oversight, monitoring, and execution responsibilities to the various MEDCOM organizations.

In the second phase, scheduled to begin October 1, 2010, the APHC (Provisional) will achieve an initial operational capability. This phase actually begins with the Department of the Army approval of the APHC concept plan, and ends when all tasks outlined in the concept plan have been completed, to include activation of the APHC and inactivation of CHPPM and the Army Veterinary Command.

APHC Region - Europe (Landstuhl, Germany)
- APHC District - North Europe (Kaiserslautern, Germany)
- APHC District - South Europe (Vicenza, Italy)

APHC Region - Pacific (Tripler, HI)
- APHC District - Central Pacific (Fort Shafter, HI)
- APHC District - West Pacific (Apra Harbor, Guam)
- APHC District - Korea (Yongsan)
- APHC District - Japan (Camp Zama)

APHC Region - North (Fort Belvoir, VA)
- APHC District - Fort Knox (KY)
- APHC District - Fort Belvoir (VA)
- APHC District - Fort Eustis/Fort Bragg (Fort Bragg, NC)

APHC Region - South (Fort Sam Houston, TX)
- APHC District - Fort Hood (TX)
- APHC District - Fort Gordon (GA)

APHC Region - West (Joint Base Lewis-McChord, WA)
- APHC District - Joint Base Lewis-McChord (WA)
- APHC District - San Diego (CA)
- APHC District - Fort Carson (CO)

Figure 2. The planned designations and locations of the 5 APHC regions and the 14 districts as of October 1, 2011.

CONCLUSION

The decision to create the APHC marks a distinct change in both the strategic and practical approaches in the Army Medical Department's delivery of services to those in its care. In the words of The Army Surgeon General,

> The establishment of the USAPHC (Provisional) is the most visible step in Army medicine's efforts to transform the nation's sick-care paradigm to a healthcare paradigm where disease and injury prevention become the foundation for American and military healthcare.[19]

While it will continue to deliver excellence in clinical and rehabilitative care, the Army Medical Department's shift to a public health-centric approach better serves its beneficiaries by sustaining and improving individual health and unit readiness through

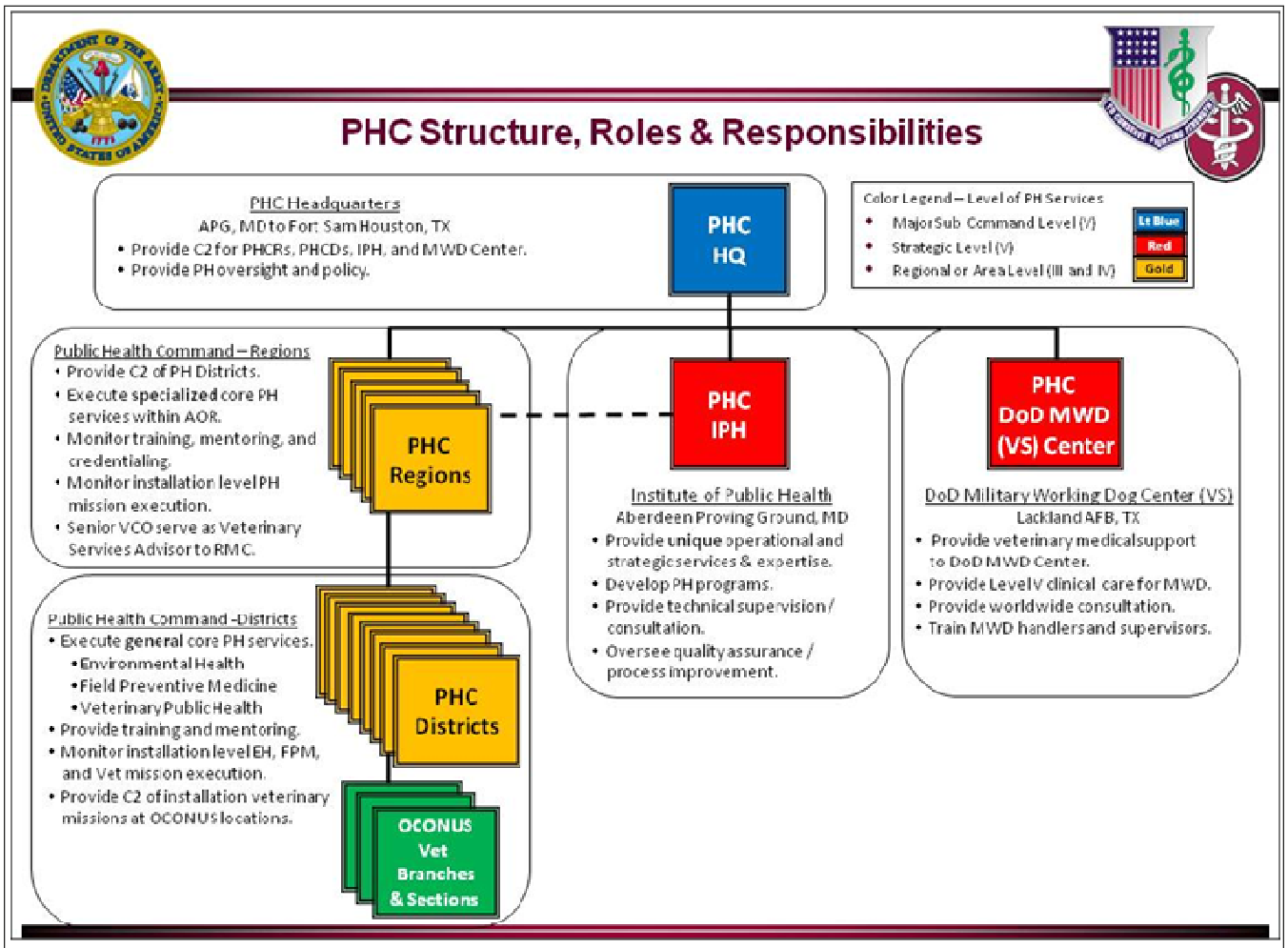

Figure 3. The planned structure of roles and responsibilities of the APHC.

Glossary

APG - Aberdeen Proving Ground
C2 - Command and control
DoD - Department of Defense
EH - Environmental health
FPM- Field protective medicine
IPH - Army Institute of Public Health
MWD - Military working dog
OCONUS - Outside of the continental United States
PH - Public health
PHC - Public Health Command
PHCD - Public Health Command District
PHCR - Public Health Command Region
RMC - Regional medical command
VCO - Army Veterinary Corps officer

prevention, promoting health behaviors and personal responsibility for health, and making necessary care more available through sound stewardship of our human and fiscal resources.

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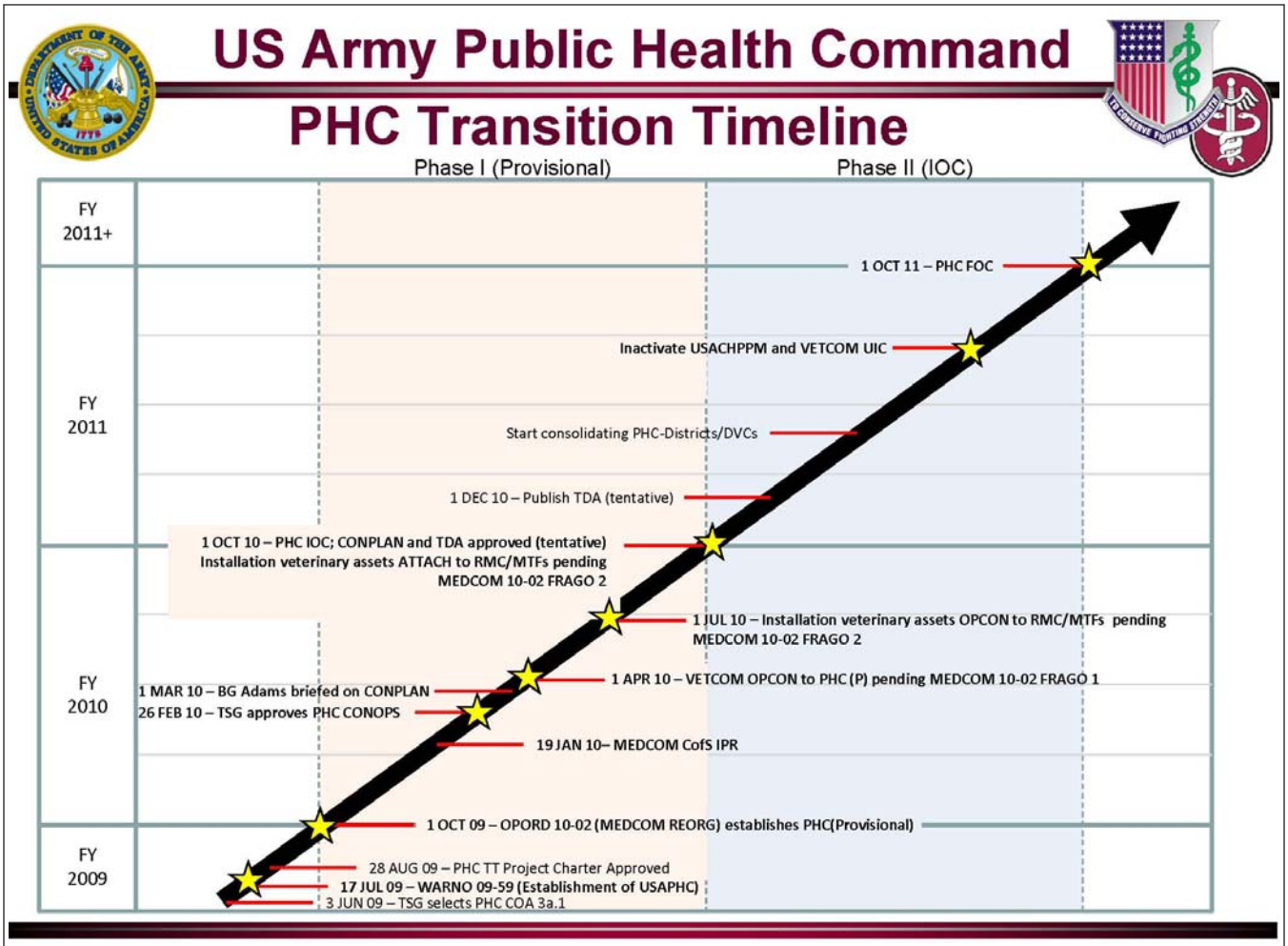

Figure 4. The planned transition timeline to full operational capability of the newly established APHC.

Glossary

COA - Course of action
CofS - Chief of Staff
CONOPS - Concept of operations
CONPLAN - Concept plan
DVC - District Veterinary Command
FOC - Full operational capability
FRAGO - Fragmentary order
IOC - Initial operational capability
IPR - In-progress-review
MEDCOM - Army Medical Command
MTF - Medical treatment facility
OPCON - Operational control
PHC - Public Health Command
REORG - Reorganization
RMC - Regional medical command
TDA - Table of Distribution and Allowances*
TSG - The Surgeon General of the Army
TT - Transition Team
UIC - Unit identification code
VETCOM - US Army Veterinary Command
WARNO - Warning order

*Prescribes the organizational structure, personnel and equipment authorizations, and requirements of a military unit to perform a specific mission for which there is no appropriate table of organization and equipment (defines the structure and equipment for a military organization or unit).

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Entomological Terrorism: A Tactic in Asymmetrical Warfare

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Abstract

The current operational environment presents military forces with enemies that use unconventional warfare to achieve their goals. Although the US government has dedicated significant resources to address threats of bioterrorism, the adaptive nature of our adversaries necessitates additional emphasis on bioterrorism awareness among military health professionals. This article provides an overview of 3 categories of entomological terrorism and examples from each category with a risk assessment.

Historically, most US wartime casualties have been from disease and nonbattle injuries. If proper precautions are not taken, diseases like malaria, leishmaniasis, giardiasis, and botulism can have a detrimental impact on military personnel, their units, and their missions. Preventive medicine and public health personnel at all levels must remain vigilant during deployments to protect Soldiers from contracting food, water, and vector-borne diseases. The current operational environment, with insurgents using unconventional, indirect attacks against US forces, has caused the military to prepare for a wide array of enemy tactics. Improvised explosive devices (IEDs), vehicle-borne IEDs, snipers, and suicide bombers have all been used against military personnel, local security forces, and various local nationals in the Iraq and Afghanistan theaters. Another unconventional tactic that could be used by our nation's enemies is the use of biological terrorism, also known as bioterrorism.

Bioterrorism is defined as the deliberate release of viruses, bacteria, or other pathogens to cause illness or death in people, animals, or plants.[1] It should be noted that this definition excludes macrobiotic organisms, such as insects, which have been used to attack humans and agriculture. We would expand the Centers for Disease Control and Prevention definition to recognize the history and future of bioterrorism as including all living organisms. Insects have the potential to act as effective instruments for bioterrorism. This article will specifically address the threat posed to both the US civilian population and military personnel from entomological terrorism. Entomological terrorism can be organized into 3 major categories: the use of insects as weapons of direct attacks, as agents of agroterrorism, and as disease vectors.[2] We would note that these categories are not mutually exclusive. For example, a plant disease vector could be an agent of agroterrorism.

Composite risk management (CRM) is the Army's primary decision-making process to identify hazards, reduce risk, and prevent both accidental and tactical loss.[3] The US Army Center for Health Promotion and Preventive Medicine *Technical Guide 288*,[4] used by preventive medicine personnel, applies the CRM concept to vector-borne disease threats encountered by military personnel. Risk management in the Army, regardless of what is being assessed, ultimately seeks to preserve the fighting force for future operations. *Technical Guide 288* provides the framework to assess entomological hazards faced by military personnel, but was not intended to serve as a guide for analyzing entomological terrorist threats to our nation. The tactics used by our adversaries in overseas contingency operations have in many instances focused on targets other than military personnel. Unconventional strategies used by our enemies have included terrorist attacks to our nation on September 11, 2001, our international embassies, and our allies to include the Iraq and Afghan governments. Bioterrorism, including entomological terrorism, can instill fear in a society, devastate economies, and cause disease throughout a populace. Entomological threats should be further evaluated with considerations given to their potential use in attacks by our nation's enemies. Applying the Army's CRM and using *Technical Guide 288* as a

guide, examples of each form of entomological terrorism (direct attacks, agroterrorism, and disease vectors) are assessed in this article to illustrate their potential threat to the health of our nation's military, economy, and society.

Direct Attacks

Stinging insects were used for millennia in conflicts as a means of defending fortifications or routing enemies from entrenched positions.[2] It may appear that modern weapons have eliminated the need to conscript insects for such purposes, but such tactics were used by the Vietcong against US troops in Vietnam,[2] and their use by terrorists in a direct attack is not altogether improbable. More likely, military personnel will have natural exposures to biting, stinging, or toxic insects as part of military deployments in less sheltered conditions and unfamiliar environments.

According to *Technical Guide 288*:

> In addition to vector-borne and zoonotic disease, entomological hazards during deployment also include those hazards associated with biting and stinging arthropods, animals, poisonous plants, and pesticide exposure. Biting and stinging arthropods can degrade mission readiness and combat effectiveness even though they are relatively free of vector-borne disease. These arthropods can cause casualties from secondary infections and even death from allergic reactions to their venom. Annoyance from high populations of pests, itching bites, and loss of sleep can also reduce morale.[4(p2)]

One documented threat to military personnel that could be used in a direct attack or encountered in the environment is the *Paederus* beetle.[5] *Paederus* is a genus of rove beetles (family Staphylinidae) and are found in the Middle East and the Asian subcontinent. Most species are slender, about 7 mm to 13 mm long, and are distinctly colored with black heads, orange bodies, black abdominal tips, and metallic blue or green elytra[5] (Figure 1). A string of suppurating sores appears when someone brushes away a beetle and inadvertently smears the insect and the toxin, pederin, across the skin. Less than a hundred-thousandth of a gram of this chemical can cause festering lesions.[2] Intense pain and temporary blindness have been reported when pederin is introduced into the eyes. These sores, although not fatal, may result in lost duty time.[6] Ingestion of the beetle leads to severe and even deadly internal damage. Pederin is lethal if injected into the bloodstream.[2]

Military personnel currently conduct operations in environments throughout Iraq that support *Paederus* beetle populations. The entomological hazard assessment[4] for *Paederus* beetles in these areas of Iraq was evaluated based on the severity and probability of exposure. *Paederus* beetles pose a "marginal" hazard to military personnel and the probability of receiving an injury by these beetles would be "occasional," therefore, the risk estimate for this entomological threat is "moderate" in areas with *Paederus* beetle populations. Military personnel can reduce the risk of the typical method of exposure to these beetles by applying an indoor residual spray (permethrin) in tents (D. A. Strickman, PhD, oral communication, January 2010), not working or resting under bright lights during May through July, properly wearing uniforms, and using window screens to help prevent *Paederus* beetles and other insects from traveling toward light sources indoors.[6]

The stings and bites of insects and arthropods are one threat the US Army should be able to manage effectively. Since its adoption, the Geneva Protocol of 1925[7] has prevented most nations from using chemical or biological weapons. The use of insects to vector pathogens is also prohibited under the Protocol. However, terrorists do not bind themselves to such protocols and could possibly employ biological weapons against the United States. The difficulty in

Figure 1: Dorsal and Ventral view of a *Paederus* beetle. Image courtesy of US Army Public Health Command (Provisional).[6]

the control of biological pathogens indicates that terrorists would probably use them at a location remote from their own territory (ie, against civilians residing in the United States). On the other hand, it is evident that terrorists are willing to both kill their countrymen and to die in attacks against US forces, which suggests that there are no places entirely safe from biological weapons. The 2 main entomological terrorism threats to the United States at home are agroterrorism and vector-borne disease threats.

AGROTERRORISM

Agroterrorism is defined as:

> the deliberate introduction of an animal or plant disease as well as damage to crops and livestock with the goal of generating fear, causing economic losses, and/or undermining social stability.[8]

Insects can be agents of agroterrorism as they can vector plant or animal pathogens or directly damage economically important crops and livestock. Table 1 identifies plant pests of significant concern in terms of bioterrorist potential. Many insects that are problematic to agriculture are invasive species. Invasive species can be defined as species that have a demonstrable ecological or economic impact and that have become established in a region outside of their native range.[10] Insects that become invasive to the United States can arrive in various ways, including:

- Accidental introductions of a species by global travel or trade
- Species originally released for agricultural or economic gains that later became problematic pests
- Species released in an act of bioterrorism against our nation

Agriculture and livestock remain a vital part of the economic stability of the United States. Although farming employs less than 2% of the country's workforce, 16% of the workforce is involved in the food and fiber sector, ranging from farmers and input suppliers to processors, shippers, grocers, and restauranteurs.[11] The US produces and exports a large share of the world's grain. In 2003, the US share of world production was 42% for corn, 35% for soybeans, and 12% for wheat. Of global exports, the US accounted for 65% for corn, 40% for soybeans, and 32% for wheat.[12]

Economic losses from an agroterrorist incident could have the following effects:

- Value losses in terms of lost production, cost of destroying diseased animals or products, and cost of containment (drugs, diagnostics, pesticides, and veterinary services).[8]
- The imposition of trade restrictions on US exports by foreign nations to prevent the disease or pest from spreading.
- Damage to the US economy as tourism and agriculturally dependent businesses suffer.
- State and federal governments burdened by the significant costs associated with disease or pest eradication, containment efforts, and compensation to farmers for their losses.

The Mediterranean fruit fly (*Ceratitis capitata* Wiedemann), commonly known as the Medfly (Figure 2), is a possible entomological agent that could be used against the United States for the purposes of agroterrorism. The species is found in Hawaii, but is not established on the US mainland . The larvae of this fly eat a wide variety of plants, including avocados, coffee, olives, tomatoes, bananas, citrus, mangos, and peaches.[2] If Medflies were established in California, a total quarantine of California fruits, both nationally and internationally, would result in the loss of 132,000 jobs and $13.4 billion.[13]

Medflies played the central role in a relatively recent entomological threat faced by our nation's citrus growers. In 1989, an ecoterrorist group known as the "Breeders" threatened to release Medflies in California if the state did not stop its pesticide spraying program. The State of California was spraying pesticides, ironically, to remove Medflies that had appeared in the Los Angeles area.[2]

Applying the criteria of *Technical Guide 288*, the severity of damage caused by Medflies to the United States would be "critical" and the probability of this pest occurring and becoming established is "likely," therefore the risk assessment for this pest is "high." There are mechanical, cultural, biological, and chemical control measures that can be used to control and eliminate Medflies, however, preventing the Medfly from establishing itself on the mainland would be less expensive than control measures.

Table 1. Exotic plant pests of greatest risk.[a]

Pest Common Name(s): Scientific Name	Expected Range	Ecological Suitability[b]	Survey Difficulty[c]	Taxonomic Difficulty[d]	Primary Damage	Potential Economic Risk	Potential Environ-mental Impact	Potential for Establish-ment
Japanese wax scale: *Ceroplastes japonicas*	67% US (eastern and western states)	High	High	Medium	Ornamentals Fruits	High	High	High
Metallic beetle, Oak splendor beetle: *Agrilus biguttatus*	67% US (eastern and western states)	High	High	Medium	Oak Beech Chestnut	High	High	High
Rice cutworm, Cotton leafworm: *Spodoptera litura*	67% US (eastern and western states)	High	Medium	High	Vegetables Field crops	High	(Low)	High
Silvery moth: *Autographa* gamma	50% US (eastern and parts of western states)	High	Medium	High	Vegetables Field Crops Greenhouses	High	(Low)	High
Egyptian cotton leafworm: *Spodoptera littoralis*	67% US (eastern and western states)	High	Medium	High	Cotton Vegetables Ornamentals Forages	High	(High)	Medium-High
Passionvine mealybug: *Planococcus minor*	67% US (western and mid-western states)	Medium	High	Medium	Many crops	High	High	High
Light brown apple moth: *Epiphyas postvittana*	90% US	High	Medium	High	Ornamentals Fruits	High	(Low)	Medium
Khapra beetle: *Trogoderma granarium*	67% US (eastern and western states)	High	Low	High	Stored grain	High	Medium	High
Arrowhead scale: *Unaspis yanonensis*	33% US (eastern, portions of midwest and California)	Medium	High	Medium	Citrus Vegetables Trees	High	Medium	High
Siberian silk moth: *Dendrolimus superans*	80% US (except parts of western states)	High	Low	Medium-Low	Conifers	High	High	High
Ambrosia beetle: *Platypus quercivorus*	33% US (eastern states and Oregon)	Medium	Medium	Medium	Oak Chestnut	High	High	Medium
Summer fruit tortrix moth: *Adoxophyes orana*	25% US (eastern states and Oregon)	Medium	Low	Medium	Fruit	High	High	High
Pink gypsy moth: *Lymantria Mathura*	50% US (eastern and parts of western states)	Medium	Low	Low	Fruit crops Forests	High	High	Medium

[a] Data adapted from the USDA Animal and Plant Health Inspection Service Mini Pest Risk Assessments.[9] There is no comprehensive summary of agricultural threats, although these pests are representative of the agents that could be used for bioterrorism. The ratings of risk presume that each of the listed categories is of equal weight. The qualitative assessments were converted into scores and summed, such that "high" = 3, "medium" = 2; "low" = 1 (in all columns "high" is associated with a quality favorable for bioterrorism). Because potential environmental impact was not explicitly listed for all species, this category was not included in the summed risk score (the authors' estimates for this assessment, based on the USDA descriptions, are shown in parentheses). When totaled scores yielded a tie, potential environmental impact and expected range were used.

[b] Ecological suitability concerns whether the pest's life history accords with climates, soils, and host plants in the United States and the extent to which these ecological conditions are available.

[c] Survey difficulty addresses whether the United States has methods to readily detect the pest (eg, pheromone traps and sampling methodologies) and the extent to which the pest and its damage remain cryptic.

[d] Taxonomic difficulty reflects the ease with which the pest can be differentiated from native insects, the variability of the pest across its life stages, and the availability of supporting materials (eg, taxonomic keys).

[e] Species evaluated in the "mini pest risk assessments" representing lower threats and not included in this table are (in alphabetic order by common name): Chestnut weevil, *Curculio elephas*; European grape vine moth or Grape berry moth, *Lobesia botrana*; False codling moth, *Thaumatotibia leucotreta*; Fruit piercing moth, *Eudocima fullonia*; Giant woodwasp, *Urocerus gigas*; Old World bollworm, *Helicoverpa armigera*; Soft wax scale, *Ceroplastes destructor*

There are ways to mitigate the threat of agroterrorism to our nation. Monitoring, containment, and continued research will help prevent a terrorist event. The following are several suggestions to stop agroterrorism:

- Increase funding for research and eradication programs of invasive species present in the United States.
- Establish or continue monitoring programs for invasive species such as the Medfly, the Emerald Ash Borer (*Agrilus planipennis* Fairmaire) (monitoring in adjacent states that have not previously had this pest), and the Khapra beetle (*Trogoderma granarium* Everts), a grain and stored products pest.
- Ensure agencies responsible for monitoring trade and security threats to the United States are trained to identify entomological hazards and deter their entry to the United States. Possible participating agencies include the Food and Drug Administration, Food Safety and Inspection Service, and US Customs and Border Protection. The agency primarily responsible for this function is the US Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS).

Figure 2. Adult Mediterranean fruit fly. Image courtesy of US Department of Agriculture (http://www.ars.usda.gov/is/graphics/photos/jun00/k8898-2.jpg).

DISEASE VECTORS

An intentional release of a vector-borne disease by adversaries of the United States is a realistic threat to our nation. Table 2 provides a list of arthropod-transmitted diseases that could be delivered in a terrorist act that pose significant risks to plant, animal, and human health. The adverse effects caused by the introduction of certain arthropod-vectored pathogens to the United States, whether accidental or intentional, could ultimately result in illness and death from disease or devastation of the economy. This could be compounded if the introduced pathogen became established within our nation's borders and persisted, despite control and eradication efforts. Engineering new strains of viruses would require resources that typical insurgent groups do not possess at present, but many naturally occurring pathogens do exist that would need minimal effort to develop into biological weapons. Furthermore, the delivery of these diseases by terrorists to US soil could be simple and leave little to no evidence of the attack.

Rift Valley fever is an excellent example of a disease that would require little effort to deliver to the United States, and could have devastating effects on the nation's public health and livestock industry. Rift Valley fever (RVF) is caused by a virus in the family Bunyaviridae and occurs in various regions of sub-Saharan Africa and Madagascar.[19] Recent outbreaks in the Arabian peninsula, the first reported cases outside the African continent, have raised concerns that the disease could extend into Asia and Europe[20] (Figure 3). Numerous mosquito species transmit the virus that causes RVF, including those inhabiting North America and the United States.[21] The virus can be passed to an infected mosquito's offspring via transovarial transmission, thus enabling its persistence and maintenance in the environment through long stretches of dry conditions. Eggs infected with the virus can lay dormant until rains arrive when they will then hatch, develop in the larval and pupal stages, and emerge as disease-carrying adults. The public health and economic impacts of a RVF outbreak in the US could far exceed anything experienced by recent West Nile virus events.[2,22] Although these diseases spread in much the same manner, both the infection rate and proportion of those exhibiting severe symptoms are vastly higher in RVF.

The intentional introduction of RVF through infected mosquitoes, humans, and/or livestock represents a

serious threat to both our military and civilian populations, whether delivered by a terrorist or through accidental introduction. The RVF virus is transmitted to humans by the bite of an infected mosquito or through contact with animals/meat that are infected. The mild form of RVF observed in most human infection manifests itself in the form of flu-like symptoms. The more severe form of the disease appears in one of 3 syndromes: ocular disease, meningoencephalitis, or haemorrhagic fever. Using RVF's approximate case fatality rate of 1%,[19] the analysis of a hypothetical attack allows us to better understand the implications of such an outbreak. If a small community with a population of just 10,000 people experienced a 10% RVF attack rate, the results would overwhelm the local health care infrastructure. Approximately 1,000 cases of the disease would require medical attention, with approximately 10 people ultimately dying from debilitating symptoms. In this age of constant news streams from cable networks (ie, CNN, MSNBC, Fox News), word of even a small outbreak of RVF would make headlines.

The absence of human cases occurring in a RVF bioterrorist attack would not equate to failure for our adversaries. An intentional release of RVF would also be a form of agroterrorism, for the livestock losses this disease can cause could cripple a large part of our national economy. Cattle, sheep, dogs, and rodents are among the many animals susceptible to RVF. Outbreaks of RVF have been characterized by high attack rates in livestock, with 30% mortality and abortion rates approaching 100%.[23] Corrie Brown, an animal infectious disease specialist who supervised the pathology section of USDA's Plum Island Animal Disease Center in New York, contends that if an outbreak occurred in the United States, domestic beef exports would shut down.[2,24] This impact on the beef industry would result in a $3 billion ($10^9$) loss to the economy.[2,24]

The composite risk assessment for the threat of RVF being delivered in an act of terrorism was estimated to be a "high" due to its "critical" severity and its probability occurrence "likely."[4]

Control measures that can mitigate the risk of RVF include:

- Continue mosquito surveillance programs to both monitor various pathogen infection rates (ie, West Nile and Eastern Equine Encephalitis) in vector populations as well as maintain preparedness in the event of an RVF or other mosquito-borne disease outbreak.
- Monitor conditions suitable for RVF outbreaks (eg, regional flooding, hurricanes) to focus mosquito control and surveillance efforts.

Table 2. Arthropod-transmitted exotic diseases of potentially significant risk to plant, animal, and human health.[a]

Disease	Vector(s)	Pathogen	Host(s)
Chikungunya	Mosquitoes	Virus	Humans[b]
Yellow fever	Mosquitoes	Virus	Humans[c]
Japanese encephalitis	Mosquitoes	Virus	Humans, pigs, birds
Rift Valley fever	Mosquitoes	Virus	Humans, livestock, birds
Lumpy skin	Mosquitoes and other flies	Virus	Cattle[d]
African horse sickness	Biting midges	Virus	Horses
Russian spring-summer encephalitis	Ticks	Virus	Humans[e]
Crimean-Congo hemorrhagic fever	Ticks	Virus	Humans[f]
Cattle tick fever	Ticks	Virus	Cattle
African swine fever	Ticks	Virus	Pigs
New World screwworm	Adult screwworms flies	NA	Mammalian livestock[g]
Tomato yellow leaf curl	Whiteflies	Virus	Tomatoes[h]
Citrus chlorotic dwarf	Whiteflies	Virus	Citrus
Citrus variegated chlorosis	Leafhoppers	Virus	Citrus
Lime witches' broom	Leafhoppers	Phytoplasma	Lime
Pierce's disease	Leafhoppers	Bacterium	Grapes
Potato wilt or brown rot	Leafhoppers, beetles, aphids	Bacterium	Potatoes[i]
Citrus greening	Psyllids	Bacterium	Citrus

[a] Data sources: USDA,[9] Frazier and Richardson,[14] Geissler,[15] Pelzel,[16] Wilson et al,[17] and World Health Organization.[18]

[b] Various nonhuman animals can serve as reservoirs.

[c] Other primates can serve as reservoirs.

[d] Insect vectors are highly suspected but have not been specifically identified.

[e] Small mammals can serve as reservoirs.

[f] Small mammals and domestic livestock can serve as reservoirs.

[g] Infestations of screwworms are not a disease in the classic sense but share many important commonalities with pathogenic infections.

[h] Localized infections have been found in California, but the disease is not yet established.

[i] Insect vectors are highly suspected based on experiments with closely related diseases but have not been specifically identified.

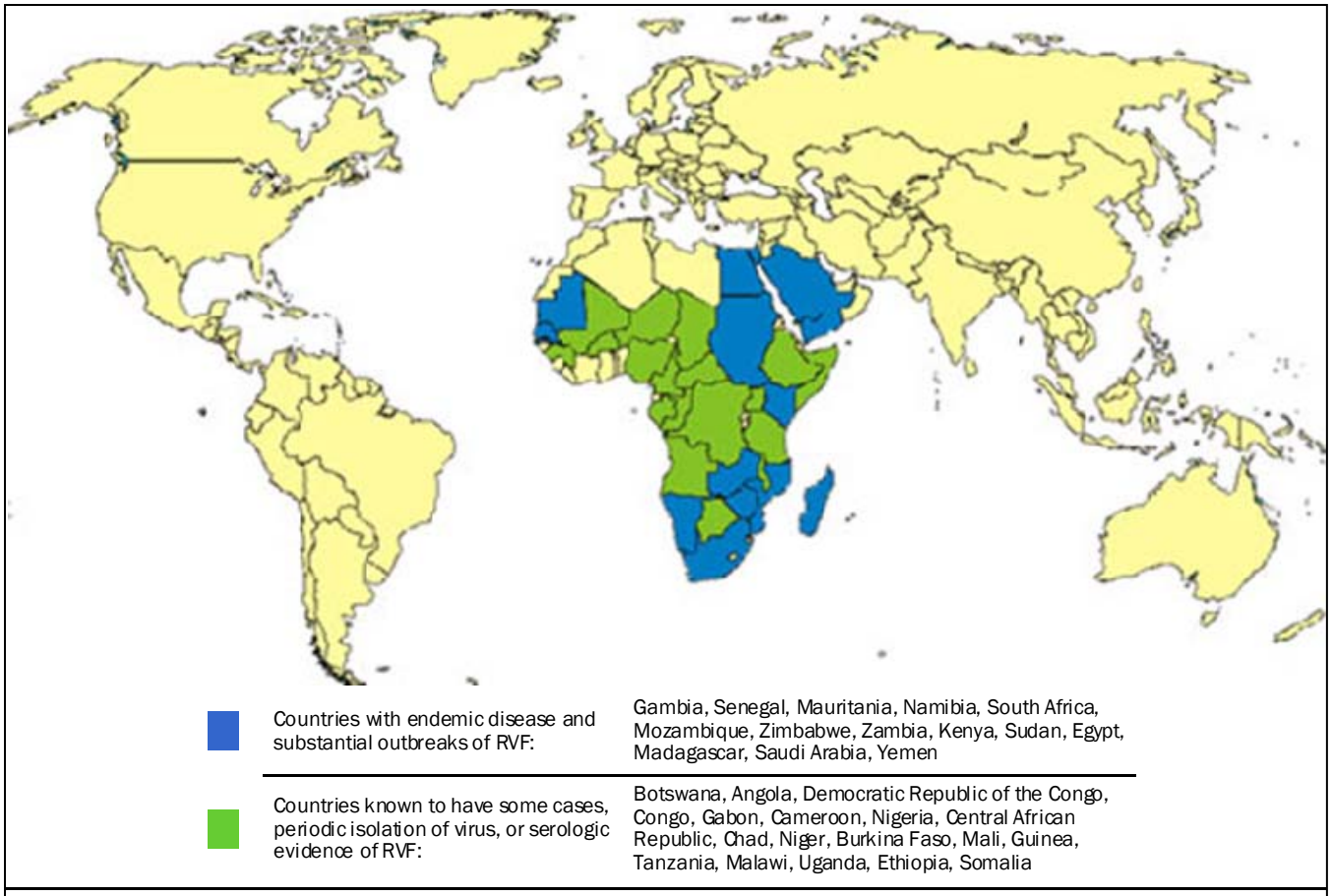

Figure 3: Rift Valley Fever Distribution Map. Graphic courtesy of the US Centers for Disease Control and Prevention (http://www.cdc.gov/ncidod/dvrd/spb/mnpages/dispages/rvf/rvfmap.htm).

- Develop and rehearse RVF outbreak response plans to be implemented by the Department of Homeland Security (DHS) and Federal Emergency Management Agency.
- Ensure RVF vaccine could be readily available for the public in the event of an outbreak. An inactivated vaccine has been developed for human use. However, this vaccine is not licensed and is not commercially available. It has been used experimentally to protect veterinary and laboratory personnel at high risk of exposure to RVF. Other candidate vaccines are under investigation.[20]
- Institute a mobile, federal vector control force that could respond to such emergencies.

Various state, federal, and international entities have recognized the threat of RVF and have implemented some of the above control measures. Contingency planning, predictive disease modeling, and outbreak response exercises represent some of the recent developments to combat RVF threats in both endemic and potentially exposed geographic regions. The Food and Agriculture Organization (FAO) of the United Nations is just one of the international agencies providing guidelines for development of RVF contingency plans.[25] The FAO provides vital information for animal and human health authorities of individual countries by specifying RVF details regarding risk analysis, prevention strategies, early warning signs, forecasting, and control strategies.

Weather patterns and anomalies have been used recently to model and predict RVF outbreaks. In Africa, outbreaks of RVF are integrally tied to widespread elevated rainfall, and the subsequent flooding and increase in vegetation.[26] Risk mapping using climate and normalized difference vegetation index data led to the first prediction of an RVF outbreak from December 2006 to May 2007.[27] The predicted RVF occurrence provided a warning period of 2 to 6 weeks that facilitated response and mitigation

activities. The outbreak that subsequently occurred validated the utilization of risk mapping models to predict future RVF events.

While contingency plans and outbreak predictions provide the logistical framework and science needed, rehearsing the execution of epidemic disease scenarios, with all responding agencies involved, ultimately provides the best gauge of response preparedness. In November 2008, Paul Gibbs, PhD, from the College of Veterinary Medicine at the University of Florida supervised a multiagency test of Florida's response to a hypothetical introduction of RVF (http://www.flsart.org/rvf/index.htm). Incorporating various state and federal participants, including the DHS, the Federal Bureau of Investigation, and the USDA, the exercise trained major stakeholders to collaborate in response to an introduction of RVF virus into Florida. In light of the original event's success, 2 additional RVF exercises were planned and conducted in Puerto Rico and the Virgin Islands by Dr Gibbs and Dana McDaniel, DVM, in 2010 (Dr McDaniel, oral communication, March 2010).

The control measures discussed could reduce the impact from an RVF outbreak, whether the virus is delivered by terrorists or arrives by accident. Without further scientific advances in RVF forecasting, vaccine development, vector control, and diagnostic capabilities, it may be unrealistic to expect to attain the necessary resources required to build and maintain comprehensive control measures to eliminate the threat to our nation of RVF and similar vector-borne diseases. We conclude that the residual risk associated with the threat of RVF, and other vector-borne diseases, remains "high."

Discussion

Entomological terrorism, regardless of its form, is a current and future threat faced by the United States. The estimated risks of the threats outlined in this article are speculative, however, it would be difficult to argue that the hazards associated with entomological terrorism are negligible. The US government has long recognized the consequences of biological warfare. The federal agencies conducting research and development on vector-borne diseases and crop pests include, but are not limited to the following:

- DHS: National Center for Foreign Animal and Zoonotic Disease Defense, and US Customs and Border Protection
- US Army Medical Research Institute of Infectious Disease (USAMRIID)
- Walter Reed Army Institute of Research
- USDA–Agricultural Research Service (ARS) and Animal and Plant Health Inspection Service

Additionally, some local abatement districts, a few state governments (ie, Florida, California), and numerous universities have also made significant contributions to research on vector-borne infectious diseases.

Merely studying the biology of a disease does not prepare us for response to an actual outbreak. Many aspects of an appropriate response to an entomological emergency still must be addressed, including:

- Is the pest management community prepared for an outbreak with the necessary equipment and knowledge to implement control techniques?
- Can pest management resources be quickly consolidated, mobilized, and deployed to outbreak locations?
- Are emergency organizations prepared with individual response plans for specific entomological threats, especially those posing high risk?

Accidental introductions of invasive arthropod species have a higher likelihood of occurring than intentional deliveries through terroristic plots. Military personnel moving to and from forward deployed environments can do their part in preventing the introduction of invasive species by thoroughly inspecting cargo transported by military transportation vehicles and by conducting retrograde washdowns of vehicles and equipment after a deployment.[28] The importance of preventing invasive species is illustrated by the costs currently incurred by these species in the United States. Damage caused by invasive species currently in the United States is estimated at $120 billion to $138 billion each year.[29] Crop losses and control costs due to invasive insects and pathogens were estimated at $25 billion in 2005.[29] There are approximately 500 invasive insect and mite species in crops and an estimated 20,000 species of microbes, including introduced plant pathogens, that have invaded the United States thus far.[29] Additional invasive species

would only compound the problem and costs caused by these pests.

Even with proper systems and technological advances in place to prevent attacks or mitigate the effects of disasters, the United States still faces a deficiency in the number of trained, qualified healthcare professionals. A large portion of the healthcare workforce (including public health professionals, clinicians, and related healthcare fields) in the United States is approaching retirement age.[30] Health professionals are not being trained at a rate needed to fill the loss of retirees.[30] Federal (including the US Army) and state agencies responsible for emergency preparedness and response will soon face personnel challenges requiring additional efforts to educate, train, and retain such public health professionals. A terrorist attack, especially with a biological weapon, would be more devastating if the medical infrastructure is poorly prepared, staffed, and funded.

CONCLUSION

Vector-borne diseases are a current threat because of the self-perpetuating capabilities and delayed morbidity and mortality following exposure or infection.[31] Most disease causing organisms used as biological weapons, particularly the zoonoses, can be delivered to a target population without risk of immediate detection.[31] This article illustrates that insects and other arthropods can be used by an enemy to attack US military personnel and civilians. Some recommendations on how to mitigate the specific threats given (ie, *Paederus* beetles, Medfly, Rift Valley fever) were presented, however, all military personnel can mitigate vector-borne disease threats by taking relatively simple actions.

- Deploying Soldiers and DoD personnel should practice operational risk management (ORM) for infectious diseases. Excellent resources for understanding and following ORM are *Technical Guide 288*,[4] as well as the website for the National Center for Medical Intelligence (http://www.phsource.us/PH/MI/index.htm).
- Personal Protective Measures should be implemented when training within the United States and when deploying outside the country. Treating uniforms with permethrin, or purchasing uniforms that are pretreated with permethrin, as well as using N,N-diethyl-3-methylbenzamide (deet) on exposed skin can reduce the likelihood of contracting mosquito- or tick-borne diseases during field training. The use of personal protective measures will not only help protect the individual from a new emerging vector-borne disease like RVF, but also prevent Soldiers from contracting Rocky Mountain spotted fever, Lyme disease, West Nile virus, Ehrlichiosis, and other vector-borne diseases present in the United States.
- Military personnel conducting food and water vulnerability assessments[32] or retrograde operations are critical players in security by helping protect food and water from exposure to biological agents and by preventing them, including vectors and invasive species, from entering the country.

Invasive pests and the diseases they may carry represent a threat that is magnified when terrorism is involved. The research conducted by academic institutions, a host of federal agencies (eg, USDA-ARS) and the US military (eg, USAMRIID), coupled with entities capable of organizing emergency response activities (eg, DHS, Federal Emergency Management Agency, state and local authorities), provide the critical framework needed to address the entomological threats we face. It would be ideal to provide a definitive countermeasure to entomological terrorism, however, this may be unfeasible due to the financial and logistical challenges involved. The most critical countermeasure to entomological terrorism is the same for any form of terrorism—vigilance by the US military, government agencies, citizens, and our allies.[31]

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Issues Related to Burn Pits in Deployed Settings

Coleen Baird Weese, MD, MPH

Not Another Agent Orange

In August of 2009, President Barack Obama promised that burn pits would not become another "Agent Orange."[1] Agent Orange was a defoliant used by the US military in Vietnam, and Veterans expressed concerns that their exposure led to a range of health conditions. This eventually resulted in the Agent Orange Act of 1991.[2] This legislation addressed the presumption of service connection for diseases associated with exposure to certain herbicide agents. According to this act, any Veteran who served in the Republic of Vietnam and developed Type II diabetes; Hodgkin's disease; Non-Hodgkin's lymphoma; peripheral neuropathy; porphyria cutanea tarda; prostate cancer; certain soft tissue sarcomas; cancer of the lung, bronchus, or larynx; or chloracne and who did not have such a condition prior to service has presumed service connection. These are based on the Institute of Medicine's* assessment of diseases related to Agent Orange exposure, specifically dioxin or 2, 4-dichlorophenoxyacetic acid. The Institute of Medicine regularly evaluates other associations and the strength of the association. This information is provided to the Secretary of the Department of Veterans Affairs.[3] In 2009, this list was extended to include B-cell leukemias, Parkinson's disease, and ischemic heart disease.[4] The legislation ensures that Veterans do not have to prove an exposure, and thus if they have any of these conditions, it is "presumed" to be related to their service if they served in Vietnam. This speeds up the process of obtaining benefits.[5] Interestingly, type II diabetes, ischemic heart disease, and prostate cancer are relatively common diseases in aging populations. Many Veterans had expressed dissatisfaction that this legislation was not passed until 1991—many years after the Vietnam War. The Institute of Medicine held its first meeting to address exposures to burn pit smoke on February 23, 2010.

Burn pits (Figure 1) have been the subject of Soldier concerns, media attention, and Congressional inquiries and legislation. A recent, simple Google search of the term "burn pits" brought up over 25 pages of pertinent media articles, websites, and discussions of lawsuits.

Figure 1. A section of an operating burn pit in Afghanistan, 2009. (Photo provided by the author)

An Old Problem, with Some New Trash…

Trash and solid waste have required attention as long as there have been armies and conflicts. Human activity generates waste. In the United States, each person generates approximately 4 to 6 pounds of waste per day.[6(p455)] Solid waste may consist of a variety of materials to include

> ...any garbage, refuse, sludge, and other discarded material including solid, liquid, semisolid or gaseous material resulting from industrial, commercial, agricultural operations and community activities.[7]

Proper solid waste management is important from a public health perspective. Improper disposal may potentially result in groundwater contamination with radioactive substances, chemicals, or by pathogenic organisms. Uncontrolled wastes also attract insects, rodents, or other vermin that may become vectors for disease organisms. In addition, it is a nuisance, aesthetically unpleasing, generates foul odors, and attracts animals. Military preventive medicine

*The Institute of Medicine, established in 1970 under the National Academy of Sciences, provides unbiased, evidence-based, authoritative information and advice on issues relating to biomedical science, medicine, and health to policy makers, professionals, leaders, and the public at large. Information available at: http://www.iom.edu/About-IOM.aspx.

physicians have long noted the importance of appropriate waste handling.

During the Spanish American War, when the city of Santiago, Cuba surrendered to General William Shafter on July 17, 1898, one of the first orders of business was the recognized necessity to clean up the city, resulting in the removal of 200 loads of trash per day for the first 2 months.[8] Similarly, MAJ Lewis Balch, Brigade Surgeon, made the following observation about the city of Trinidad:

> To insure the health of the troops in this province, necessary sanitary work should be done quickly… The camps are near towns. Disease is to be feared from these towns… It is therefore just as necessary that sanitary measures for prevention, the cleaning of streets, garbage collection, disinfection, reports of contagious disease, its location and character, the isolation of infected persons or things, and such like measures be taken, as it is to have camps pitched in healthy localities and properly policed.[9]

In deployed settings, there are a variety of conditions that may affect the process of waste disposal. There may be minimal to no waste stream segregation, disposal infrastructure, or technology to support incineration and landfills for disposal options. There may be local individual and neighborhood disposal sites that utilize dumping above ground and burning. Vermin control may be minimal. In many locations, if military waste is concentrated at a burn pit or disposal site, locals may attempt to scavenge the site for items for their own use or resale. During a recent observational visit to some locations in Iraq and Afghanistan, waste handling was observed to differ somewhat based on the location and maturity of the camp. Base camps located in more urban locations with means to use local nationals may have formal waste removal, with hauling to a recycling center where segregation of recyclables is performed. This can provide local jobs. At other isolated locations, recycling is less feasible because segregated materials must be transported somewhere. Typically, hazardous materials must be packaged and shipped out of theatre. This is not always possible, and as Miller and Roberts point out,

> However, if there is not a supporting infrastructure or contracting possibilities, or if units are not located near such support, or if other tactical considerations prohibit such arrangements, then field disposal methods must be employed. Generally, the options are burial, incineration, or a combination of these two methods.[6(p450)]

Figure 2. Solid waste material sorting area at Joint Base Balad, Iraq. (Photo provided by the author.)

The nature and composition of trash has changed over the years, as bottled water becomes the norm, Styrofoam is used for food containers, and individuals have personal electronics like computers, music players, and cellular phones, many with batteries. This adds complexity to waste handling and sorting (Figure 2). The plastics most commonly encountered include polystyrene, polyethylene, and polyethylene terephthalate, which is used in single use drink bottles (Figure 3). These plastics contain carbon, hydrogen, and oxygen, and with sufficient oxygen can be completely converted to carbon dioxide and water when burned at high temperature. These are not toxic. However, burn pits are inherently difficult to control with respect to temperature and oxygenation, and thus intermediate compounds may be formed. Additionally, polyvinyl chloride or other plastics containing chlorine may form dioxins when burned. An article reviewing

Figure 3. A pile of plastic water bottles at the Joint Base Balad solid waste material sorting area at Joint Base Balad, Iraq. (Photo provided by the author.)

the emissions of organic air toxics from open burning noted that due to less than ideal combustion conditions, open burning generates soot and particulate matter, carbon monoxide, methane and other light hydrocarbons, volatile organic compounds, and semivolatile organic compounds including polycyclic aromatic hydrocarbons. Depending on the source, dioxins and furans and polychlorinated biphenyls (PCBs) may be produced, as well as metals such as lead and mercury. As open burning is not regulated, I found only 4 citations which provided sampling data from open burning at landfills. Of the four, one had data on criteria pollutants, two had data on semi-volatile organics, and two had information on dioxins, furans, and PCBs. None had information on metals or acid aerosols.[10]

Joint Base Balad

Joint Base Balad is one of the largest air bases in Iraq, and was home to 25,000 military, civilian, and coalition personnel. Since 2003, burn pits have been used to facilitate solid waste disposal activities at Balad.[11(p3)] The burn pit, estimated at 10 acres in size, was the largest in Iraq. It was estimated that about 2 tons of material per day was burned in the early stages of troop deployment, but by 2008 it was noted that it might be as high as several hundred tons per day. "Rough sort" was accomplished where flammables, ammunition, and bulk metals were removed. The pit did not always effectively burn the volume of wastes generated, and smoke had been known to blow over living areas under various weather conditions.[11(p3)] Although incinerators had been obtained for the base, they were not operational due to some contractual issues. During the period of 2005-2006, some samples were collected by preventive medicine personnel, with occasional detections of volatile organic compounds and dioxin, but not at levels associated with any health effects. From January 2007 through April 2007, a sampling effort was conducted by onsite military public health personnel, with support from the Air Force Institute for Operational Health (AFIOH) and the Army Center for Health Promotion and Preventive Medicine (now the Army Public Health Command (Provisional)). As described in the report,

> The air sampling targeted expected emissions from the burn pit to include particulate matter, volatile organics, metals, polycyclic aromatic hydrocarbons, and polychlorodibenzodioxins/furans (dioxins and furans). Sampling locations were selected to represent typical and maximum exposure levels for the general population. The samples were collected over multiple 24 hour periods to account for some of operational and meteorological variability in exposure levels. A total of 163 samples were collected resulting in 4811 individual analyte results.[11(pES-2)]

Sample results were compared to military exposure guidelines (MEGs). These are values below which no health effects are anticipated for the associated exposure duration. These values and their applications have been reviewed by the Committee on Toxicology of the National Academy of Sciences.[12] The one-year MEGs assume an exposure to that concentration for one year. If a chemical is detected above this MEG, it will not necessarily be a health concern as the MEG assumes a one-year exposure, which would not be the case if the source is identified and rectified, or if conditions are variable. The one-year MEGs were exceeded in 52 samples, of which 50 were for particulate matter (PM) less than 10 μm in diameter (PM 10). Particulate matter levels were typical of what would be expected in the region, and were similar to background levels not in proximity to the burn pit. PM has previously been identified as a common exposure due to blowing dust, vehicle emissions, and other sources. While it did not appear that the burn pits significantly increased particulate matter levels, PM from combustion may vary in composition from more typical regional particulate matter associated with crustal material such as dust. All PM samples were analyzed for metal concentrations, and no metal was detected above a one-year MEG in these samples. Apart from particulate matter, MEGs for volatile organic compounds (VOCs) were exceeded twice. Concentrations of acrolein and hexachlorobutadiene exceeded the MEG in one of 44 samples. Each sample was analyzed for 77 different VOCs. No other VOCs were detected in the other 43 samples. No dioxins or furans were detected above a one-year MEG in any of the 32 samples analyzed for dioxins and furans. No polycyclic aromatic hydrocarbons (PAHs) were detected above a one-year MEG in any of the 30 samples analyzed for PAHs.[11(p5)]

The results were used for a composite risk management estimate (also sometimes called an operational risk management estimate) that focuses on mission impact. This methodology uses comparisons to the MEGs, and then evaluates the severity of the health risk (how high was the level?) and the

probability of occurrence (was anyone exposed for the duration? How frequently was it detected?). The subsequent risk estimate for exposure to all substances analyzed in this sampling effort was considered low, not considering PM 10. The single acrolein measurement which was above the one-year MEG was below the 14-day MEG. This suggests that an occasional finding at that level would not be a concern. Acrolein can be irritating to eyes, nose, and lungs at levels much higher than measured, or if exposure is continuous for long periods. The single hexachlorobutadiene sample result was above the one-year MEG, but below the 8-hour MEG. This suggests that the measured level was not sufficient to cause an acute effect, but, on the other hand, it would be important to see that this was an infrequent detection. Hexachlorobutadiene is a solvent that can cause dizziness or headache at an elevated level. Given that these compounds were detected over the most conservative one-year screening level only once, the probability that individuals would be exposed to elevated levels for an entire year was considered unlikely.[13]

The data from the Balad burn pit sampling effort was used in a quantitative screening human health risk assessment, using the Human Health Risk Assessment Guidance for Superfund methodology outlined by the US Environmental Protection Agency (EPA).[14] This evaluation uses comparison values which are designed for longer term exposure scenarios of the general population, including children and the elderly. It allows for theoretical or probabilistic cancer risk estimates based on time at site used for the exposure scenarios as well as additive assessment of carcinogenic (cancer) risk. It uses what is termed exposure point concentrations (EPCs), calculated as the 95th upper confidence limit of the mean of each chemical, which is very conservative. Risks were calculated assuming a 24-hour/7 day per week exposure, for 12 months, 4 months, and one month. Additionally, a combined EPC was derived, as well as EPCs representing various locations where sampling occurred. Using this methodology, both noncancer and cancer risk were "acceptable" or "safe" as per the EPA classification. Two incinerators became operational at Balad by July 2007, and plastic segregation (Figure 3) and other measures such as disposal of cooking oil and grease were instituted. Additional sampling was conducted in October and November of 2007 with results that again showed some infrequent detections of volatile organic compounds. By April 2008, a third incinerator was operational. By June of 2009, more incinerators were operational, others were being installed (Figure 4), and open burning had been reduced to approximately 10 tons per day. The burn pit was closed on October 1, 2009.

Figure 4. Incinerators in operation at Joint Base Balad, Iraq, November 2009. (Photo provided by the author.)

While many of the assumptions or applications of data in the risk assessment were conservative which might point to an overestimation of risk, the screening health risk assessment could not definitively address all concerns regarding human health risk for several reasons. The methodology does not incorporate PM 10 or PM 2.5 concentrations. PM is a mixture, and does not have a toxicological value for use in the methodology. The list of analytes was not exhaustive. The sampling was conducted over a 4-month period, and represents conditions during that time. The waste streams can vary, and analyte concentrations would be presumed to vary. In short, if meteorological conditions are variable and waste streams change, it is difficult to generalize. Screening health risk assessments indicate the general probability that a risk is present under very specific exposure conditions. This can be useful to make decisions regarding the need to take remedial actions, but is not well-suited to inform regarding an individual's risk for a health outcome. All risk assessments have stated assumptions and limitations which tend to be overlooked in summary statements communicated to individuals not familiar with the methodology. The US Central Command (CENTCOM) worked rapidly to declassify the report to make it available to interested parties, and risk communication was conducted, but it is unknown as to whether the report actually relieved people's concerns. It is of interest to note that if the report was evaluated in a vacuum, most risk managers would see

it as evidence that the situation did not require remedial actions, although they might request additional data to cover information gaps, such as sampling for different analytes, or in a different season.

The use of PM 10 measurements to address chronic risk is still under consideration. Relative to the United States, high levels of PM 10 and PM 2.5 are common in the CENTCOM areas.[15] Acute effects include eye and respiratory irritation and potential aggravation of asthma. To address long-term risk, variable daily PM exposure levels must be considered. Under the Ambient Air Quality Standards for PM 10, the EPA identifies short term health effects associated with acute, daily exposure levels.[16] Health effects associated with long-term exposure to elevated levels of particulate matter have been suggested, such as increased rates of chronic obstructive pulmonary disease (asthma, bronchitis), but the aggregate levels of exposure related to increased risks are not clearly defined. In 2009, the US Army Public Health Command (Provisional) (USAPH (P)) asked the Committee on Toxicology of the National Academy of Sciences to review an extensive enhanced particulate matter sampling effort which sampled for particulate matter every sixth day for one year at 15 sites in the CENTCOM area of responsibility.[17] A key question is how to use this data to understand risk of health effects. A report is expected this year.[18]

The Defense Health Board (DHB) reviewed the conclusions of the initial screening health risk assessment. The DHB is an independent board comprised of experts from private industry and universities. The DHB agreed with the conclusion that no long-term health effects should be expected due to dioxin or the analytes measured and used in the risk assessment. However, that statement is not equivalent to definitive, long-term health risk. Conclusions regarding long-term risk are limited by the short-term nature of the sampling event. The DHB also made some recommendations and offered to remain engaged on the issue.[19] Currently, a strategy for additional sampling is under evaluation.

The goal of preventive medicine efforts is the elimination or reduction of any identified hazards. Various CENTCOM policies have instructed commanders to use all other means feasible to reduce reliance on burn pits. The USAPHC(P)/Air Force Institute of Health sampling effort at Balad was conducted when concerns arose regarding the potential health implications of the burn pits. Other preventive medicine assets in theatre have sampled intermittently at burn pits at other locations, or have taken samples in troop locations when there was concern about smoke. These are typically not sufficient in number for use in a risk assessment. The results of the sampling efforts have not identified a definite hazard based on measured analytes compared to available standards. In a sense, then, the sampling could be viewed as supporting a conclusion that there is no clear hazard. However, as previously noted, sampling identifies conditions at the time of sampling and it is understood that conditions can be variable. Burn pit sampling is intermittent and waste streams and meteorological conditions are variable. While sampling can be used to identify a potential concern, it does not refute all concerns because it cannot address all locations and conditions at all times. As such, limitations to sampling will generally be identified, as these are complex, variable situations with multiple potential hazards. Additionally, the methodologies available to evaluate complex mixtures in terms of potential health effect are limited. Therefore, sampling does not always reassure, nor lead to definitive answers to complex questions.

Clear expectations of the purpose and limitations of sampling data must be understood. Those who communicate findings must be clear not to over-generalize the findings. From a preventive medicine perspective, the prevention, reduction, or mitigation of untoward exposures is the goal. If operational constraints prevent this goal from being achieved, it should be recognized that sampling data which fails to demonstrate a risk may not alleviate concerns because it has limitations in number and type of sample, time and space, and the population at risk. Sampling that does demonstrate a potential risk may be difficult to interpret to precisely define the predictive risk, and the population at risk on large base camps. Thus, sampling is best used as an adjunct to prudent practices.

The difficulties inherent in using intermittent environmental data to determine health risk have been well described. A Committee on Environmental Epidemiology of the National Research Council report

entitled *Public Health and Hazardous Wastes* evaluated epidemiological studies conducted around hazard waste sites and identified several limitations.[20] These included limited exposure data, nonspecific health outcomes, insufficient power, latency and confounding, and small relative risk. Most of these limitations would apply to the use of intermittent sampling data to evaluate health outcomes in populations where actual levels of exposure of individuals are not known. More specifically, the Committee on Health Effects of Waste Incineration of the National Academy of Sciences published a report entitled *Waste incineration and Public Health*.[21] Although the report specifically evaluated the relationship between incineration and health effects in communities surrounding incinerators, many of the same issues apply to the use of burn pits. The report identified particulate matter, lead, mercury, dioxins, and furans as the contaminants of most concern. It noted that epidemiological studies had failed to identify health effects but noted that the problems of misclassification, limited sampling data, health effects with multiple potential etiologies, etc, limited conclusions. The report also noted that the variability of emissions, periods of less than optimal performance of incinerators, changing weather conditions, distance of population from the incinerators, and susceptibilities and activity patterns of the surrounding populations are important uncertainties in the study of health effects related to incineration.

Many of the limitations cited in the 2 reports are relevant to the assessment of the association between burning trash and future health outcomes. Sampling will likely always have limitations, and the epidemiological studies conducted with or without exposure levels to contaminants will have limitations. Ideally, epidemiological studies use populations of sufficient size and reasonable comparison groups, and address the issue of latent conditions. This may allow for an assessment of the relative rate of potential health outcomes, which will contribute to the understanding of whether or not outcomes appear to be occurring at increased rates, and provide an estimate of the size of the increase.

While surveillance for health outcomes of interest is a role of preventive medicine, it is a secondary goal to that of striving to prevent the occurrence of such outcomes. Attention to waste management issues by preventive medicine personnel in 1898 was prompted by nuisance and infectious disease concerns, as opposed to those relating to chemical exposure. To this day, waste and waste handling remain major, significantly more complex concerns.

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Using Geographic Information Systems to Maximize Environmental Surveillance Efforts and Impact

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Sheila Denice Adams

Abstract

There has been tremendous advancement in geographic information systems (GIS) software and hardware over the last 2 decades. This article illustrates how these advancements can be used to greatly increase the ease and efficiency of collecting environmental samples and demonstrates how environmental data collected within a GIS is more valuable because of the visualization, analysis, and historical capabilities of the technology. This article reviews 6 actual field surveys conducted using desktop GIS and field GIS by entomologists with the US Army Public Health Command (Provisional). While these examples involve entomological data, the techniques and procedures are applicable to any type of environmental data.

Introduction

What is a field geographic information system? A geographic information system (GIS) makes it easier to organize, store, access, retrieve, manipulate, synthesize, and apply information to our benefit. The geographic component describes where events, activities, and other things happen or exist on the face of the earth and relates them in space to other data. Google Maps and Google Earth (Google, Inc, Mountain View, California) are examples of a simple GIS. A desktop GIS application frequently used in the Department of Defense (DoD) for planning and mapping is ESRI's ArcView (Environmental Systems Research Institute Inc, Redlands, California). For the purpose of this article, a field GIS is defined as a software/hardware system that allows the user to instantly view the samples location on a map; to electronically record the latitude and longitude of a location; to enter extensive, customized data about that location; and to easily transfer the data into a desktop GIS application. Standalone global positioning systems (GPS) generally do not fit these criteria because they lack the ability to enter extensive, customized data about a specific location and are unable to save the information in a file format (shapefile), which can easily transfer the data into a desktop GIS application.

Figure 1. Field GIS Hewlett-Packard personal digital assistant with US GlobalSat GPS, and Farm Works field GIS software shown mapping a mosquito breeding pool identified by black arrow.

Examples

Mosquito Breeding Pool Mapping

Figures 1 and 2 show a field GIS system that we have used extensively to take literally tens of thousands of data points. In the example shown in Figure 1, we chose to map a mosquito breeding pool by selecting the boundary theme, then selecting "GO" and walking the perimeter of the pool.

Once we arrive back at our starting point the data table opens (Figure 2). This table tells us the perimeter and area of the pool so we can calculate the amount of insecticide needed to treat for mosquitoes, and allows us to enter treatment and survey notes into the data table. Figure 2 illustrates an open pick-list which allows us to record the type of breeding site.

Mosquito Survey

Figures 3, 4, and 5 show the planning and execution of a multiteam

mosquito survey. Figure 3 shows the area to be surveyed broken into 5 equal areas labeled Oscar, Yankee, Golf, Bravo, and Victor. Each team was assigned an area and given a field GIS loaded with the data for only their respective area of responsibility. The data layers on the field GIS included roads, streams, and human action areas.

Figure 2. Field GIS data table opened for the mapped mosquito breeding pool and ready for data entry.

Each team walked throughout their area and mapped mosquito breeding sites and applied larvacide as necessary. Because the mapped larval sites appeared on the field GIS map, it was easy to insure complete and thorough coverage of the wooded area. Figure 4 shows the results of 3 days of surveillance. The red dots are the larval breeding sites that were found and the columns show the results of mosquito light traps. The ability to map this data while onsite proved valuable because it became immediately obvious that the number of larval sites found in the vicinity of the light trap in the southwest corner were insufficient to explain the number of adult mosquitoes caught in that light trap.

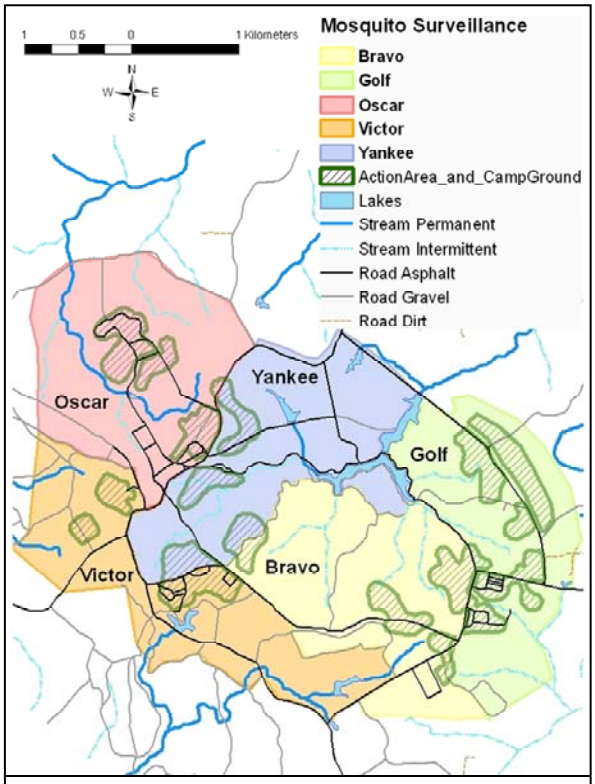

Figure 3. The area to be surveyed broken into 5 named equal areas with roads, streams, human action or activity areas.

The area was resurveyed the next day, and an intermittent stream and temporary pool were discovered to the southwest (Figure 5). These are mapped in green and light blue. Please note that the odd shape of the temporary pond is due to poor signal reception by an earlier generation GPS. While the shape of the temporary pool is not accurate, its location is accurate to within 30 feet. These breeding sites were treated with larvacide and mapped for future reference.

Had we not had the capability to rapidly load the surveillance data into a GIS, we would not have realized that a major breeding site had been missed while we were still onsite and able to investigate. This clearly demonstrates the value of taking GIS into the field and doing even a simple analysis prior to leaving the field. This example also shows the historical value of GIS. In addition to a shapefile with the larval breeding sites, the installation was provided a topographical map showing all the larval breeding sites. In the future, the sites can be rechecked using the topographical map or the shapefile can be loaded into a field GIS and found using the navigation tool. This preserves the efforts of the surveillance team because the information is easily accessible. Had the team simply recorded the latitude and longitude in a table, it is unlikely that anyone in the future would take the time and effort necessary to manually enter the coordinates into a GIS so that the information could be used.

Tick Population Studies

Figure 6 illustrates the clear superiority of GIS as a survey planning tool. In this scenario we wanted to investigate the relationship between the tick population and soil type, soil slope, and vegetation type (deciduous or coniferous). The tick population would be determined by dragging a one-meter by one-meter flannel cloth 100 meters through the habitat. Each soil type, soil slope, and vegetation type would have to be sampled an equal number of times over the survey week. An analysis of the GIS soil layer revealed that while there were 27 soil types within the study site, 12

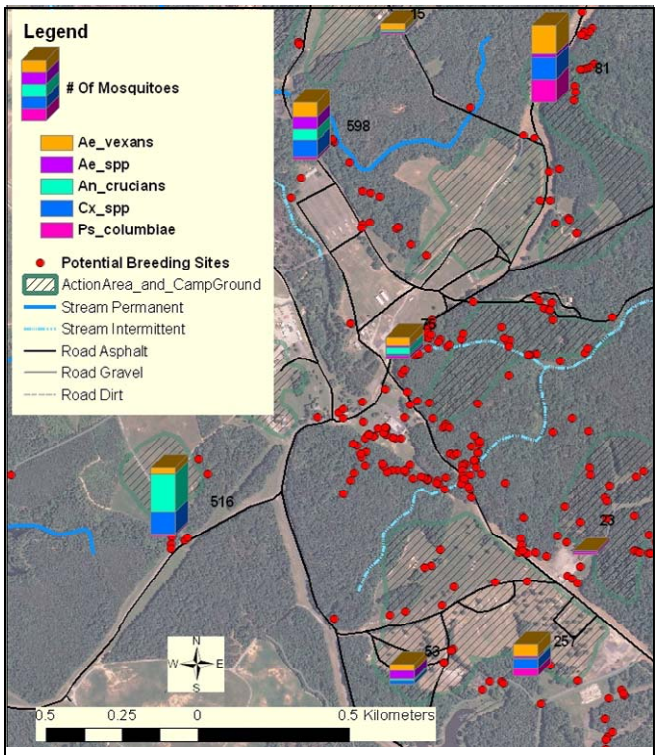

Figure 4. Survey site showing larval sites as red dots and results of mosquito light trap data as stacked columns.

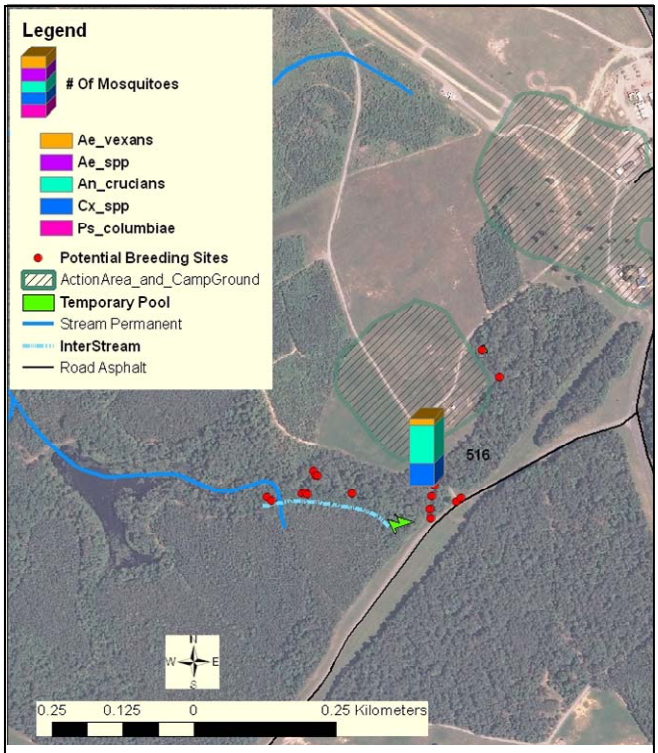

Figure 5. Location of pond, green, and intermittent stream, light blue, discovered upon resurvey of the area.

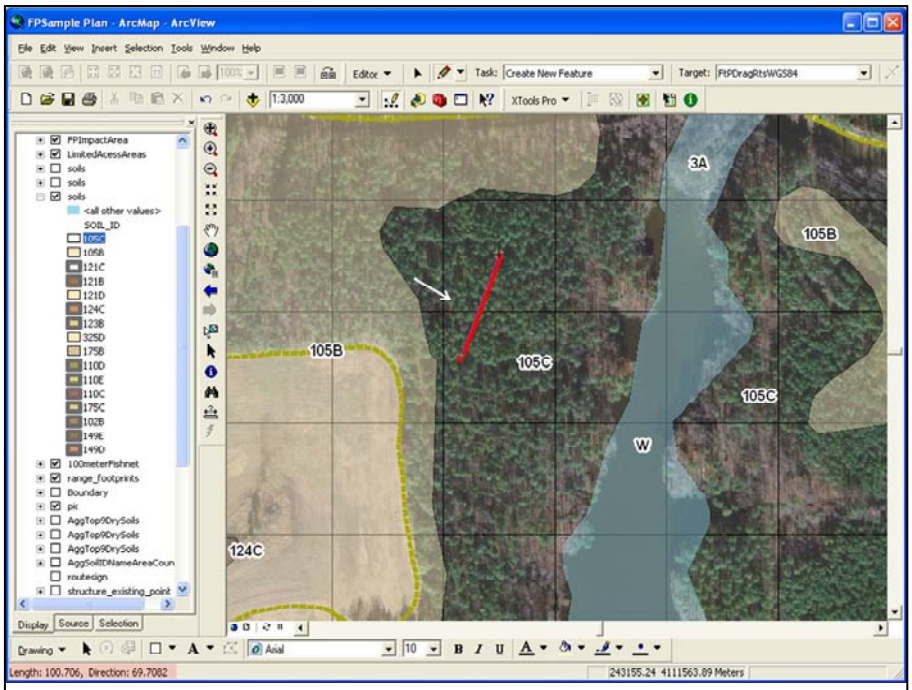

Figure 6. Using GIS to insure that proposed tick drag, red line, is within desired vegetation, soil type and slope.

Figure 7. Tick survey site showing post to mark the site, dry ice on white cloth, and inset, the collecting of ticks off the cloth with masking tape.

types accounted for 88% of the study site. Each of those 12 soil/slope types would have to be sampled 8 times for a total of 120 drags.

Figure 6 shows a section of the study site with the soil layer (numbered polygons), soil slope (indicated by a letter), and a winter aerial photo (allows one to discern between deciduous or coniferous). Using the Create New Feature Task, drag locations were selected within a particular soil type/slope and vegetation type. The arrow indicates a line being drawn to represent a drag in soil type 105, slope C, coniferous. In the bottom left corner of the window the program shows the length of the line drawn, in this case 100.7 meters, and the direction of the line, 69.7 degrees true north.

These tools allowed all 120 sample sites to be selected prior to going to the field and ensured that each parameter was sampled equally. The drag routes were divided equally among the 4 teams, and each team received a field GIS system with only their assigned drag routes. The drag routes were numbered in the order they were to be done. Designating the drag completion order controls for weather related sampling bias. In the field, each team used the field GIS to select the beginning of their next drag, then used the navigation feature to go to the starting point. A compass was used to determine the direction of the drag. This approach ensured the successful accomplishment of the sample plan with no confusion or time lost searching for survey sites on the ground.

Figures 7 and 8 illustrate the high value of georeference data. In this survey of lone star ticks, 103 sites were selected throughout the study area. At each location, 3 collection sites were placed about 5 meters from each other, consisting of a piece of dry ice on slippery white cloths. The site was left, and after 2 hours survey personnel returned to the site and collected the ticks off of the white sheet using a piece of masking tape (Figure 7).

Since many of these sites were deep in dense woods, the GPS component of field GIS was critical to ensure that the teams could return to the sites within the allotted time interval. However, the greatest contribution was the geostatistical data analysis made possible because the sites had been georeferenced. Without georeferencing the sites, the most we could have done with the data is report the basic statistics: ticks collected ranged from 0 to 522 per site, the median was 3, the mean was 30.5, and the standard deviation was 70.8. About all this type of analysis tells you is there are places with lots of ticks and places with few ticks, something anyone familiar with the area would know without the survey.

Figure 8 shows the data following geostatistical analysis. The region within the yellow to red colored areas is the part of the study site where there is a 50% or greater probability that those regions contribute to 85% of the tick population. A detailed discussion of the geostatistics involved is provided by Brenner et al.[1]

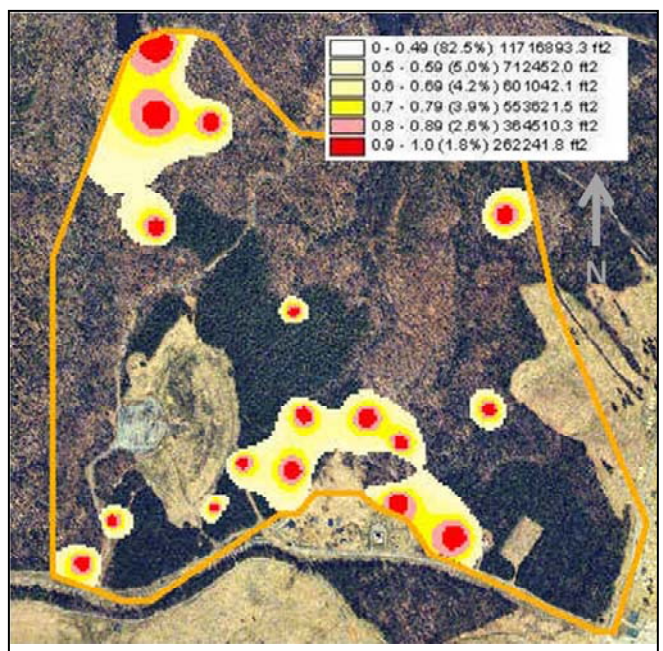

Figure 8. Results of geostatistical analysis showing those areas, yellow to red, which contribute to 85% of the tick population.

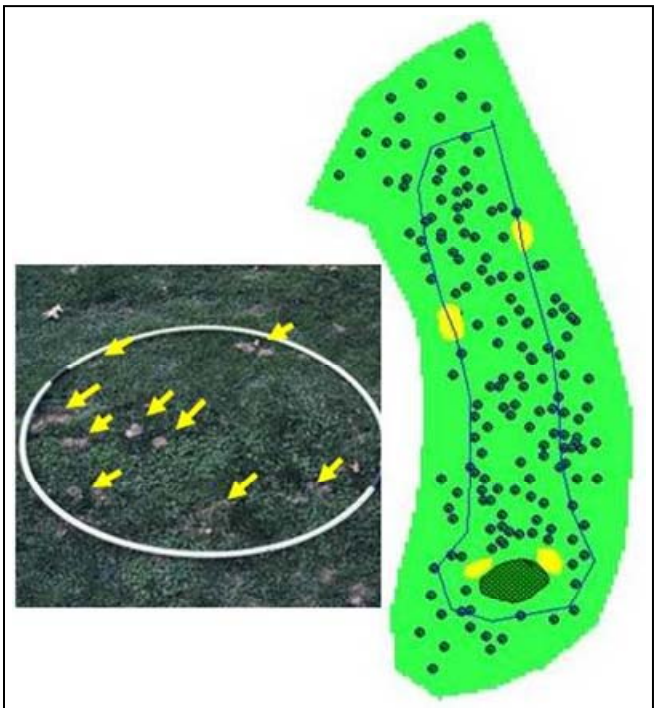

Figure 9. Sampling ring with yellow arrows pointing to green June beetle mounds on a golf course fairway and location of sample sites.

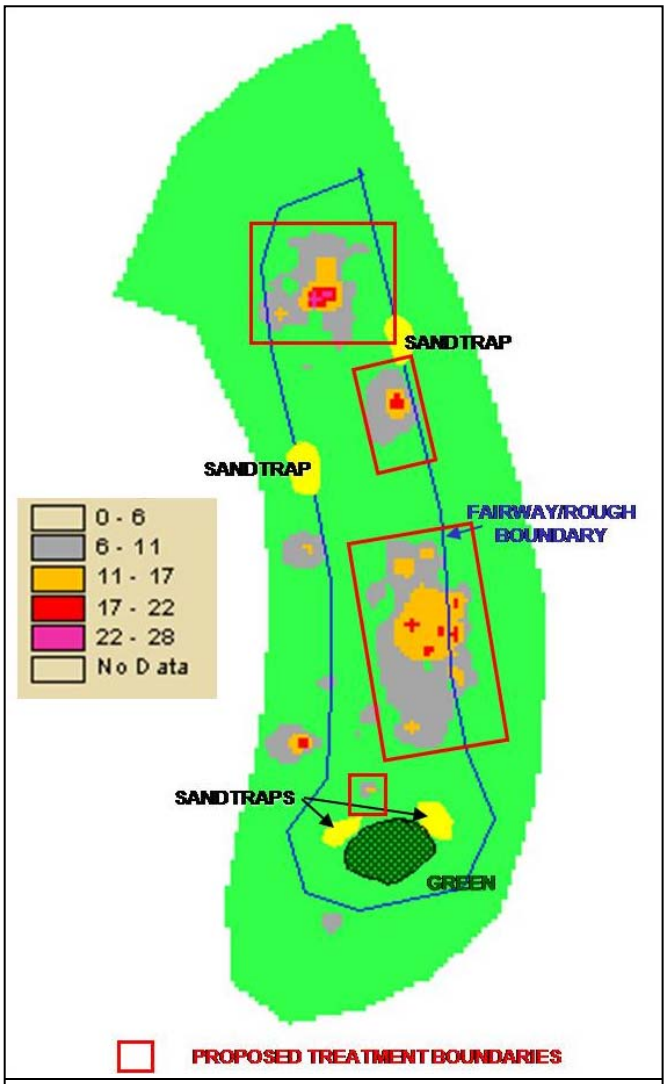

Figure 10. Raw data population contours show those areas, gray to purple, where the population action threshold (6 or more mounds per sampling ring) was exceeded. The red polygons are the proposed pesticide treatment areas.

The Figure 8 legend shows the probability associated with each color area, the percent of the total area (which is indicated by an orange line), and the total square feet. For example, the clear uncolored area has a probability of 0 to 0.49, and accounts for 82.5% or 11,716,893 square feet of the study site. Therefore, 85% of the ticks were on just 17.5% of the study site.

Unlike the basic statistics, this is actionable information since, once mapped, those areas accounting for 85% of the tick population can either be treated or avoided. Insect populations, like most environmental data, are not randomly distributed but occur in clumped distributions. Therefore, it is common to find that the majority of a population is on a minority of the area of interest. The ability of geostatistical analysis to identify and map these areas is a powerful tool.

June Beetle Control

Figures 9, 10, 11, and 12 provide another example of how environmental data collected within a GIS is more valuable because of geostatistical analysis capability. In the scenario associated with the figures, the task was the prevention of green June beetle damage to a golf course fairway. Green June beetles negatively impact play by creating dirt mounds as they tunnel into the turf each morning. Typically the spray technician would treat the entire fairway. In order to be more efficient, we mapped the green June beetle population. This was accomplished by counting the number of dirt mounds within each of 163 sampling rings dropped on the ground. Figure 9 shows the sampling ring and dirt mounds, and the location of the sample sites on the fairway which were recorded with field GIS hardware/software.

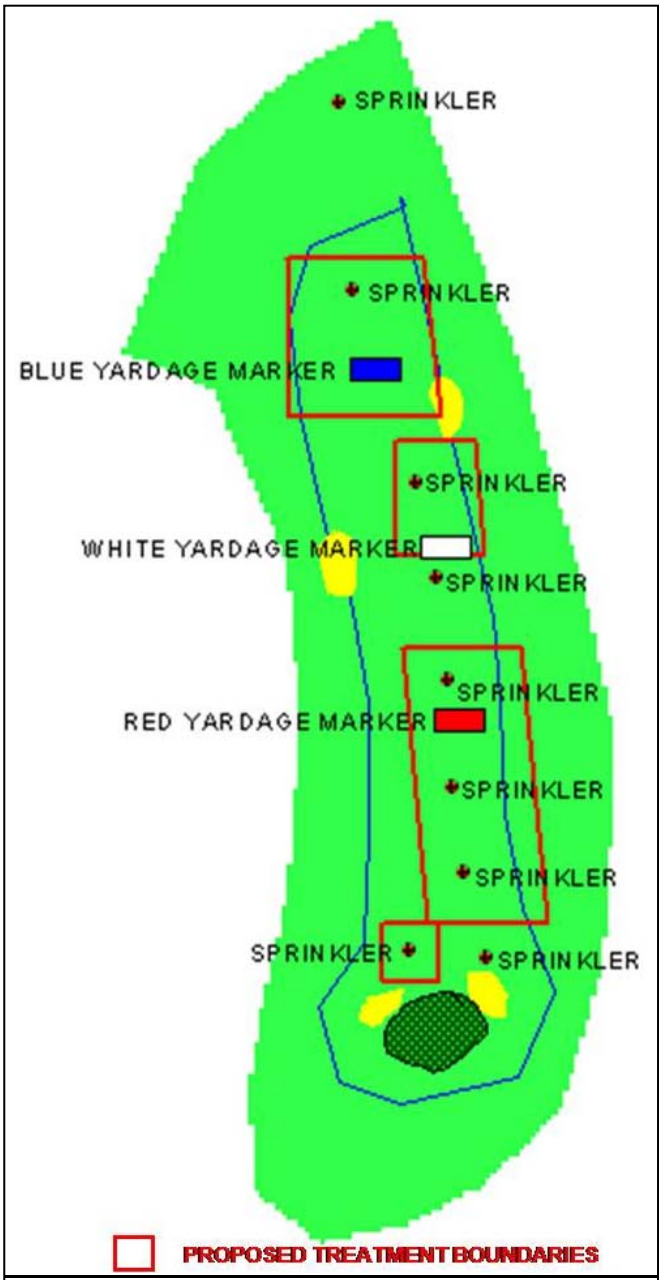

Figure 11. Treatment map presented to spray technician.

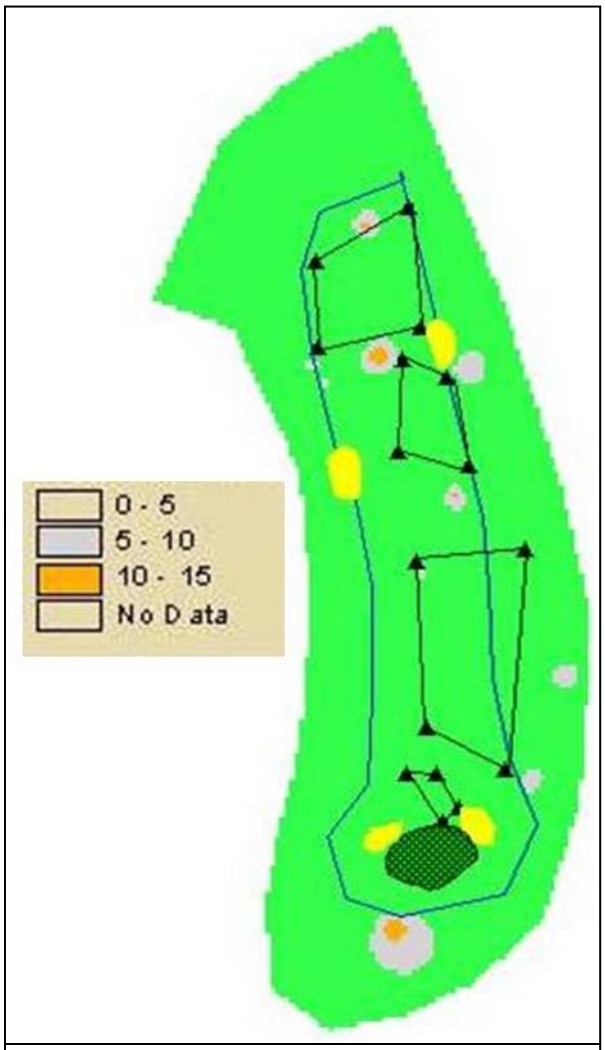

Figure 12. Post insecticide treatment map showing raw data population contours, gray to orange, where there were 6 or more mounds per sampling ring. The black polygons are the areas actually treated with insecticide.

The golf course superintendent set a threshold of 6 or more mounds per sampling ring as the trigger for control action. Because the field data was collected in a GIS within a half hour of the last sample, we were able to produce Figures 10 and 11. Figure 10 shows the raw data population contours produced by performing a geostatistical inverse distance weighting analysis of the data.[1] The areas colored gray to purple display where there were 6 or more mounds per sampling ring. The red polygons are the proposed pesticide treatment areas.

Figure 11 is the map that was provided to the spray technician. The treatment boxes were drawn so they could be referenced with readily apparent landmarks: yard markers, sprinkler heads, rough/fairway boundary, sand traps, and green.

The post treatment survey (Figure 12) shows that 95% control was obtained by treating less than 30% of the total fairway. In this case, use of GIS reduced the

amount of pesticide placed in the environment, reduced cost because less area was treated, and achieved the desirable level of control.

Pesticide Residue Mapping

Figure 13 is an example of mapping environmental data other than insects. In this scenario, a pesticide storage facility was to be converted to an office. Forty seven wipe samples were taken and analyzed for pesticide residue. The outline of the building was converted to a shapefile and loaded into the field GIS. Since GPS signals do not penetrate buildings well, the manual location tool was used and the location of the wipe samples were visually georeferenced, using the building outline as a reference. Inverse distance weighting was used to create contours of the total pesticide concentration, and all areas exceeding the threshold of 5 or more micrograms are shown in Figure 13. At a glance, this map shows where remediation is needed. This data presentation is far superior to a 6-page table detailing the results of the individual wipe samples.

Additional examples illustrating the value of using GIS for environmental data can be found at http://chppm-www.apgea.army.mil/Entomology-GIS/.

SUMMARY

The 6 examples presented here clearly illustrate that use of GIS improves the efficiency and efficacy of field work and ensures that field teams do not waste time by inadvertently sampling outside their area of responsibility. Data entered into a GIS is more valuable because the spatial component is captured. The spatial component allows the data to be related to other spatial data and be geostatistically analyzed. Geostatistical analysis is a powerful tool that allows one to identify and map the areas of concern so either remediation efforts can be focused where they are most needed, or those areas of greatest concern can be avoided. Providing a map of the data is far superior to providing data tables and hoping that the reader will be able to interpret the information accurately. Maps also provide a historical reference superior to data tables. Field surveys and analysis of environmental samples are very expensive. It is, therefore, only logical to enter the data into a GIS so that the greatest return on that investment will be realized.

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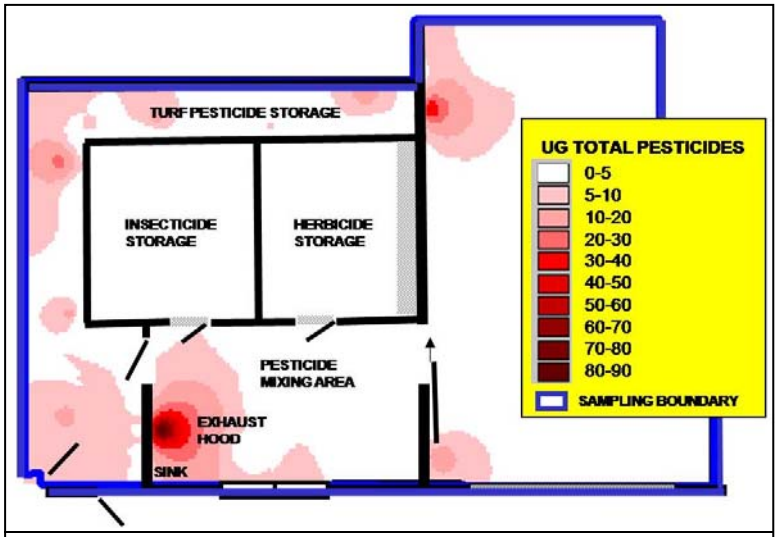

Figure 13. Raw data contours showing those areas where total pesticide concentrations exceeded the threshold of 5 μg per wipe sample.

Mystery of the X-Ray Overexposure: An Innovative Risk and Media Communication Mentoring Workshop

COL Mark A. Melanson, MS, USA
Lori S. Geckle
Lyn C. Kukral
Michele Costanza, PhD

Introduction

This paper describes a unique, integrated professional development workshop that was recently designed and conducted for Army Nuclear Medical Science Officers (NMSOs) to further hone their special expertise in health physics (radiation safety), while developing their skills in both risk and media communications. The 2-day workshop, held in conjunction with the Annual Force Health Protection Conference, was a collaborative effort, bringing together health physics, mentoring/coaching, risk communication, and public affairs experts. The key to a highly successful training event was the amplification of individual and group NMSO self-awareness, the study of a real-world Army health physics radiation case study, and the practical use of effective risk and media communication principles. The workshop was also an effective group mentoring experience for all of the officers. Other force health protection practitioners may benefit from the lessons learned from the development and implementation of this truly innovative professional development vehicle, and can use it as a template for their own professional groups or organizations.

Workshop Cadre

In order to accomplish this very ambitious training event, a highly diverse group of experts was brought together to both design and conduct the workshop. The leader of the cadre was the career field leader for the Army's roughly 60 NMSOs (lead author M. A. Melanson). An independent consultant was contracted to assist with the self-awareness, mentoring, and coaching portion of the training. To provide risk communication expertise, a senior risk communicator from the Army Public Health Command (Provisional) (APHC(P)) partnered in the effort. The APHC(P) public affairs officer was also invited to craft the media communication piece of the exercise. Finally, 2 health physicists, one civilian and one NMSO, also participated in the development and implementation of the workshop case study.

Workshop Participants

Twenty-four Army NMSOs registered for and attended the 2-day workshop. They included both junior and senior officers from the Active Army, the Army Reserves, and the Army National Guard, and represented a diverse cross section of the specialty. The demographics were 6 lieutenants, 12 captains, 3 majors, and 3 lieutenant colonels. The officers came from various stateside and overseas duty stations and accounted for roughly half of the Army's inventory of NMSOs.

Goal of the Workshop

The workshop goal was to provide the NMSO participants with an integrated learning opportunity based upon a real world case study, enhancing individual and group health physics expertise while providing practical risk communication and media communication training. The cadre also wanted to foster a supportive learning environment that would allow individual and group self-awareness and foster individual and group mentoring.

Workshop Overview

The workshop was a preliminary conference to the Army's Annual Force Health Protection Conference (FHPC), a premier military public health conference. It was scheduled to unfold over 2 consecutive days, just before the opening of the main FHPC. In addition to being an icebreaker and warm-up for the participants, the first day allowed the NMSOs to increase their own self-awareness while also learning about the overall

group and its individual members. The enhancements of individual and group awareness resulted in an increased understanding and mutual respect among the individuals. This served to facilitate the group learning efforts planned for the second day.

On the second day, the participants applied their newly found self and group awareness to solve a complex health physics problem based upon a real world radiation overexposure case study. Once organized into small groups each led by a senior officer, the NMSOs were presented with the case study and then began to collect critical information to determine what actually happened. Once the case study was solved, the next phase was preparation to explain the risks of the alleged radiation overexposure incident to nonscientists. The culmination of the workshop was 2 role playing exercises where 2 selected participants either explained the radiation risks to an actor playing the alleged overexposed Soldier, or conducted a staged media interview with a simulated news reporter.

Workshop Design

Design of the workshop's 2 interrelated parts occurred concurrently. As the workshop leader worked closely with the mentoring and coaching consultant to design the self and group awareness day, he simultaneously worked with the health physics experts to convert the real world overexposure incident into a daylong exercise while partnering with the risk and media communication subject matter experts to plan the 2 role playing exercises. Fortunately, the workshop leader had an existing good working relationship with the entire workshop cadre which greatly facilitated this ambitious integrated effort.

Design of Day 1 – Self and Group Awareness

The mentoring and coaching consultant was briefed on the overall goal of the workshop's first day: self and group awareness. The cadre leader also expressed his desire to use the Myers-Briggs Type Indicators (MBTI) (CPP Inc, Mountain View, CA), a popular and useful self-awareness tool. The consultant then suggested that the use of the MBTI could be bolstered by the addition of training about Emotional Intelligence Competencies (EICs).

Myers-Briggs Type Indicators

First developed in 1962, the MBTI was the product of collaboration between 2 psychologists, Katharine Briggs and her daughter, Isabel Briggs Myers.[1,2] The MBTI is directly based upon the cognitive theories of the famous psychologist Carl Gustav Jung.[3] Through the use of a questionnaire, the MBTI identifies and measures psychological preferences by which people perceive the world and make decisions. The questionnaire first determines how an individual gets his or her energy, either from looking inside or from interacting with others. Next, it assesses how a person prefers to receive information, by focus on details or by viewing the big picture. The survey then addresses how a person's decisions are made using this information, by using logic or relying on feelings. Lastly, the test reveals how the individual orients him or herself with respect to the rest of the world, by being regimented or by being flexible.

Emotional Intelligence Competencies

The theory of emotional intelligence stems from the seminal work by Dr Daniel Goleman[4,5] and is traceable to Charles Darwin's work on the role of emotions in survival and adaptation.[6] Mastery of emotional intelligence is the result of mastering key competencies designated as EICs. These EICs are broken into 2 large groups, Personal Competence and Social Competence. Subcompetencies under the category of Personal Competence include Self-awareness (emotional awareness, accurate self-assessment, self-confidence), Self-regulation (self-control, trustworthiness, conscientiousness, adaptability, innovativeness), and Self-motivation (achievement drive, commitment, initiative, optimism). The other group of competencies, Social Competence, includes Social Awareness (empathy, service orientation, developing others, leveraging diversity, and political awareness), and Social Skills (influence, communication, leadership, change catalyst, conflict management, building bonds, collaboration and cooperation, and teamwork). Given the goals of the workshop, the mentoring and coaching consultant recommended focusing on the following 6 EICs: Communication, Empathy, Developing Others, Self-Confidence, Teamwork, and Collaboration.

Throughout the day, interactive exercises or "games" were used to help understanding and awareness of self-awareness tools and to sustain individual and group participation. This made the day fun and memorable. Many of these games involved intentional pairing of junior officers with senior officers to facilitate flash mentoring. Along with this broad guidance, the consultant was also provided an overview of the second day, so that she was aware of the skills and

insights necessary for the participants to work through and solve the radiation overexposure case study and complete the role playing exercises. The schedule of the first day is outlined in Figure 1.

Design of Day 2 – The Radiation Overexposure Mystery

The second day was technical. The focus was on the investigation of a real world health physics case study and the preparation and delivery of both a risk communication message and the completion of a mock media interview. Given the central place of the case study in the second day of the workshop, the focus shifted to a summary of the actual alleged radiation overexposure incident.

The Case Study – A True Health Physics Mystery

The mystery to be solved by the participants was closely based on an actual potential radiation exposure incident that occurred in the summer/fall of 2008. A Soldier, an x-ray specialist with the 25th Infantry Division at Schofield Barracks, was scheduled to deploy to Iraq. As part of his preparation for deployment, the individual deployed with his unit to the National Training Center (NTC), Fort Irwin, California, for collective unit training. Upon arrival at Fort Irwin, the x-ray tech went to the post hospital to obtain a radiation dosimeter to wear while he simulated shooting radiographs while training in the field. He was given a radiation dosimeter, also referred to as a radiation badge, by the Fort Irwin Medical Department Activity (MEDDAC) Radiation Safety Officer (RSO) to wear during the 10 days that he trained at the NTC. Upon completion of the training, the deploying Soldier turned the dosimeter in at the Radiology Clinic of the Fort Irwin MEDDAC. The Soldier then subsequently deployed to Kuwait on his way to Iraq. Since the dosimeter was on a quarterly exchange cycle, it remained in the MEDDAC Department of Radiology, stored with the other dosimeters for a couple of months. Then, the badge was shipped to the US Army Dosimetry Center at Redstone Arsenal, Alabama, for processing.

0800 – 0830	Welcome. Logistics of Room and Workshop. Purpose and Objectives. Introductions.
0830 – 1000	Administration of the MBTI Questionnaire. Overview of Personality Type Theory and MBTI.
1000 – 1015	Break
1015 – 1115	MBTI Debrief. Validation of Personality Types.
1115 – 1200	Emotional Intelligence Competencies
1200 – 1300	Working Lunch: Stress and Type
1300 – 1400	Communication and Empathy
1400 – 1415	Break
1415 – 1500	Developing Others
1500 – 1600	Self-Confidence Tools and Strategies; Teamwork and Collaboration
1600 – 1615	Wrap Up
1615 – 1645	After Action Review

Figure 1. Schedule for day 1, group and self awareness.

When the dosimeter was read, it indicated that there was a dose over 40 times the allowable annual legal limit. Further, the reading was the largest radiation dose ever recorded in the over 50-year history of Army radiation dosimetry. Most important, this high level of radiation dose could pose a serious health risk if it had been actually received. The Army Dosimetry Center immediately notified the RSO at Fort Irwin MEDDAC, the Army RSO, and the Radiological Hygiene Consultant to the Army Surgeon General (author Melanson).

Given the magnitude of the dose and the complexity of the incident, the initial investigation was passed to the Command Radiation Safety Officer (CRSO) for Western Regional Medical Command (WMRC), another Nuclear Medical Science Officer. With guidance from the Radiological Hygiene Consultant, the WRMC CRSO obtained information about the radiation characteristics and output of the field medical x-ray system used by the deploying Soldier while he was training at the NTC. Information about the effective energy of the radiation on the exposed dosimeter was obtained from the Army Dosimetry Center. The deployed Soldier was contacted and interviewed by the Theater Radiation Safety Officer, another NMSO deployed to Iraq. During the interview, the potentially overexposed Soldier provided information about the number of times he fired the x-ray machine during the 10 days of NTC field training, where he was standing with respect to the x-ray machine, and whether or not he was wearing a lead apron.

Through further investigation, it was scientifically determined that the Soldier could not have received the dose on the dosimeter. First, the effective

energy of the radiation dose on the radiation badge, a thermoluminescent dosimeter, was greater than the maximum energy of the field medical x-ray system. This proved that the x-ray machine could not have produced the massive radiation dose on the badge. Additionally, it would have taken over 700 shots of the x-ray system to have delivered the large magnitude dose measured on the dosimeter. Since the Soldier was not using any other radiation sources and had no other source of potential radiation exposure on the NTC, it was concluded that the badge was irradiated after it had been turned in to the Radiology Department at the Fort Irwin MEDDAC, but before the badge was sent to be processed about 2 months later. The theater RSO in Iraq met with the deployed x-ray tech to inform him that he did not receive this large dose of radiation, what his estimated radiation dose actually was, and to answer any questions that he might have. He was relieved to learn that he had not been overexposed to radiation and was safe.

With the determination that the badge was irradiated after it had been returned by the deploying x-ray technician, the question still remained as to how the dosimeter received such a high radiation dose. The Radiological Hygiene Consultant conducted a formal investigation into the incident. This investigation included going to Fort Irwin MEDDAC and interviewing the hospital staff. As it turned out, the effective energy of the radiation measured on the dosimeter was consistent with the fluoroscopy x-ray system located within the Fort Irwin MEDDAC X-Ray Department. Interestingly enough, over 15 minutes of deliberate fluoroscopy operation with the badge in the beam would have been required to produce the massive radiation dose. Unfortunately, the investigation could not ascertain who intentionally irradiated the dosimeter after the deploying Soldier turned it in and before it was sent to the Army Dosimetry Center for measurement.

0800 – 0815	Group Assignments and Group Assembly
0815 – 0830	Introduction of Radiation Overexposure Case Study
0830 – 1100	Groups Work on Case Study and Gather Information
1100 – 1230	Open Discussion and Presentation of the "Solution"
1230 – 1400	Lunch and Group Preparations for Role Playing Exercises
1400 – 1430	First Exercise Participant Selected and Group Assistance in Final Preparation
1430 – 1445	Risk Communication Role Playing Exercise
1445 – 1515	Risk Communication Training and Feedback
1515 – 1545	Second Exercise Participant Selected and Group Assistance in Final Preparation
1545 – 1600	Medic Communication Role Playing Exercise
1600 – 1630	Media Communication Training and Feedback
1630 – 1700	After Action Review

Figure 2. Schedule for day 2, radiation overexposure case study.

Designing an Exercise to Solve the Overexposure Mystery

It was expected that after the events of the first day, the NMSOs would come together as a group and would be prepared for the next phase of the workshop. The schedule for the second day is shown in Figure 2. Before unveiling the case study, the ground rules of the day were explained. Next, the NMSOs were divided into 4 separate, 6-person groups, each lead by a senior field grade officer (lieutenant colonel or senior major). Once the groups were identified and allowed to reseat themselves with their leader and new teammates, an introduction of the real-world case study was given, providing the participants some, but not all of the information required to solve the mystery. The teams then had to process the initial information received, identify additional data that they needed, request this new information, incorporate all newly obtained data into their evolving understanding of the incident, and finally determine whether the overexposure was real or not (which it was not). After this, the 4 groups developed a plan to estimate and explain the radiation dose and risk to an actor playing the allegedly overexposed individual and another actor playing a news reporter investigating the incident. When each of the 4 groups had developed a plan to brief the incident, an individual from within one of the 4 groups was selected to play in the first role playing event, the risk communication exercise. After the risk communication role planning exercise was completed, the risk communication expert provided a half-hour presentation on risk communication, and also evaluated the first participant's performance in the role playing exercise.

With the risk communication exercise completed, the participant for the media communication exercise was selected and allowed a brief time with his or her group to finalize preparation for the mock media interview. As in the case of the previous role playing exercise, the participant

performed the interview with the reporter. Once that was completed, the media communication expert delivered a lecture on effective media communication and critiqued the performance of the second participant. The last day concluded with an after-action review of both the second day and the entire workshop.

Workshop Execution

Day 1 – Self and Group Awareness

The first day of the workshop proceeded pretty much as planned. The participants were enthusiastic about the agenda for the entire workshop, especially the second day. As the career field leader for the Army NMSOs explained the relevance and importance of the first day's activities to successful completion of the case study on the second day, he also affirmed the importance of self and group awareness in effective Army officer leadership. The mixture of lectures and games served to sustain individual and group interest, and helped the participants relax and remain focused on the workshop. Throughout the day, COL Melanson reminded the group that they, as scientists, were very different from most members of the general public and individuals who work in the news media, and that they should keep this in mind as they prepared briefings for the second day. At the end of the first day, an after-action review was held (without the consultant present) and the feedback was constructive. While the attendees enjoyed the day, they would have preferred to have more time to delve into the Emotional Intelligence Competencies since many were already familiar with the Myer-Briggs Type Indicators.

Day 2 – Solving and Explaining the Radiation Mystery

As expected, the group of attendees was comfortable with each other and warmed-up for the second day's activities. Everyone was told that they had a chance to be selected to engage in one of the 2 role playing exercises; this risk of being "put on the hot seat" helped to sustain individual participation and focus. The conference room was then rearranged to facilitate the exercise as shown in the conceptual presentation of Figure 3. Group tables were rearranged so the 4 groups could face each other. The controllers who had designed the case study exercise were placed in the front right corner and were prepared to respond to written questions from the groups. Each table was given a courier to deliver written questions to the controllers. The workshop leader served as the exercise conductor and timekeeper to help keep everything on schedule. A separate table was placed in the center of the room to serve as a "fishbowl," where the 2 role-playing exercises would play out while the other participants silently watched. Once the case study summary was presented, the exercise commenced. There was a slight delay as the groups got organized, but they quickly began asking additional questions of the controllers.

Periodically throughout the morning, the conductor would stop the exercise and conduct a "reset," which involved the conductor asking each of the groups what they had learned from asking questions of the controllers. At first the groups were unhappy about this since it interrupted their individual group's momentum and there was an innate desire to outperform the other groups and not share what they had learned. The workshop leader explained that the goal of the exercise was not to "beat" the other teams. The goal of the exercise was to ensure that whoever was selected for each of the 2 role-playing exercises was completely prepared to succeed. After the explanation, the groups no longer focused on outplaying the other groups. Just before the lunch break, the 4 groups had fully investigated the case study and had all of their facts. Over a working lunch, the groups prepared their information for briefing the potentially overexposed Soldier and the news reporter.

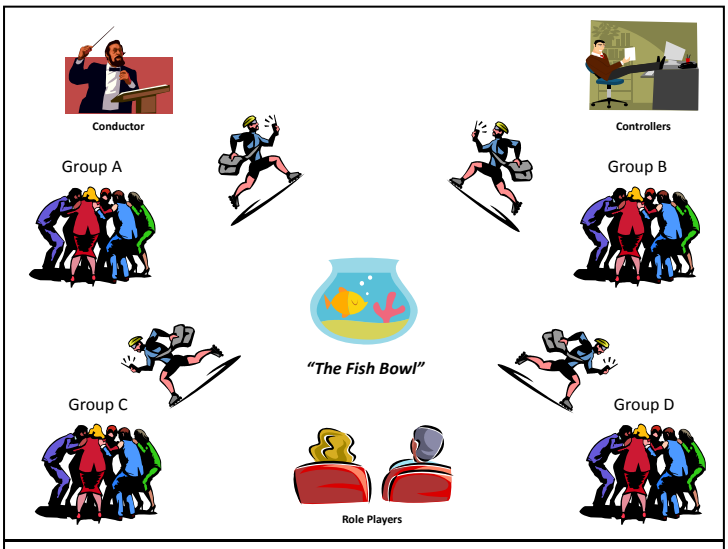

Figure 3. The conceptual layout of the conference room for the Day 2 role-playing exercise.

After lunch, the workshop shifted to the 2 role-playing exercises. This began by selecting the first participant. The conductor had thought about randomly selecting the player, however, the decision was made to select a senior company grade officer with prior risk communication training in order to maximize success and provide a positive example for the others observing the exercise. Two actors were involved in the first role-playing exercise: one of the controllers played the Soldier (he also was the theater RSO in Iraq who actually briefed the possibly overexposed individual), and the risk communication expert played the Soldier's wife. Overall, the first participant did very well. She showed genuine empathy and calmly explained the situation and the process that she used to come to the conclusion that the Soldier was not overexposed. Unfortunately, her overreliance on calculations to estimate the Soldier's dose did not resonate well with either the Soldier or his wife, and ultimately limited the effectiveness of the risk communication message. Once the risk communication exercise was completed, the risk communicator gave a short briefing on effective risk communication and highlighted the positive and negative aspects of the role-playing exchange. The key points of the risk communication training were defining risk communication as an interactive process, the importance of empathy, and the fact that risk is a combination of the magnitude of actual hazard plus the degree of personal outrage of the person subjected to the risk.[7] Elements of successful risk communication include the credibility and the skill of the risk communicator and the effectiveness of the risk message. Credibility is first built upon empathy, then it rests upon honesty and openness. Finally, trust and credibility rests upon dedication and commitment on the part of the risk communicator, and ultimately his or her competence.[8] The audience was also warned to avoid humor and jargon.

Next, the exercise immediately shifted to the mock media interview. The second "contestant" was selected by the workshop leader. This individual was a seasoned, midcareer major who had recently returned from a deployment to Iraq. The public affairs officer played the role of the reporter and started the interview on a positive note. Then, however, she shifted to a more adversarial posture, implying that the Army system for monitoring Soldiers was flawed and her impression that the interviewee was hiding something. Although the second participant got flustered, he still managed to maintain his composure and completed the interview. As in the case of the risk communication exercise, the role-playing was followed by a lecture on effective media communication that also critiqued the performance of the second participant. The media communication training explained the similarities and differences between risk communication and media communication. Both need planning and preparation and use effective communication techniques. Risk communication focuses on addressing concerns, whereas public affairs explains the message of the organization. In public affairs, it is important to stay on the record, to stay in one's lane, and to avoid speculating on hypothetical questions. Also, it was stressed that one must never lie. Tips included preparing messages in advance and rehearsing them, stating these messages up front, and keeping them simple. The importance of "speaking with one voice," that is a consistent message was also emphasized. The audience was told that it was proper to say "I don't know," but that one should commit to finding out the answer and providing it later. The public affairs officer also stressed the importance of setting the record straight and correcting reporter errors.

In order to wrap-up the exercise, the conductor presented the resolution of the actual case study to the participants. Coincidentally, all of the key players involved in the real incident were actually present and part of the cadre for the second day's exercise. An impromptu chronological walk-through of the incident was done. Finally, after-action reviews were held with the group for the second day, and then for the entire workshop. Feedback from the group was overwhelmingly positive. The only complaint was the decision to have the participants work over the lunch period on both days.

SUMMARY

This paper presents an innovative training workshop that combined self and group awareness with the completion of a real world radiation overexposure case study to enhance the technical skills of the attending Army Nuclear Medical Science Officers. It also included 2 role-playing exercises to learn and practice effective risk communication and media communication techniques. The workshop was structured to allow a supportive learning environment that was conducive to individual and group mentoring.

As previously stated, the feedback from the participants was overwhelmingly positive. Other public health practitioners may find this innovative professional development approach useful, and may wish to use the design of this work-shop to further their own professional development.

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The Impact Of Peer-Based Training on Reducing Radiation Doses from X-Ray Operations in an Interventional Pain Management Clinic

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ABSTRACT

This paper describes the measurement and characterization of the radiation exposure to the staff, patients, and the general public as a result of the operation of an interventional pain management (IPM) clinic, as well as the effectiveness of a peer-based fluoroscopy training program to keep doses as low as reasonably achievable (ALARA). During the last decade, pain management has evolved into an essential part of patient care. IPM, a subfield of pain management, uses fluoroscopic imaging in its procedures. As a result, there are 3 separate populations who could possibly receive exposure to ionizing radiation as a result of an IPM radiographic procedure: staff, patients, and the general public. Staff doses, as well as doses to the general public, are easily measured with radiation dosimetry. Conversely, it is very difficult to characterize the radiation dose to a patient during a fluoroscopic procedure and, realistically, it is not possible to measure patient dose directly. However, it is plausible to infer relative patient exposure from direct measurement of the physician's dose. The most common and practical way to measure the dose to members of the general public is to monitor the ambient radiation levels within a medical treatment facility and extrapolate these measurements to the general public. Ultimately, the goal is to maintain all doses (patient, physician, and the general public) using the ALARA principle. Using a Panasonic thermoluminescent dosimetry system, it was determined that a peer-based fluoroscopy training program effectively reduced the cumulative dose to clinic staff by approximately 50%. It was also determined that the standard building materials used in our facility provide enough shielding to keep doses to members of the general public below acceptable limits.

INTRODUCTION

Although physicians have sought to relieve their patients' pain for centuries, pain management as a specific medical discipline began with the founding of the International Association for the Study of Pain in May 1973.[1] During the last decade, pain management has evolved into an essential part of patient care. Physician specialists, such as physiatrists, are medical doctors who specialize in physical medicine and rehabilitation with a special interest in musculoskeletal conditions. Some physiatrists have advanced training in interventional pain management (IPM).[2] In this specialized subfield of pain management, procedures such as diagnostic and therapeutic nerve blocks, sympathetic blocks, discography, peripheral nerve blocks, and radiofrequency denervation are performed. Additionally, fluoroscopy is an integral part of IPM and is primarily used to ensure target specificity and accurate delivery of the injectate.[3-6]

In 2002, Walter Reed Army Medical Center, a large US Army teaching hospital, began the operation of an IPM clinic. There are 3 separate populations that could possibly receive exposure to ionizing radiation as a result of this clinic's activity: staff, patients, and the general public. There have been multiple studies to characterize the exposure of the IPM specialist to ionizing radiation.[3-8] However, it is much more difficult to characterize the radiation dose to a patient during a fluoroscopic procedure. Since the primary method of exposure to the physician performing a fluoroscopic procedure is scattered radiation from the patient, the relative dose to the patient can be inferred

from the measurement of the physician's dose. This idea of inferring a relative dose to the patient from a direct measurement of the physician's dose assumes a proportional relationship between the two; therefore, a decrease in the physician's dose is equivalent to a proportional decrease in the patient's dose. In order for a relative dose based on a physical dose measurement to be meaningful, it must be compared to a similar measurement (eg, dose measurements before and after a training event). The 2 relative doses must also have equivalent proportionality to the base measurements. In the case of fluoroscopy, a proportionality based on scattered radiation would change if the geometry between the patient and physician, or if the presence of shielding material changes significantly. If these requirements are satisfied, it is valid to assume that comparing 2 similar exposure scenarios would yield comparable relative dose assessments.

It is impractical to directly measure the dose to each member of the general public that might be exposed to ionizing radiation as a result of this clinic's activity. The most practical way to estimate these doses is to measure the ambient radiation levels around the IPM clinic and extrapolate these measurements to conservative estimates of the doses to the general public.

The mission of the Health Physics Office at our facility is to maintain the doses resulting from any medical use of ionizing radiation as low as reasonably achievable (ALARA). During an annual review of our dosimetry program at the end of calendar year 2003, the dosimetry custodian noticed an average increase in the total effective dose equivalent (TEDE) to those personnel who are occupationally exposed to ionizing radiation and are issued personnel dosimetry. The increase was not large (from 0.60 mSv to 0.80 mSv), but a quick review of the dosimetry data revealed a large discrepancy in the average dose received by the physicians, residents, and fellows in the IPM clinic as compared to personnel working elsewhere in the facility. In order to reduce these doses, a special training program focused on the proper use of fluoroscopic x-ray equipment by the IPM clinic staff was implemented to supplement the regular annual radiation safety training. This paper describes the measurement and characterization of the radiation exposure to the 3 populations listed above as a result of the operation of an IPM service, as well as the effectiveness of this new training program in reducing radiation doses in the clinic.

Materials and Methods

X-Ray Source

The fluoroscopic x-ray systems used in our facility's IPM clinic (photo on page 47) are the General Electric Model OEC 9800 (GE Healthcare Systems, Waukesha, Wisconsin). This c-arm style unit has many features that are designed to limit both the user's and the patient's radiation exposure while maintaining acceptable image quality. Despite these features, the c-arm units have the ability, if not used properly, to produce an x-ray field capable of delivering significant levels of exposure to both patient and user alike. This fact became evident during an annual x-ray safety compliance survey of these units when the maximum exposure level at 30 cm from the focal spot was measured to be 128 roentgens per minute with an MDH ion chamber (Radcal Corporation, Monrovia, California).

Dose to Patients and Staff Members

In the US Army, all personnel who are occupationally exposed to ionizing radiation and may exceed 10% of the occupational dose limit of 5 rems (50 mSv) per year are issued dosimetry.[9] The US Army uses a thermoluminescent dosimetry (TLD) system to measure and characterize this exposure. The TLD system is provided by the US Army Dosimetry Center, Redstone Arsenal, Alabama. This center is accredited by the National Voluntary Laboratory Accreditation Program for the determination of TEDE using a dosimetry system manufactured by Panasonic (Secaucus, New Jersey). This dosimetry system consists of a Panasonic model UD-802AS dosimeter in a model UD-874AT holder and a model 710 reader.

In order to determine the TEDE, a combination of 2 dosimeters is used. One is worn on the trunk of the body under any lead shielding and the second is worn at neck level outside of any lead shielding. The TEDE is calculated from the deep (depth of 1.0 cm in tissue) dose determined from each dosimeter using the following formula[10]:

$$\text{TEDE} = 1.5 \times \text{Body} + 0.04 \times \text{Neck}$$

where Body and Neck refer to the deep dose determined from the dosimeter worn on the trunk of the body and at the neck level respectively.

Fluoroscopy Training Program

The need for physician training programs on the effective use of fluoroscopic x-ray equipment has been presented in the literature.[11,12] However, the methods used to provide this training can vary significantly. Within the US Army Medical Department, the individual Radiation Safety Officers at different medical facilities have employed varied training methodologies ranging from instruction by the health physics staff to internet-based training. The selected methodology used at our facility was peer training. In August 2004, a training class in the proper use of fluoroscopy was given to the IPM clinic staff by an experienced, board certified interventional radiologist. All personnel in the IPM clinic using fluoroscopy were required to attend the training. The class included the following topics: pulsed and low dose fluoroscopy; fluoroscopic magnification modes; use of last image hold; time, distance, and shielding concepts; recognition of the x-ray field size; and proper wear of dosimetry.

In order to determine the effectiveness of this training program, the cumulative TEDE to the staff of the IPM clinic was compared before and after the training. The dosimetry for the personnel in this department is exchanged monthly. The cumulative TEDE for the clinic was tallied using all individual monthly dose readings for 2 equal time periods (July 2003 through September 2004 and October 2004 through December 2005) immediately before and after the described training. It is important to note that no new personnel joined the clinic staff during the period of this study.

Doses to Members of the General Public

Since x-ray operations are regulated by the individual states, there are no specific federal regulations that deal with the shielding of x-ray facilities. Despite this, there are multiple federal regulations limiting the dose from ionizing radiation to members of the general public.[13,14] The dose limit of 1 mSv per year is incorporated into the US national consensus standards used to determine the shielding requirements of x-ray facilities.[15] Additionally, the US Army has specific requirements for the shielding of x-ray facilities which are published in *Technical Bulletin MED 521*.[16] Paragraph 4-12 of this bulletin states that "…a qualified expert will … ensure that the design [of the x-ray facility] is adequate to meet regulatory dose limits and keep doses to personnel ALARA."[16(p4-10)]

Due to the mobile nature of a c-arm fluoroscopic x-ray system, the facility design (eg, shielding) that normally accompanies the installation of a permanent x-ray system is not required. However, according to the National Council on Radiation Protection and Measurements: "If a mobile x-ray system is used in a fixed location, a qualified expert shall evaluate the need for structural shielding."[15(p14)] This is precisely the situation that occurred as a result of starting an IPM clinic at our facility. Originally, the clinic was to only be at its present location temporarily. However, when it was decided that the location would be permanent, the shielding of the rooms containing the x-ray units had to be evaluated. In order to do this, 14 Panasonic model UD-802AS dosimeters in model UD-874AT holders were placed both inside and outside of each protective barrier in the patient treatment rooms, patient waiting area, and the hallway adjacent to the patient treatment rooms. The dosimeters were left in place for a period of 2 months in early 2004.

RESULTS AND DISCUSSION

Dose Reductions From Training

The cumulative dose to a member of the IPM clinic staff before the implementation of the new training program was 18.14 mSv. After the training, the cumulative dose dropped to 9.55 mSv. This marked decrease demonstrated that the new training program was effective in reducing the dose to the staff of the IPM clinic. Since the doses to the staff are proportional to the doses patients receive, the training program was effective in reducing the patient exposure as well. Discussions with the staff revealed that the primary procedural change that occurred as a result of the training were the use of the last image hold and the low dose mode. Therefore the relative doses had equivalent proportionality to the direct measurements both before and after the training event.

It was recognized that changes in fluoroscopic procedures due to the new training program are not the only potential cause for a reduction in staff doses. Workload changes could also affect the measured cumulative doses. However, since beginning operations in 2002, the workload at our facility's IPM clinic has seen a slight increase and has subsequently stabilized at around 5000 fluoroscopic procedures annually. This includes the time period considered during this study.

Shielding Evaluation

Only 4 of the 14 dosimeters that were used in determining the shielding properties of the barriers in the IPM clinic showed a measured deep dose greater than background (as measured with control TLDs). The 4 dosimeters were all located within the 2 treatment rooms and recorded monthly deep doses of 0.10 mSv, 0.25 mSv, 0.28 mSv, and 0.30 mSv respectively. All dosimeters in patient waiting areas and the hallway showed no discernable exposure above background. The Panasonic dosimeters used in this study have a minimum detectable dose of 0.01 mSv.[17] Therefore, a dose of up to 0.12 mSv per year would not be detectable in the areas measured. It was determined from these results that no additional shielding was required for the IPM clinic to be in compliance with Army regulations.

Conclusion

The operation of an IPM clinic exposes clinic staff, patients, and members of the general public to ionizing radiation. With a few simple precautions, the radiation exposure to all 3 populations can be maintained below regulatory limits and in accordance with the ALARA principle. It was not necessary to make any shielding enhancements to our IPM clinic to protect the members of the general public. The primary method of reducing dose to the staff and patients was through the implementation of a peer-based training program focused on effective use of the c-arm fluoroscopes. Using an experienced interventional radiologist in the training process worked very well as evidenced by the significant reduction (by a factor of two) in the total doses to the clinic staff after the peer-based training program.

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One of the treatment rooms of the Interventional Pain Management Clinic at Walter Reed Army Medical Center.

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Resiliency Training for Medical Professionals

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Abstract

For the past 10 years, the military medical system's costs have increased by an estimated 167%. Behavioral health issues and physical ailments are major contributors to the increased costs. As a result, fatigue and burnout of medical professionals are growing concerns. The Army Medical Department (AMEDD) recognizes that physical and psychological stressors adversely impact personal well-being and organizational goals. Thus, an emphasis on enhancing the individual's resiliency framework is essential to the stamina and long-term endurance necessary to sustain the continued provision of high quality medical care. To that end, the Army Medical Command (MEDCOM) has instituted the Provider Resiliency Program. The Professional Provider Resiliency Training (PPRT) conducted by the AMEDD Center and School should be a key element of the MEDCOM Provider Resiliency Program. The PPRT provides medical professionals the opportunity to significantly develop and enhance their resiliency skills. This article includes outcome data from 172 medical professionals who attended the PPRT. Specific focus is on their perspective about resiliency training. The findings in this article revealed that the doctors (100%), nurses (98%), behavioral health providers (90%) and other professionals (100%) who attended the PPRT course valued the training and indicated that they will use the learned mind-body resiliency techniques.

Introduction

The Army Medical Department Center & School launched the Professional Provider Resiliency Training (PPRT) course in May 2009. The purpose of the course is to provide a venue where medical professionals can learn self-resiliency techniques targeted specifically for medical staff, ie, doctors, nurses, ancillary staff.* The course integrates the most advanced research, concepts, techniques, and theories as they relate to self-care management. Throughout this course, medical professionals have the opportunity to participate in various experiential learning exercises, such as mind-body techniques that are aimed at improving self-care. Using personal introspection, medical professionals focus on internal and external stressors/processes that contribute to workplace burnout and compassion fatigue. The purpose of this article is to promote an understanding of the extent to which medical professionals value resiliency training, identify which mind-body techniques are most helpful, and identify if they are more aware of the value of developing a resiliency self-care plan.

*Civil Service level GS-11 and above, enlisted military rank E7 and above

Key Concepts Reviewed

All providers are at risk for fatigue and burnout which result from work stressors. In the military environment, the risk is likely to be much higher given the current tempo of operations. For example, the *USA Today* reported that the cost of military health care programs has increased significantly (increase projected as 167%, 2001-2011).[1] Further, the increase is a result of more physical problems and mental health issues due to multiple deployments. Most medical professionals experience fatigue on some level at some point and time in their career. When medical professionals value their work and workplace, but are exposed to physical and/or psychological stressors, a fatigue response is not uncommon. Fatigue may result from exposure (typically observing the aftermath of an event or when details of a traumatic/stressful situation are shared) to an extremely stressful event that a patient experienced and shares directly or indirectly.[2] Fatigue adversely affects a person's framework; emotional, cognitive, physical, social, and spiritual aspects are compromised.[3] The concept of provider fatigue in the Army Medical Department builds on the basic concept of fatigue in the current literature. Provider fatigue encompasses the realities of the

military environment, which includes the unique aspects of a military theater of operations. The impact of fatigue under either circumstance includes feelings of being trapped, on edge, exhausted, overwhelmed, and infected by others' trauma. Fatigue and burnout are often discussed as 2 separate phenomena even though they share similarities,[4] and are connected. Burnout occurs over time and is a feeling of helplessness that results in low workplace performance.[2] Burnout characteristics are not that different from fatigue, however, symptoms may be more exacerbated and one's perspective of the workplace is negative, value of the work is not apparent, resulting in feelings of unhappiness, disconnectedness, and insensitivity.[2] In this article, fatigue and burnout are viewed on a continuum. If one experiences fatigue and it remains unmanaged, the likely result will be burnout.

Resiliency can be a protective factor to combat fatigue and burnout. A resilient framework will likely promote satisfaction in the workplace and in other spheres of a person's life. Resiliency is a state of being that promotes wellness and decreases the impact of physical and psychological stress.[5] A strong resiliency framework entails intact and healthy adaptive emotional, cognitive, physical, social, and spiritual characteristics. Stressful or traumatic events that are experienced will shape one's resiliency framework, either directly or indirectly. Thus, the positive factors that manifests from these experiences are desirable traits that lead to a strong resiliency framework.[6] A simplified definition is presented to focus the reader on the concept of resiliency building factors/skills that are indicative of how we perceive events and take care of ourselves. The self-care plan is derived when a medical professional makes a conscious effort to nurture their physical, mental, emotional, social, and spiritual aspects.[7]

There are internal resiliency factors/skills that we personally evolve, and external factors that we manage but may not control completely. External factors refer to organizational factors in the clinical environment or theater of operations. All medical professionals have the ability to promote individual positive self-growth on some level. Thus, a person's internal resiliency factors can be evolved into a positive or negative framework over time. The resiliency training at the Army Medical Department Center and School is aimed to do just that—provide medical professionals with a multitude of resiliency building skills to enhance their resiliency framework over time across all aspects outlined in the self-care plan. It is a medical professional's responsibility to embrace the concept of personal responsibility for improving his or her own mental and physical stamina. When this occurs, he or she is more likely to be receptive to enhancing or developing new resiliency skill building techniques.

Resiliency Theoretical Framework

Internal resiliency factors that we want to see in our medical professionals can be vast. Certainly, many medical professionals possess resiliency building skills. We are all familiar with some basic concepts and maybe even personally embrace them consciously, thus contributing to a stronger resiliency framework. Siebert's Resiliency Model[5] is presented as a unified theory. He identifies 5 key principles that are indicative of a resilient person:

- Managing health
- Problem-solving
- Increasing self-strengths: self-esteem, self-confidence, and self-concept
- Developing positive response choices
- Learning good lessons from difficult situations

The following case study is presented to assist the understanding of this theoretical framework:

CPT Lee is a behavioral health officer working in an Army medical treatment facility. She has been in the Army for 10 years. In 2007, she was deployed to Iraq. While deployed, she became very distraught with the long deployment. Her thoughts became more negative, she personalized situations that affected the entire unit and ignored managing her weight and health. To make matters worse, her tour of duty was extended for an additional 3 months. She described herself as depressed and ineffective at her job.

CPT Lee now identifies herself as someone who has changed her perspective on how she manages stressors/challenges. She embraces Siebert's key principles[5] as a way of life. This is a new way of thinking, doing, and managing for her, but the work and commitment that she has put forth has been rewarding. CPT Lee notes that her outlook on life now is significantly more positive and that she is much happier as a person. She further states that her

subordinates, coworkers, and leadership have repeatedly commented on her ability to reframe situations in a positive manner ("the glass half full"). When asked to describe her past and present perspective in dealing with a stressful work situation, she shared the following experience: recently she was informed that she will deploy as a backfill in support of another behavioral health officer. She noted that while the situation is not desirable, due to the acquisition of the skills, she is prepared for the task and has a positive perspective about the situation.

She learned several new resiliency skills at the PPRT and developed a self-care plan that is realistic for her. Now, she is proactive in updating her self-care plan which keeps her focused on the 5 target areas. Table 1

Table 1. CPT Lee's successful application of Siebert's 5 key resiliency principles which countered her fatigue/burnout responses to her perceived negative deployment experience.

Siebert's Resiliency Principles[6]	Symptoms of Fatigue/Burnout	Successful Development of Resilient Framework/Perspective
Health Management (Overall Wellness)	CPT Lee was not taking personal responsibility for her overall well-being. Her negative perspective consumed her and led to cognitive, emotional and behavioral responses that were debilitating. Her lack of motivation was evident in her work and personal self care.	She has been very proactive in managing her overall well-being. Her positive perspective led to adaptive cognitive, emotional and behavioral choices. She realizes that she does not have control over many events that affect her life in the military, but she does have control over how she perceives them, and her reactions.
Proactive Problem-Solving	During the deployment, she often felt powerless and focused on those things that were upsetting to her. She was often miserable and had negative thoughts. CPT Lee expressed how helpless she was and noted that she slept a lot. Her emotions drove her and how she perceived her environment.	Recently she was informed that she must backfill another behavioral health officer in 8 weeks. CPT Lee has been busy preparing her family by ensuring that all personal matters are in order and spending quality time with the family doing fun and eventful activities. She came up with a "to do" list at work to ensure that she closed out all administrative and patient care activities appropriately. Weekly updates were sent to her supervisor. She is able to look at things rationally.
Increase Self-Strengths: Self-Esteem, Self-Confidence, and Self-Concept	As a way of life, she isolated herself from others and avoided people that were positive. When she had the opportunity to help in humanitarian missions, she declined unless required by her supervisor.	CPT Lee maintains her weight and health, rewards herself for accomplishments, and often volunteers to assist her supervisor with command briefings. She is more open to learning how to improve her work performance, as well as her life. She embraces events as opportunities to grow and change.
Developing Positive Response Choices	When her tour of duty was extended, she often complained to peers and became passive on the job. She did not see the value of her contributions to the overall war effort.	When her supervisor told her that she would be tasked to backfill another officer for 3 months, she initially became anxious. Immediately she calmed herself by reframing the situation—she only had to go for 3 months. She began to think about the hidden opportunities that the 3 months might present.
Learning Good Lessons from Difficult Situations	During the deployment, she would often tell her family that there was nothing positive about her experience and that she was miserable. She was often tearful and tangential, and perceived most of her experiences as negative.	CPT Lee realized that during her first deployment, everything about the situation was negative from her point of view. She is now able to identify personal gains from a difficult situation by changing her view of the past. Now she realizes that she is happier and accomplishes a lot more when she focuses on being proactive and positive about the situation. Even her ability to manage complex situations is markedly improved. Additionally, people like to be around her and she exudes a positive energy in the work place and at home.

synopsizes CPT Lee's experience with fatigue and burnout, and how she successfully dealt with them.

Difficult experiences, traumatic situations (direct or indirect), stressful life events (expected or unexpected) in the workplace or in our personal lives are inherent of the human experience. In a military theater of operations environment, physical and psychological stressors should be expected, and reactions to experiences are often very intense. The cognitive-behavioral literature presents the ABC model, which is an evidenced based model used in multiple settings.[7-10] Additionally, this model asserts that when we experience any situation (A), it is interpreted and we formulate a belief (B) about that experience, which may be rational or irrational. This leads to an emotional, behavioral, and thought response (C), based solely on the belief we derive. This is an excellent tool for understanding how any situation can be cognitively framed by a person. A medical professional with a resilient framework will likely be a rational person that has a positive thought process. Table 2 presents the ABC model in the context of the CPT Lee case study.

The PPRT offers skills to medical professionals that aid in managing stress, which leads to a restructuring of thoughts from a perspective of helplessness or negativity to an empowering attitude with a positive outlook. The PPRT provides training on mind-body techniques, which include deep breathing, journaling, tai chi, meditation, guided imagery, and biofeedback, just to name a few. These are techniques that most medical professionals have heard of, theoretically understand their benefits, and often recommend to patients. Yet, medical professionals typically do not focus on themselves and what they personally need to enhance or sustain a strong resiliency framework.

In an effort to enhance one's resiliency framework, one must have a myriad of skills that are nurtured and practiced over time. Three questions are answered in this article:

- Do medical professionals who attended the AMEDDC&S PPRT course value the training?
- What are the top 3 mind-body techniques that medical professionals viewed as most helpful?
- Is there a relationship among the following variables: I found value in the materials; I will use the techniques; I am thinking more about self-assessment; and I am thinking more about developing a self-care plan?

METHODOLOGY

This study used a convenience sample of 172 professionals (82%) from a total of 210 medical professionals who attended the PPRT course. Participation was voluntary. Professionals were nurses, behavioral health providers, doctors, and administrative and enlisted personnel. Professionals were predominantly in the Army and consisted of civilian and military personnel. A response was defined as a completion of any part of the survey. Data was collected from 7 different cohorts beginning in May 2009 and ending in March 2010. The end of the course surveys were used to answer the questions for this study. There are 3 major sections in the survey:

- First part – basic demographical information.
- Second part – a 5-item (Likert Scale) self-report scale used to answer the questions for this research.
- Third part – open-ended questions that allowed respondents to give feedback about the course in their own words.

Participants

The majority of the participants (89%) in the study were professionals from various Army medical treatment facilities. There were also representatives from the other services, Reserve and National Guard components, and the Department of Veterans Affairs (11%). Most participants were nurses and behavioral health practitioners.

Findings

As shown in Figure 1, most attendees were either Army nurses (35%) or behavioral health professionals (23%), 12 participants (7%) were Army doctors, and 21 attendees (12%) were enlisted. The majority of participants work in a hospital environment (41%), and 33% of the participants indicated that they worked in a Warrior Transition Unit (Figure 2). The Great Plains Regional Medical Command (20%) and the South East Regional Medical Command (20%) had the highest number of attendees, while the Europe Regional Medical Command recorded the lowest number (8%) (Figure 3).

MIND-BODY TECHNIQUES

The vast majority of the participants in this study found the PPRT valuable. Ninety-eight percent of the nurses, 90% of the behavioral health providers, and 100% of the doctors, enlisted personnel, and ancillary professionals reported that they found value in the materials provided. Most participants in the study found the deep-breathing exercise (95%), tai chi (86%), and guided imagery (85%) to be the 3 most helpful mind-body resiliency techniques. Overall, 96% of the participants reported that they plan to use the learned mind-body techniques in the future. The study also provides valuable information indicating that the PPRT enhances the self-awareness of participants and their propensity to develop effective coping skills. Results from the survey showed that 90% of the participants were more mindful of their personal resiliency after completing the training. Additionally, 92% reported that they were thinking more about conducting self-assessments, and 93% reported thoughts of developing a self-care plan.

Table 2. Application of the ABC model[8-11] to CPT Lee's experience with fatigue and burnout.

Negative Belief Perspective	Positive Belief Perspective
Activity/Event Deployment Experience	**A**ctivity/Event Upcoming Deployment
Belief–My contributions do not matter Thought-Why even try, my efforts will not have an impact	**B**elief–Deployment is part of the job Thought-Not so bad, I only have to go 3 months; shift focus to more important tasks to prepare; close out loose ends at work and spend quality time with family
Consequence–Emotional (tearful and often depressed); behavioral (isolate, avoid, passive approach); cognitive (negative outlook and thought process)	**C**onsequence–Emotional (happier with family, more positive); behavioral (active at work and with family, task oriented and focused, proactive in workplace); cognitive (organized thoughts; oriented, optimistic outlook)

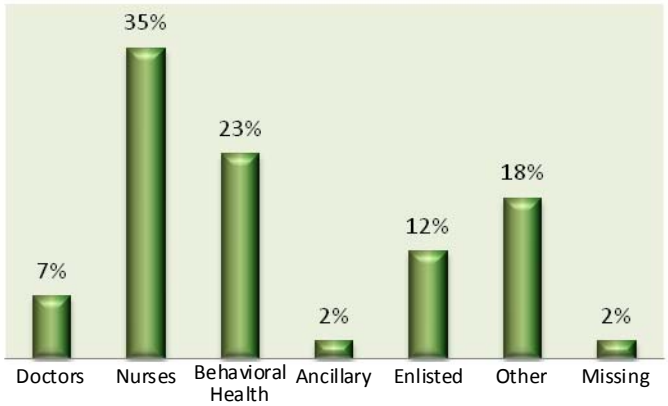

Figure 1. Distribution of medical professionals who participated in the study.

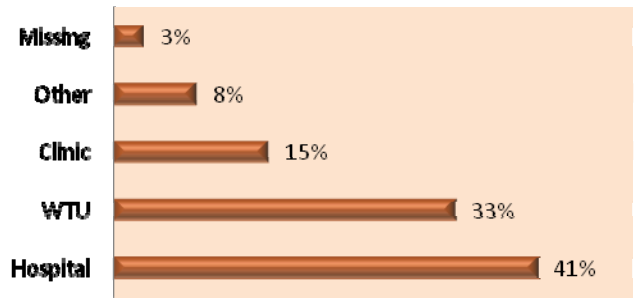

Figure 2. Distribution of work locations of participants in the study

A correlation was computed using the Spearman's rank correlation coefficient (rho) nonparametric test to determine the magnitude and direction of the relationship between each pairing of the following Likert Scale variables[11,12]:

1. Value materials
2. Plan to use techniques
3. Thinking more about self-assessment
4. Thinking more about developing a self-care plan

Table 3 demonstrates the significant positive relationship between each pairing of the variables. The magnitude of the relationship between each of the variables was strong. Participants who valued the material are also more likely to indicate that they plan to use techniques learned in the future (correlation coefficient $\rho = 0.589$); and participants who are thinking more about self-assessment are also strongly related to participants who are thinking more about developing a self-care plan ($\rho = 0.649$). The relationship is not by chance as determined by the test of

significance. The results do not imply causation between the variables. It is more likely that medical professionals value the training and plan to use the skills because they require resources and support. Further, they need to focus on taking care of themselves to enhance their resiliency framework, given the increased workload demands in the military medical environment.

DISCUSSION

In their 2005 report, the Mental Health Advisory Team (MHAT) recommended that the US Army Surgeon General "research and establish a program designed to prevent and reduce compassion fatigue and burnout."[13] The MHAT report revealed 45% of deployed primary care providers and 33% of behavioral healthcare providers self-reported burnout. Most importantly, the study showed that 15% of all providers reported that burnout affected their overall performance. As a result of this finding, The Acting US Army Surgeon General established the Provider Resiliency Program to institute provider fatigue surveillance and oversight, and training for the providers. In a recent analysis on burnout of medical personnel, using the Professional

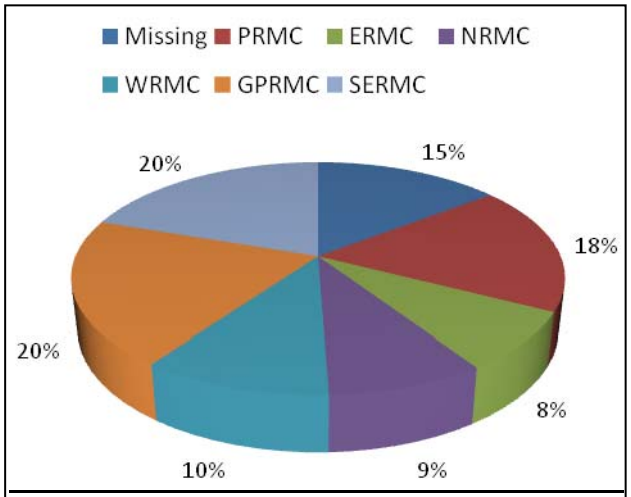

Figure 3. Distribution of participants in the study as sourced from regional medical commands.

Glossary:

GPMC - Great Plains Regional Medical Command
SERMC - Southeast Regional Medical Command
PRMC - Pacific Regional Medical Command
WRMC - Western Regional Medical Command
NRMC - Northern Regional Medical Command
ERMC - Europe Regional Medical Command

Table 3. The statistical correlation (Spearman's rank correlation coefficient nonparametric test) between each pair combination of the Likert Scale variables as reported in responses of the participants.

		Variable 1	Variable 2	Variable 3	Variable 4
Value in materials provided (Variable 1)	Correlation Coefficient		0.589*	0.244*	0.246*
	Sig. (2-tailed)		**0.000**	**0.002**	**0.002**
	N		167	160	162
Plan to use techniques in future (Variable 2)	Correlation Coefficient	0.589*		0.240*	0.248*
	Sig. (2-tailed)	**0.000**		**0.002**	**0.001**
	N	167		160	162
Thinking more about Self-assessment (Variable 3)	Correlation Coefficient	0.244*	0.240*		0.649*
	Sig. (2-tailed)	**0.002**	**0.002**		**0.000**
	N	160	160		161
Thinking more about Developing a Self-care Plan (Variable 4)	Correlation Coefficient	0.246*	0.248*	0.649*	
	Sig. (2-tailed)	**0.002**	**0.001**	**0.000**	
	N	162	162	161	

*Correlation is significant at the 0.01 level (2 tailed)

Quality of Life Scale, 18% of medical personnel in MEDCOM (52,000 participants) reported burnout.[14] In contrast, doctors and enlisted personnel reported a higher percentage rate of burnout, 27% and 23% respectively, when compared to the MEDCOM-wide percentage. The adverse personal effects of fatigue and burnout are self-medicating behaviors, depression, and acute stress responses.[2]

Building resiliency will counter fatigue and burnout. Organizational prevention programs are believed to enhance personnel well-being and counter fatigue responses.[2] In a study on resiliency using an experimental design conducted in a large government organization, findings indicated that participants in a resiliency program reported more improvement than the control group.[15] Interestingly, this result prevailed even though the experimental group reported more adverse pretest scores. The training cited in that report consisted of 35 hours over a 5-week period. The total hours trained is consistent with the PPRT course. Additionally, the training in the study is similar to the PPRT, which focuses on mind-body techniques that are aimed at enhancing self-care. Throughout the PPRT, the curriculum focuses on maladaptive cognitive shifts that occur as a result of exposure to difficult situations or secondary trauma. Building cognitive skills is one of the cornerstones of resiliency training because it aims to combat distortions that lead to distressing outcomes.[6] The case study depicted earlier is a good example of how cognitive processes can lead to negative or positive responses which have an impact on the person and organization.

The concept of resiliency in the Army is new and the Army Medical Department's endorsement of this prevention effort is a model for other services and the civilian medical community. However, that endorsement of provider resiliency is not without controversy, indeed, some medical professionals are leery. There are a number of possible reasons for that reticence, including:

- A lack of trust in the system or its intent.
- Embarrassment with pursuing training that promotes self-growth.
- They may not fully understand the relevance.
- They view it as a waste of time.
- Fear of validating that their job might be negatively impacting them.
- They simply anticipate becoming overwhelmed with yet another mandated training requirement.

It has been shown that participants who attended the training view it as valuable (93%, n = 167) and plan to use the techniques learned (92%, n = 162). Additionally, the relatedness among the variables revealed all significant results. Leaders, supervisors, and medical professionals will require more education on the overall benefits of resiliency training.

Nurses and behavioral health providers represent a higher percentage of participants attending the training. Given the recent findings of the analysis of fatigue and burnout in MEDCOM,[13,14] more doctors and enlisted personnel should be encouraged to attend the PPRT. Moreover, the long-term benefit of the training will enhance personal endurance. Refusal to address fatigue and burnout issues result in turnover, lower morale, lower productivity, greater use of sick leave, and physical illness that lead to patient errors.[2] In short, long-term organizational gains outweigh the short-term sacrifice. Medical professionals are typically not trained or encouraged to sustain and manage a self-care plan that enhances resiliency. Therefore, leadership endorsement, time, information, education, and consistency will prompt a cultural shift in support.

Conclusion

The documented increased demands in the military environment continue to impact medical professionals. Fatigue and burnout responses have an undesirable impact on personal well-being and the organization. Organization prevention programs can be effective. The PPRT is very similar to a program[15] that has demonstrated positive effects of resiliency training. The MEDCOM Provider Resiliency Program is a great opportunity for the Army Medical Department to show medical personnel that the leadership is interested and concerned about their well-being, and understand that training opportunities benefit personal interest and organizational mission sustainment.

The results of this study cannot be generalized and must be received with caution. As a baseline, it does establish a clear precedent about how medical personnel perceive training. Of special note, the majority of the sample included nurses and behavioral health personnel. In the future, a more stringent study will include input from doctors, enlisted personnel, and other ancillary providers to validate findings.

More information is needed about participants who attended the training. For example:

(*a*) Are the medical professionals in this study more likely to focus on self-care as a norm?

(*b*) Why do they elect to attend training?

More research on understanding the impact of resiliency as it pertains to personal and organizational benefits in the military medical environment is needed. Future studies that encompass an experimental design and look at the differences between medical professionals who receive training and those who do not will be cutting edge research. Future studies must also be able to demonstrate value to the organization using measures of sick-day absence, retention, and customer satisfaction, to name a few. Thus, a resiliency program that demonstrates efficacy is imperative to justify funding for continued surveillance, training, and future research initiatives.

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Observed Noncompliance with Implementation of Vector-Borne Disease Preventive Measures Among Deployed Forces

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Abstract

Failure by individual service members and units to implement preventive measures to mitigate environmental health threats have always resulted in reduced efficiency of the Warfighter, with the attendant reduction in combat capability. This article describes observations at 2 sites in northern Iraq from July 2007 to September 2009 of deficiencies in the use of preventive and protective measures to reduce incidences of vector-borne diseases. Observations included individual service member's indifference or negative attitude toward use of personal protective equipment and unit leaders' failure to provide required resources and enforce use of personal protective measures. Implications of these actions and recommendation for enhancing compliance are discussed.

Background

Due to the nature of military operations, US Soldiers are exposed to various diseases not commonly experienced by the general population. Service members deploy to various parts of the world, usually in developing countries, where infectious diseases continue to be a leading cause of mortality and morbidity. Among the major concerns are vector-borne diseases such as malaria, leishmaniasis, trypanosomiasis, dengue fever, and other arboviral infections. Other diseases that are potential sources of concern for deployed military are parasitic helminthes. In disease endemic areas, the local population may not manifest these diseases but remain as reservoirs. Service members who occupy such areas could easily get the infections due to lack of prior exposure to these diseases.[1] Also, multiple deployments to different disease-endemic regions may confound diagnosis, prevention, and treatment due to repeated exposure to different parasite species. This may result in the reintroduction of parasites in areas where they had formerly been eradicated, and thereby burden the health care system.

The US military has mechanisms in place to ensure that disease and nonbattle injuries (DNBI) are prevented by continuously searching for better ways of protecting the Warfighter. Some of the active preventive programs include medical threat assessment and risk communication, use of vaccines and chemoprophylaxis, and research and product development. In the area of vector–borne disease prevention, personal protective equipment consisting of use of topical insect repellent, *N, N-diethyl-3-methyl benzamide* (deet) and proper wear of permethrin treated uniforms remain the first and most effective line of defense. The continuous search for safer and more effective arthropod repellents for skin and clothing applications, development of more effective insecticide treated bed nets, dissemination of information and training materials, and timely vector assessment and control is testimony to the importance that US military medical community places on force health protection (FHP).

The military also ensures that preventive medicine (PM) detachments are part of the deployed force. The PM detachments perform continuous checks on food facility sanitation, air quality monitoring, water safety, and general sanitation. They conduct surveillance of vectors of medical importance to assess disease threat, determine pest population, and recommend management and control. This is important since it not only facilitates vector control but also puts in place integrated pest management practices in order to reduce pesticide use. Historically, DNBI have been reported as causing more casualties than combat, and "seriously degrading the mission" more than combat-related injuries. From the time of Napoleon who lost over 80% of his half million Soldiers to DNBI during the French invasion of Russia in 1812[2] to the most recent

US military operations in Liberia, Somalia, Iraq, and Afghanistan, noncombat related injuries continue to reduce military efficiency.[3] Many of the disease infections were attributed largely to noncompliance with recommended disease preventive measures.[4]

Units deploying for combat operations are expected to be fully prepared to execute their mission successfully. Consequently, commanders take time to ensure that personnel are trained on all equipment and maneuvers to be used during combat prior to deployment in accordance with the Army training and evaluation program manuals. In the area of combating vector-borne diseases, supplying personal protective materials and training on recommended PM measures have to some extent been part of the predeployment preparation process. The outcome of this preparation has been a reduction in the rates of DNBI as reported for Operation Iraqi freedom (OIF) and Operation Enduring Freedom (OEF) when compared to Operations Desert Shield and Desert Storm.[5] However, despite the numerous FHP resources available to individual service members, US forces continue to be plagued by numerous vector-borne diseases that could easily be prevented if proper personal protective equipment is used as recommended.

Observed Concerns

This report covers the period of the author's deployment with the 926th Medical Detachment (PM) to the Iraq theater from July 2007 to September 2008. During this period, failure by individual Soldiers as well as gross failure by leadership to enforce implementation of simple PM recommendations were rampant. Following are some of the aspects of noncompliance to implement vector-borne disease preventive measures that were observed at the Contingency Operating Base (COB) Speicher and Forward Operating Base Q-West.

Many of the Soldiers wore physical training shorts and tee-shirts in the evenings and remained outdoors for extended periods of time for various recreation activities. Also, due to high temperatures, physical training was conducted in the early hours of the morning or evening. Both periods coincide with the peak biting periods for sand flies and mosquitoes.

We created a questionnaire, shown at Figure 1, to gather initial information about the existing environmental conditions, knowledge of preventive measures, and availability and use of preventive materiel when responding to a unit's complaints of arthropod bites or request for pest control. From the responses to the questionnaires, we concluded that there was a marked distinction in the level of knowledge about personal preventive measures and availability of protective equipment (PPE) between the Active Army and Reserve (USAR) units.

Availability of PPE was noticeably less among USAR units. More than 75% of the USAR units deployed without treated uniforms and did not have any Individual Dynamic Absorption Application (IDAA) kits for uniform treatment. Also, over 50% of these units had not been issued deet but had other types of arthropod repellents that were bought from the post exchange or were sent to them by family members. Some of the most commonly used repellents included OFF! Deep Woods Insect Repellent Spray (S.C. Johnson & Son, Inc, Racine, WI) containing 23.8% deet; OFF! FamilyCare Insect Repellents pump-spray containing 5% to 15% deet; and Cutter (Spectrum Brands, Inc, Atlanta, GA) family Insect repellent containing 7% deet. Among Active Army units, approximately 50% of the units did not have permethrin-treated uniforms, although they had been issued the IDAA kits. Furthermore, more than 75% of the Soldiers did not know how to use the kits. About 75% of units had deet but more than 50% of the Soldiers did not use it as recommended for various reasons, such as safety concerns. Almost 90% of all units deployed without bed nets.

One of the greatest challenges involved waste disposal. At COB Speicher, food waste was dumped at the burn pit and left overnight. Much unburned food was left outside the pit attracting many wild and feral animals. Rotting food waste also provided good breeding habitat for flies. Waste was not separated and heaps of tires, metal, plastic, and wood littered the landfill, providing breeding sites for mosquitoes and habitat for snakes, scorpions, rodents, and small mammals. In turn, rodent and other small mammals' burrows provided breeding ground for sand flies. Thousands of birds flocked the area for food and shelter and posed serious problems for aircraft, especially during landing, since this area was close to the flight line.

Wild and feral animals were a major problem on COB Speicher. Food waste left in open bins close to the Soldiers' central housing units (CHUs) attracted animals. To compound this issue, Soldiers continuously fed dogs, cats, birds, and foxes, thereby encouraging them

Unit Name:	**Phone#:**	**DATE:**
Unit Commander:	**SGM/1st Sergeant/Detachment SGT**	
COB/FOB:		
Building Number:	**LSA:**	**GRID:**
Complaint:		

GENERAL CONDITIONS			
		YES	NO
	Total		
a. Branches cut back at least 2 feet from roof, ledges or other access ways?			
b. No debris allowed accumulating for greater than 72 hours?			
c. No vegetation around buildings/tents			
d. *No standing water, or suspected animal burrows in/around site?			
e. No hollow Sidewalks or walkways?			
More than 2 "N0" marks, equal high risk (Denotes critical issues equal to 2 "No")*			
STRUCTURAL CONDITIONS			
a. If dropped ceiling, are all tiles securely in place, present, good repair?			
b. Windows closed at all times, or approved screening present?			
c. *Walls free of holes greater than 1/4 inch in diameter?			
d. Floors extend to meet the walls with no gaps?			
e. *Floors free of cracks/holes greater than 1/4 inch.			
f. Doors hung properly, with no gaps greater than1/4 inch?			
g. If "No" are door sweeps or seals installed and in good repair?			
More than 2 "N0" marks, equal high risk (Denotes critical issues equal to 2 "No")*			
SANITARY CONDITIONS			
	Total	YES	NO
a. Garbage cans cleaned adequately at least daily or when filled up?			
b. Garbage bags present/used?			
c. Dirty or soiled linen kept in approved containers.			
d. *Area free of live pets or mascots of any kind?			
e. Rodent traps checked daily?			
f. Fly traps removed once 70% full?			
g. *Food stored/consumed only in approved areas?			
h. *Food (including drink mixes) stored in hard plastic/metal containers?			
i. *No evidence of rodents (droppings, gnawing, rubmarks)?			
More than 2 "N0" marks, equal high risk (Denotes critical issues equal to 2 "No")*			
EDUCATION/PREVENTIVE MEASURES			
a. *Acting Field Sanitation Team certified and appointed (on orders)?			
b. Proper wear of the uniform IAW FM 21-10 enforced?			
c. Uniforms treated with permethrin?			
d. # of treated uniforms /soldier			
e. Use of deet enforced?			
f. # of deet tubes issued?			
g. Other types of insect repellents?			
h. Repellents obtained from?			
i. Education of Arthropods of military importance posted/provided?			
j. Time PT conducted?			
k. PT uniform?			
l. Evening/nonduty hour uniform?			
More than 2 "N0" marks, equal high risk (Denotes critical issues equal to 2 "No")*			
ASSESSMENT TOTAL			
	Total		
Input the total number of "Yes"/"No" observations from above.			
FINDINGS			
Circle all that apply			
		YES	NO
Area **IS / IS NOT** at risk of infestation due to RODENTS/SNAKES/SCORPIONS/MOSQUITOES/SAND FIIES/OTHER.			
If other, specify:			
Inspector Name:	Rank/Grade	Phone	
Signature:			
Representative Name:	Rank/Grade	Phone	
Follow up inspection date:			

Figure 1. The 926th Medical Detachment (PM) questionnaire used for vector assessment and control requests.

to remain in close proximity to human habitation. Foxes, cats, and sometimes dogs were observed sleeping under CHUs during the day and wandering in search of food in the evenings with no fear of humans (Figures 2 and 3). Some Soldiers adopted dogs and cats as pets, and on occasion kittens were found hidden in Soldiers' CHUs. Some Soldiers also released animals from traps set by the civilian vector control contractor, thereby frustrating efforts to remove animals from living areas. This also exposed these individuals to possible bites and scratches because trapped animals exhibited highly aggressive behavior.

Rodents were attracted to the living and work areas as a result of poor food storage and disposal. Trash bins filled with food waste were oftentimes left open. Soldiers complained of mice gnawing on their fingers and toes while they slept, a consequence of rodent-human cohabitation. Also, the rodents attracted snakes to these areas. Since most of the buildings had numerous openings due to bombings and other acts of war, exclusion was almost impossible. Large numbers of plastic tamper-proof rodent bait stations [a] containing 0.005% Brodifacoum anticoagulant rodenticide[b] placed around most buildings reduced mice numbers but could not eliminate the problem because there was an unremitting supply of new rodents from surrounding farms. The result was an incredibly high number of rodents, demonstrated by the large amount of rodent droppings as shown in Figure 4.

Birds were another vector control problem. Large numbers of pigeons, sparrows, and other species of birds were common both inside and outside of buildings. Bird droppings and feathers accumulated inside and outside of many occupied and unoccupied structures. Mechanical removal of birds by shooting with a pellet rifle (.22 caliber)[c] or trapping with bird traps[d] was mostly used to reduce the population. Unfortunately, when removed from one building, the birds migrated to another building, and their control was almost impossible. To compound this control problem, Soldiers put up bird feeding stations and continuously provided food and water to birds. This attracted more birds, as well as other animals, to these feeding stations that were often close to living and work areas.

Filth fly and other types of fly infestation were common occurrences. Dining facility entrances without adequate mesh screening and/or air curtains had serious fly problems. Soldiers left doors open allowing fly movement into and out of food serving areas. Also food waste bins outside the dining areas were not emptied and cleaned daily (or when filled), leaving food waste to rot, which in turn created fly breeding habitats. Fly traps (Fly Terminator Pro, Farnam Companies Inc, Phoenix, Arizona) [e] with a fly attractant [f] placed outside the dining facility could not eliminate flies altogether.

Sanitation was not properly practiced, especially around most of the living and work areas. Grass and shrubbery were not removed from around tents and hard structures. The vegetation served as habitat for rodents, scorpions, snakes, and sand flies. Buildings, tents, and storage containers were poorly maintained and had large openings that facilitated rodent and other animal entry. Discarded piles of wood waste, old sand bags, and other barrier materials provided habitat for scorpions, snakes, and rodents around buildings.

Infestation from the common bed bug, *Cimex lectularius* Linnaeus (Hemiptera: Cimicidae), was observed among US forces, contractors, and third country nationals (TCNs). Bed bugs, which are part of reemerging pests, especially in developing countries, were to a lesser extent a problem among US service members. Infestations were more common among civilian employees, especially the TCNs. Soldiers complained of sand fly bites which we confirmed to be caused by bed bugs. Unfortunately, many Soldiers lacked education/information on bed bug infestation or what to do if infested.

IMPLICATIONS

Soldiers continued to complain of arthropod bites and sometimes sought medical treatment due to dermatitis, secondary infection, or allergic reactions to bites. During this period, sand flies tested for leishmania parasite infection were all negative. However, some Soldiers became infected with cutaneous leishmaniasis indicating the presence of the parasite in this region. Although there were only 2 reported cases of cutaneous leishmaniasis and no cases of malaria in the 2 locations during this period, malaria and leishmania remain significant medical problems for US personnel deployed worldwide. Over 500 cases of cutaneous leishmaniasis were

a. National Stock Number (NSN) 3740-01-423-0737
b. NSN 6840-01-508-6085
c. NSN 1005-01-544-1044
d. NSN 3740-01-542-9963
e. NSN 3740-01-561-9678
f. NSN 3740-01-561-9732

Figure 2. Fox resting next to a military central housing unit. (Photo provided by the author.)

Figure 3. Dogs resting next to a Soldier's work area. (Photo provided by the author.)

reported among US Soldiers in the first year of OIF.[6] Four cases of visceral leishmaniasis were reported among US personnel deployed to Iraq[7] and 38 cases of malaria reported in US personnel deployed to eastern Afghanistan from 2002 to 2004.[6] Even in the absence of diseases, annoyance pests could negatively affect morale and performance.

Pesticides were often used to control disease vectors that were above the recommended threshold of 25 female anopholine mosquitoes or 15 female phlebotomine sand flies per trap per night. Pesticide application frequency was, on average, one to 2 applications per week during peak periods. Due to the nature of sand fly habitat, control of immature forms was very difficult, and adult control through fogging was the most applicable method. Two of the most commonly used insecticides were Scourge[a] (Bayer CropScience LP, Montvale, NJ) containing 4% resmethrin and 12% piperonyl butoxide, and Anvil 10+10 ULV[b] (Clarke Inc, Roselle, Illinois) with 10% 3-Phenoxybenzyl-(1RS, 3RS; 1RS, 3SR)-2,2-dimethyl -3-(2-methylprop-1-enyl) cyclopropanecarboxylate. We observed that repeated pesticide applications were always required to bring down sand fly numbers. This may be partly due to the harsh climatic conditions where pesticides were rapidly degraded, ineffective application methods in targeting precise microhabitats,[8] or already developed pesticide resistance as a result of chemical use in agricultural and other pest control needs by the host nationals. Selection pressure may result in development of insecticide resistance due to persistent pesticide applications. This phenomenon has been reported for most vectors of human diseases and classes of pesticides.[9,10] Continuous monitoring of insecticide resistance emergence in disease vectors is therefore necessary in military operations where chemical control is constantly used.

a. NSN 6840-01-359-8533
b. NSN 6840-01-474-7706

Figure 4. Rat and mouse droppings collected outside a food storage room. (Photo provided by the author.)

Scorpion stings were mostly from less poisonous scorpion species, although we found some of the medically important scorpion genera, *Androctonus* and *Leiurus* (Buthidae) and *Hemiscorpius* (Liochelidae) in this region. Stings were mostly on the legs. All individuals who were stung were wearing shorts and tee-shirts. Many of these cases required hospitalization for observation. Serious cases of scorpion stings have been reported elsewhere during OIF and OEF deployments. In 2006, a US Army entomologist in Kuwait was stung by the deadly scorpion *Androctonus crassicauda* and had to be airlifted for medical treatment.[11] This

scorpion sting report is not an isolated incident. From 2005 to 2006, 9 cases of snakebites and 85 cases of scorpion stings and spider bites were reported among 3,265 Soldiers deployed to Iraq and Afghanistan.[12]

Filth flies are not only nuisance pests but are also important in mechanical disease transmission and may act as intermediate hosts for a number of helminthes.[13,14] Flies in dining facilities frequently came into contact with food. This can enhance mechanical transmission of disease pathogens. Flies play a significant role in the spread of diarrheal diseases that contribute to reduced military effectiveness during deployments. Cases of gastroenteritis associated with Norovirus, Shigella, and *Eschericia coli* (Migula), Castellani and Chalmers (Gamma Proteobacteria: Entorobacteriaceae) have remained a problem among deployed forces. In a study conducted in 2003 at Doha, Qatar, on US Soldiers during rest and recuperation leave, 70% of Soldiers reported at least one episode of diarrhea while 54% reported multiple incidences during deployment to Iraq and Afghanistan. Among these individuals, 43% reported a decline in performance for 2 days, while 17% indicated they had to take bed rest for 2 days due to a diarrhea episode.[15] A study in 2004 found that 66% of US Soldiers in Iraq experienced diarrhea, with 50% reporting more than one episode.[16]

Fly larvae sometime invade human organs and tissues, a condition referred to as myiasis. Fly larvae in the human eyes results in ophthalmomyiasis or ocular myiasis. Common cause of ocular myiasis is deposition of the sheep nasal bot fly (Oestrus ovis Linnaeus (Diptera: Oestridae)) or human bot fly (*Dermatobia hominis* Linnaeus (Diptera: Oestridae)) larvae in the cornea of the human eye. Ocular myiasis patients complain of red watery eyes, swollen conjunctiva, and sometimes a sensation of foreign body in the eye. One case of ocular myiasis occurred on Contingency Operating Base Speicher in March 2008. A male Soldier reported to the optometry clinic complaining of painful, watery eyes and a feeling of "sand in his eyes." He reported that a day before this visit, a fly had hit his eye while it was buzzing around his face. The optometrist observed and removed 4 small worms from over the cornea of his left eye. Antibiotic and antihistamine drops were prescribed and the patient was asked to report back after 2 days. He did not return for his follow-up appointment. The worms were sent to the base entomologist for identification. They were identified as the first instar larvae of the sheep nose bot fly. This case accounts for the second report of *O. ovis* ocular myiasis in the northernmost part of Iraq. Bot fly ocular myiasis cases from Iraq have been reported from the Baghdad area with only one other case reported north of Baghdad at Mosul.[17] Other cases have been reported elsewhere in Iraq[18] and Afghanistan.[19] Ocular myiasis is not only medically important but is also traumatizing to the affected individual.

Large numbers of birds roosting in buildings constitute health hazards. Bird nests harbor ectoparasites such as pigeon fleas (*Ceratophyllus columbae* Gervais (Siphonaptera: Ceratophyllidae)), chicken mites (*Dermanyssus gallinae* De Geer (Acarina: Dermanyssidae)), ticks (*Argas reflexus* Fabricius (Acari: Argasidae)), and biting lice. Although these parasites may not transmit diseases, their bites could cause allergic reaction and discomfort.[20] Bird droppings attract filth flies and may carry disease pathogens. Soil contaminated with bird droppings accumulated over a long period of time may contain spores of the fungi *Histoplasma capsulatum* Darling (Ascomycetes: Onygenaceae) or *Cryptococcus neoformas* (San Felice) Vuillemin (Tremellomycetes: Tremellaceae). Inhalation of these spores may cause diseases such as Histoplasmosis and Cryptococcosis. Although these diseases are mild in healthy individuals, they may become fatal in a person with a compromised immune system.

Cohabitation of rodents and humans may potentially expose individuals to various rodent diseases. Worldwide, rodents transmit over 35 diseases. Mice may transmit diseases to humans through their bites, droppings, and urine. Rat bite fever is an infectious bacterial disease caused by *Streptobacillus moniliformis* Levaditi, Nicolau, and Poincloux (Fusobacterales: Fusobacteriaceae) and *Spirillum minus* Carter (Spirochaetales: Spirillaceae) and transmitted mostly through bites and scratches from rats and mice. Eating food contaminated with mice urine or feces could cause salmonelosis or leptospirosis. Rodents carry ectoparasites such as fleas. Bites from fleas infected with the bacterium *Yersinia pestis* (Lehmann & Neumann), Van Loghem (Enterobacteriales: Entorobacteriaceae) cause plague, a disease that caused millions of deaths in Europe during the Middle Ages[21] and is still endemic in some countries.[22]

Close association of humans with feral and wild animals could potentially expose service members to zoonotic diseases. Over 75% of emerging and re-

emerging pathogens are reported to be zoonotic.[23] Feral dogs and other canids that roam the military camps in search of food may transmit numerous disease pathogens to humans. Of importance are diseases such as rabies, helminthes, and bacterial and fungal infections.[24] Close contact with dogs and cats may facilitate transmission of ectoparasites which may cause prurities and secondary infection from scratching.[25] Bites from fleas could potentially transmit diseases. Of all the diseases transmitted from animals to humans, rabies is the most severe. It has worldwide distribution and causes over 55,000 deaths every year.[26]

Although bed bugs do not transmit diseases, their bites may cause allergic reactions that could range from pruritic papules[27] to hemorrhagic vesicular lesions and urticaria.[28] Bed bug infestation may result in loss of sleep due to persistent biting and itching, ultimately affecting an individual's quality of life and combat readiness. Repeated bites may cause individuals to become constantly agitated and nervous, resulting in substantial psychological problems.[29]

Recommendations

The first line of defense against vector-borne diseases and annoying arthropods is the proper use of personal protective measures (PPM). It is the responsibility of the individual service member to implement recommended PPM. Soldiers must educate themselves on the importance of the use of PPM. Strict adherence to PPM will only occur when service members understand the serious consequences of noncompliance. This knowledge will promote development of confidence in the effectiveness of the personal protective equipment, thereby minimizing the disease threat.

Commanders at all levels have direct responsibility for the protection of the health of Soldiers under their command. It is, therefore, imperative that unit leaders receive aggressive training on importance of PPE use and remain informed of all possible medical threats in various regions. Proper PPE use should be included as a required training task in the mission essential task list and should be part of predeployment training. Distribution of PPE to service members should be completed early in the predeployment phase whenever possible. Unit leadership should ensure that Soldiers are educated and motivated on the importance of PPM and are equipped with all required resources. They should remain vigilant, continuously emphasize the use of PPM, and perform unscheduled welfare visits to Soldier living quarters to ensure compliance. When possible, unit leadership should minimize unnecessary outdoor activity at dusk and dawn when disease vectors are most active. Also, trousers and long-sleeve shirts may give better protection than shorts and tee-shirts during physical training. Deet should be applied to exposed skin at all times.

Proper sanitation must be continuously emphasized. Unit leadership should enforce proper waste disposal. Waste bins should be emptied and cleaned daily or when filled. Segregation of waste at the source to allow proper burning should be enforced. Food storage or consumption in living areas should be discouraged and pest breeding habitats should be eliminated where possible. Leaders should enforce the US Army 5th Corps General Order Number 1 (GO-1) (March 19, 2003), with all its modifications, as it pertains to the adoption of wild and feral animals as pets and mascots and feeding or caring of these animals. GO-1B prohibits "adopting as pets or mascots, caring for, or feeding any type of domestic or wild animal." Individuals who keep or feed animals, regardless of their rank or position, should be subject to discipline under the Uniform Code of Military Justice* as specified in GO-1. Entrances to food service facilities should be equipped with adequate mesh screening and/or air curtains. Holes and cracks in the walls, doors, and windows should be sealed through the use of materials available on the base. Vegetation should be cleared and debris removed from around living and work areas.

At higher command levels, authorities should ensure that all mandatory PPE is available to deploying personnel. The responsibility of acquiring PPE should not be left entirely to individual units. It should be distributed through a centralized process such as central issue facility, rapid fielding initiative (RFI), or other means that ensure that every unit receives all required resources before deploying. This is more so for mobilized USAR units which had more difficulty obtaining PPE than did Active Army units. Similar findings have been reported elsewhere among military services and branches of each service.[31] In a study

*The Uniform Code of Military Justice (UCMJ), a federal law,[30] is the judicial code which pertains to members of the United States military. Under the UCMJ, military personnel can be charged, tried, and convicted of a range of crimes, including both common-law crimes (eg, arson) and military-specific crimes (eg, desertion).

within the Army, 40% of Active Army and Army National Guard personnel reported receiving issued deet compared with 21% of personnel from the USAR. Marked differences were observed in numbers of personnel having at least 3 permethrin-treated uniforms. The USAR units fared poorly with only 6.2% of personnel having 3 permethrin-treated uniforms, compared to 54% of personnel in the Active Army units.[32,33] The basis for this difference should be established and efforts made to ensure that all deploying personnel receive recommended PPE. If for any reason equipment cannot be issued to Soldiers before they deploy, RFI teams may be forward-deployed, and it may be advantageous to preposition required PPE in different locations in theater.

CONCLUSION

The military continues to commit considerable resources to FHP. Because of this, the Department of Defense FHP effort has made massive strides in combating environmental health threats during contingency operations, especially in disease endemic regions. However, despite this success, military personnel continue to be plagued by preventable diseases not related to combat. We observed poor implementation of PPM among individual Soldiers as well as serious failure by commanders at all levels of responsibility to emphasize the use of PPM. This indicates the need for reevaluation of current regulations, such as GO-1 and *Army Regulation 40-5*[34] which specifies the responsibilities of individual Soldiers and commanders in the implementation of PPM. Governing regulations and orders should clearly spell out disciplinary consequences for failure to strictly adhere to the use of required PPM. Military leadership should ensure that leaders at all levels face serious consequences if they fail to enforce use of PPM. Leaders should understand that they are responsible for the health of their troops and that they will be held accountable for DNBI among Soldiers under their command. It is therefore imperative that unit leaders strictly enforce PPM use and lead by example. Command discipline is indispensable. In the words of then Lieutenant General Sir William Slim, the commander of the British XIV Army in Burma during World War II:

> Good doctors are no use without good discipline. More than half the battle against disease is fought not by doctors, but by regimental officers.[35]

General Slim sacked commanders who failed to enforce malaria prophylactic treatment. His aggressive leadership resulted in the enforcement of malaria chemo-prophylactic drug use, which dramatically reduced the number of malaria cases among his troops. This demonstrates that combined efforts from military policy makers, the medical community, leadership at every level of command, and the individual Soldier are needed to combat DNBI among deployed US forces.

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Evolution of the Army Hearing Program in a Deployed Environment

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In 2007, Army Audiology transformed from a program focused on hearing conservation to one focused on maximizing operational capabilities.[1] This new program centered on systems and strategies enabling a Soldier to maintain and, in some cases, improve auditory awareness. These goals were achieved through the 4 elements of the Army Hearing Program: hearing readiness, clinical hearing services, operational hearing services, and hearing conservation.[2,3] Hearing readiness is the metric applied to annual audiometric testing that enables tracking of the audiologic health of Soldiers. *Army Regulation 40-501*[4] outlines the categories of readiness, which are reflected in the Army Medical Department Medical Protection System (MEDPROS) medical readiness database. The MEDPROS categories are indicative of medical readiness, and thus better ensure achievement and maintenance of a deployment-ready force. Operational hearing services focus on battlefield-relevant solutions to communication and protective systems that enable a more effective force. An example of this component is integration of a variety of noise-cancelling headsets with ear-level microphones that enable a Soldier to monitor his or her environment while reducing ambient noise. Hearing conservation is a garrison-based mission with the goal of hearing loss prevention in industrial-based operations.[5] Clinical hearing services determine the extent of audiologic and otologic illness or injury and can provide treatment strategies. Both the hearing conservation and clinical services components have been well established since 1978 as outlined in *Department of Defense Instruction 6055.12*.[3] The need to incorporate all components of the Army Hearing Program in-theater has existed for a number of years, however, the priority of the clinical mission and complexities of transportation within the Iraq Joint Operational Area limited the services available.

Historically, the role of the deployed Army Audiologist (Area of Concentration 72C), involved a predominately direct clinical care mission. Located in Baghdad's International Zone, the audiologist was sole provider of audiological diagnostic care in the US Central Command's Iraq area of operations. The audiologist's primary duties involved evaluation and treatment of otologic and audiologic injuries and illness, and was therefore heavily engaged in the evaluation and treatment of blast injury. The role also involved supporting clinics throughout Iraq that conducted abbreviated hearing testing, either for the purposes of inclusion in physical examinations or to evaluate a need to evacuate to higher echelons of care for diagnosis and treatment. With the sole otolaryngology clinic located at Joint Base Balad (JBB), medical management of otologic injury proved cumbersome. Fortunately, the handover of Ibn Sina hospital to the Government of Iraq in October 2009 presented the opportunity to expand the hearing program to a more active role in prevention. This also enabled collocation with the otolaryngologist to provide more expeditious evaluation and treatment. These developments combined with the gradual reduction of the clinical mission (patient encounters decreased by half from 2007 to 2008) and allowed the program's efforts to shift towards the preventive and education mission. In essence, the move enabled the Theater Audiology Consultant to incorporate all components of the Army Hearing Program into daily practice, rather than serving in a primarily clinical role.

Although the proposed collocation with the otolaryngologist at the Air Force Theater Hospital initially seemed ideal, space requirements precluded this move. Instead, the audiology clinic moved to a level II clinic on JBB, which presented new prospects for the program. Of note, the generous space in the level II clinic doubled as a classroom. The clinic could accommodate instruction of up to 6 hearing technician students who not only used the training systems (Figures 1 and 2), but also were able to use the diagnostic booth for more realistic training. During

one of the courses conducted in the midst of a pre-move site inspection at JBB, the Environmental Science and Engineering Officer (author E.O. Price) from the adjacently located 223rd Medical Detachment (Preventive Medicine) (PM DET) volunteered to teach a section of the course on noise hazard evaluation. This block of instruction presented information about the improvements in noise surveillance and noise-induced injury prevention resulting from the symbiosis of the 2 specialties of audiology and environmental science.

Figure 1. Medics practicing earplug fitting during Theater Medic Hearing Program training at Camp Taji, Iraq. (Photo provided by CPT Cave.)

Figure 2. Medic performing otoscopy during Theater Medic Hearing Program training at Camp Taji, Iraq. (Photo provided by CPT Cave.)

The first opportunity to blend the capabilities of the 2 fields arose with the identification of a trend of worsening test results noted by the audiologist during annual audiometric testing of a JBB aviation unit. So informed, but not having full equipment capabilities, staffing, or experience, the audiologist combined forces with the 223rd PM DET to conduct a presurvey inspection. After collaborating on areas identified as potentially hazardous and creating a schedule to allow capture of the most representative sampling, the PM DET conducted noise dosimetry of the aviators' environment spanning several days, while the audiologist conducted area noise sampling. Since adequate crew rest is a particular safety concern to aviation operations, a portion of the dosimetry involved measuring noise within sleeping quarters. The audiologist provided the unit with a report of the findings and recommendations on how to improve communication in the noise hazard environments and mitigate the noise exposure in their sleep areas. As the final piece to the study, the unit received a health education briefing, which included information about the threat of noise exposures in theater and how to mitigate some of these threats, and, most important, the results of the unit's noise survey.

All unit members were offered an opportunity to be otoscopically examined and refitted with hearing protection devices at the conclusion of the briefing. These fittings also identified aviators who had difficult to fit ear canals for whom custom devices were ordered for their communication earplugs to ensure better noise attenuation and improved communication. The briefing also provided an opportunity to advertise the recently expanded audiological capabilities at JBB.

The PM DET's experience with conducting noise surveys proved invaluable. In garrison, the industrial hygiene section of preventive medicine will often perform the noise surveys in conjunction with the environmental science section. Therefore, the audiologist's role in noise assessment and abatement is usually a consultative one. The audiologist's role often does not involve interpretation of results and noise measurement. In theater, this role became key to the success of the program. The PM DET had regular missions to remote forward operating bases in a vast area of operations which limited staffing resources available to conduct this noise monitoring. The environmental science and engineering officer and the audiologist collaborated to devise a system to successfully cover the requests for noise surveillance (Figure 3). Generally, noise monitoring was initiated by a complaint of suspected noise hazards reported by the unit safety officer or commander to the PM DET. The PM DET would notify the audiologist, who would then conduct a preinspection assessment. The audiologist would assess the equipment and staffing needs for the study and request resources from the PM DET accordingly. In the case of occasional equipment shortages, the Bioenvironmental Engineering Section of the USAF 332nd Expeditionary Aerospace Medical Squadron, also assigned to JBB, provided the equipment. This afforded the opportunity for specialists of both services to compare notes on noise hazardous areas identified around the base. The Air Force provided a key resource of aircraft-related noise

data. This data could be incorporated into the reports, given that not all aircraft to which the service members were exposed were present during the study. After data collection, the audiologist would generate the report of findings and recommendations. Of note, the report included specific recommendations not only for noise abatement, but for personal protective equipment, often implemented clinically. The audiologist also had access to research relevant to improved speech understanding amidst background noise among various types of integrated hearing protection and communication devices. Presented with these findings, the noise-monitored unit could often justify the expense of personal protective equipment compatible with more tactically relevant solutions beyond passive earplugs. Each unit was offered a briefing to review the findings of the results of the noise survey.

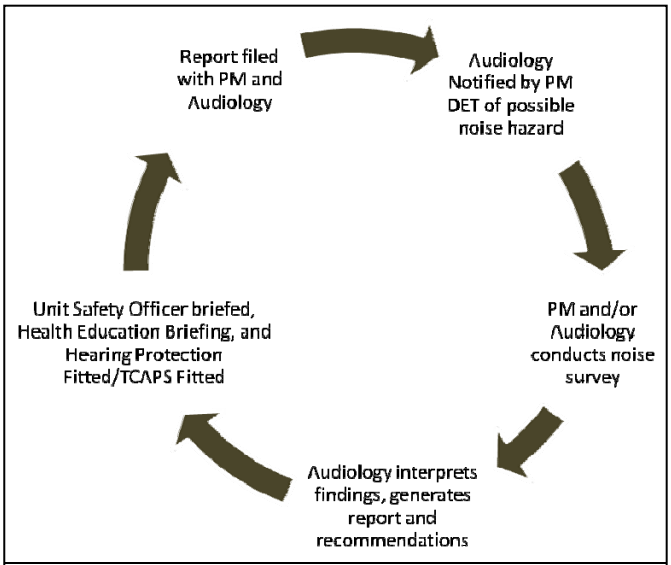

Figure 3. The noise hazard identification and mitigation model which was developed and applied in Iraq.

CONCLUSION

Through the coordination of preventive medicine assets in theater, the scope of services afforded the deployed Soldier expanded to include noise surveillance, education, and tactically relevant hearing protection. This allowed continuation of prevention of noise-induced hearing injury despite the constant threat of noise exposure. Positioning these assets among denser living areas also improved access to care.

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Battling Body Fat

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COL Kyle D. Campbell, MS, USA

According to the Department of Defense (DoD) Medical Surveillance Monthly Report, the number of troops diagnosed with weight issues has doubled since the start of the Iraq war in 2003.[1] Stress from long deployments and unhealthy habits such as too much fast food or playing video games for extended periods of time have been identified as possible causes for this increase. Although the causes may have been identified, human factors such as the health and career implications of obesity are often overlooked. This article examines one program that the Army uses to battle body fat, with the ultimate goal of stopping and reversing the spread of obesity among both Soldiers and Family members.

In a collaborative effort, the US Army Medical Department Activity in Heidelberg, Germany, partnered with the US Army Center for Health Promotion and Preventive Medicine-Europe (USACHPPM-EUR) to develop the Heidelberg Army Wellness Center. The Center implemented a comprehensive wellness program that answered the question, "How is the Army battling body fat?" and became the model for wellness centers throughout the Army. Although wellness has had its share of definitions, historically, the concept was first suggested by Halbert Dunn, MD, who began using the phrase "high level wellness" in the 1950s.[2] Since then, wellness has been generally accepted to mean a healthy balance of mind, body, and spirit that results in the overall well-being of an individual.[3] The leading causes of death in modern society have been linked largely to the behavior choices a person makes each day. The change from the 19th century to the 20th century brought with it a transition in the focus of health concerns from infectious diseases to those mediated by lifestyle. It became prudent to seek methods to increase the homeostasis of life and to find a balance with mind, body, and spirit. Wellness has illustrated the impact that a slight change in perspective can have on both an individual's health and the bottom line of organizations. Medical application of wellness emerged based on the works of Kenneth Cooper, MD, and Andrew Weil, MD, both of whom demonstrated the profitability of prevention.[3]

The Army Medical Department Activity in Heidelberg examined the basic constructs of wellness and devised a process that integrated health promotion and a wellness program into clinical care practice. An important factor was the research by Logsdon et al[4] into the effect of physician intervention in the adaptation of healthier lifestyle changes, such as exercise compliance among patients. They found that individuals who received physician-initiated counseling were more likely to report positive behavior changes regarding exercise than were reported by matched controls. Therefore, key to the development of the wellness process at Heidelberg was the encouragement of physicians to counsel patients on the benefits of engaging in positive health behaviors, such as exercise and diet. After a physician suggested lifestyle modification to the patient, he or she would be referred to the Heidelberg Army Wellness Center. Establishment of a process that linked the physicians to the Center was our first step in creating the model for successful wellness applications.

The DoD notes that physical fitness, which includes components such as aerobic and anaerobic fitness, body composition, and weight management, "…is a vital component of combat readiness and is essential to the general health and well being for Armed Forces personnel."[5] In 2008, approximately 60% of all DoD services personnel, male and female, were classified as overweight.[6] In a percentage of these cases the excess body weight can lead to degradation in performance for the Soldier. Problems can arise from the amount of time a Soldier may spend on a medical profile, or from

other health care needs associated with the excess weight and body composition, all of which contribute to a reduction in operational readiness. Indeed, this is not an exclusive concern of the US Army. Each of the armed services has physical fitness programs, each with its own specific focus to test and maintain each individual's body composition and physical fitness.

According to regulatory guidelines of *Army Regulation AR 600-9*,[7] *Army Regulation 350-1*,[8] and *Army Field Manual 21-20*,[9] failure to meet physical fitness standards or weight control standards can have a detrimental effect on a Soldier's career. The primary objective of the Army Wellness Centers is the prevention of such occurrences in the first place. To assess the effectiveness of this concept, the Heidelberg Army Wellness Center and USACHPPM-EUR began a collaborative effort with the Seventh Army's Noncommissioned Officer Warrior Leader Course to address a disturbing situation among the students. The noncommissioned officer instructors noted a trend in students reporting for the course who were either overweight, over body composition, unfit, or a combination of those conditions. The Warrior Leader Course trains 432 Soldiers over 30 days, 8 times a year. During each class in 2007 and 2008, 10% of the Soldiers were not able to meet body fat standards at the end of the training cycle. Working together, the Heidelberg Army Wellness Center and the USACHPPM-EUR developed a new program to reduce the number of those body fat failures at the end of the Warrior Leader Course.

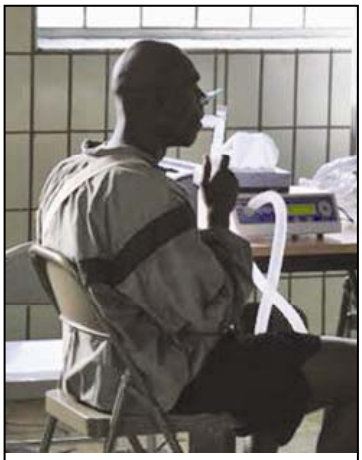
Figure 1. Metabolic measurement device in use.

The purpose of the weight reduction initiative was to determine if metabolic testing, or indirect calorimetry, combined with a 4-week dietary intervention would result in decreased body weight within a selected cohort of Soldiers judged as overweight. All Soldiers who did not meet body fat standards were directed to participate in the health education program at the beginning of the Warrior Leader Course. Metabolic testing was used to measure daily caloric needs. Body fat was measured using bioelectrical testing, which also provided information on intracellular hydration. Data on each Soldier's total body weight and body fat were collected within 3 days of reporting to the course, and again at the end of the training. After the initial evaluation, each participant received an individualized meal plan based on their metabolic results. An educational class was provided to review test results as well as to illustrate effective principles of proper nutrition and exercise for weight reduction.

Metabolic testing using indirect calorimetry is an advanced method for measuring the resting metabolic rate of individuals. Identification of a Soldier's resting metabolic rate is the first step in designing an individualized intervention that meets the needs of the person. The process of metabolic testing is rather simple to complete. It is important to note that anyone receiving a metabolic analysis must not have eaten or exercised for at least 4 hours before testing. Consumption of any type of food or drink, engaging in physical activity, or smoking can elevate the resting metabolic rate, which would result in an inaccurate reading. The scientific principle used in indirect calorimetry is based on the metabolic requirement of oxygen to produce energy. For each 208 mL of oxygen consumed, the body burns one calorie of energy.[10] Therefore, measuring the amount of oxygen ingested into the body and then exhaled determines the oxygen absorption rate. During testing, the nose is clipped with a special clamp. Inhaled and expired air is isolated through a single use, 2-way breathing valve. The valve is designed to allow air to enter, but closes in the reverse direction when air is expired, which prevents contamination of the air sample. The metabolic measurement device has an oxygen sensor and flow meter which are used to analyze both the concentration of oxygen and its volume (Figure 1).

It is important to understand the resting metabolic rate because if the human body does not receive enough calories per day to maintain basic life function, the body literally "thinks" it is starving to death. The human body is a complex organism that requires key things from the environment—air, water, and food—in order to survive. Without them, life could not exist. Food can be greatly manipulated, and a person could survive without water for 2 to 10 days depending on

temperature. Without air, however, life ceases to exist. The resting metabolic rate represents between 60% and 75% of the body's total energy needs for the day and shows the minimum amount of calories the body needs per day just to survive, ie, to be able to breathe and think. Resting metabolic rate is vital for basic life function. Throughout human evolution, the body has been able to adapt to times of both famine and abundance. The problem in modern times is that food is plentiful, but the body does not know this. If the body experiences prolonged periods of less food consumption than it needs, a starvation response is triggered that prompts the body to become extremely conservative in energy expenditure. In some cases of extreme dieting, the body will even metabolize lean muscle tissue to be used as energy, just to protect fat cell stores. Therefore, an understanding of a person's resting metabolic rate can help the development of programs specific enough to avoid triggering the starvation response in the body.

Upon arrival, Soldiers report to the evaluation center at the Warrior Leader Course. Each student completes a simple questionnaire that asks for weight, height, and age. Special dietary concerns are addressed by evaluating specific health needs of the Soldiers. For example, if a Soldier was under treatment for high blood pressure, an appropriate meal plan would be provided to meet this medical need. All meal plans at the Noncommissioned Officer Academy programs have been developed by dietitians registered with the American Dietetic Association.

Body fat is assessed using a process called bioelectrical impedance assessment. Bioelectrical impedance assessment is based on the principle of conductivity of electrical current and resistance. First, the basic data of weight, height, and age are entered into the bioelectrical impedance assessment machine. Using the weight and height measurements, a body surface area is determined. The Soldier is placed in a supine position on an exercise mat with hands and feet extended straight out. Small electrodes are placed on the wrist, hand, foot, and ankle (Figure 2). The electrodes are coated with a sticky gel substance that adheres to the skin, which creates a seal between the skin and the bioelectrical impedance assessment contacts. Wires are attached to the electrodes. A low current, which is completely painless, is applied and the resistance of the body is evaluated. Since water is an efficient conductor of electricity, the current applied to muscle, which contains about 70% water, just passes through. However, resistance occurs when the current encounters fat. The amount of resistance (in ohms) is measured and helps determine how much fat mass is in the tested body surface area.

When correctly performed, bioelectrical impedance assessment can provide an accurate and safe measurement of body fat. In fact, if the Soldier is hydrated enough (55% to 65% for males and 50% to 60% for females) the test yields impressive results. Identification of the ratio of fat mass to lean tissue will help determine if the intervention is having a positive effect on total body fat reduction. By comparing results before and after the program, an accurate assessment can be made as to whether the intervention was a success or failure. Body fat testing provides a very crucial analysis of the program's true effectiveness in meeting the Army's physical fitness standards.

Figure 2. Bioelectrical impedance assessment data collection. Note the electrodes attached to the subject's right foot and ankle. Other electrodes are attached the to the subject's right hand and wrist (not visible).

The final component in weight reduction intervention is education, not only about the test results and what they mean, but also how the Soldier can successfully apply them in his or her environment. To accomplish this, a class called "Upping Your Metabolism" was developed. Soldiers learn about metabolism and how simple changes, such as frequency of intake of food, can elevate the resting metabolic rate. In addition, teaching Soldiers how to modify their dietary habits whether they are in the field, at home, or deployed is key to long-term success. The class provides a heavy emphasis on the application in real world settings of what the metabolic test reveals. After all, the entire program would be virtually worthless if nobody could sustain or maintain the plan for the long haul. Assisting Soldiers to understand how the body

processes energy and what environmental changes can be made to achieve a better balance in caloric needs has resulted in some impressive outcomes.

CONCLUSION

The results achieved by the Heidelberg Army Wellness Center and USACHPPM-EUR indicate the wellness program was relevant to improve functioning and human performance at the Noncommissioned Officer Academy's Warrior Leader Course. Eight class cycles were completed in the 12 months from August 2007 to August 2008. Aggregate data collected (N = 154) indicates that 99% of Soldiers participating in the program met body fat standards at the end of the intervention. At the end of the 4-week program, the average body weight loss per Soldier was 9.9 lbs with a reduction of 3.6% body fat. Longitudinal data collected after 6 months to ascertain the long-term effectiveness showed that more than 86% of participants had maintained or continued their weight loss. This data appears to indicate that this wellness program is very effective for active duty Soldiers. Further studies would be needed to assess the effectiveness of the program for active duty Family members, Army civilians, and members of the general population.

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Aguardiente at the Alamo: Alcohol Abuse and the Texas War for Independence, 1835-1836

Wayne R. Austerman, PhD

Alcohol abuse has been a problem for armies ever since the first sip of barley malt passed the lips of a Sumerian spearman. The problem continues to challenge both commanders and health care providers alike in the modern United States Army as the 21st century begins. There is a certain irony in Fort Sam Houston's status as the home of Army medicine, for the post's namesake was an alcoholic for much of his adult life. Furthermore, the Republic of Texas began its quest for independence and eventual statehood under his leadership in the midst of a war which saw alcohol abuse play a significant role in the near-defeat of the Texian forces in the very battle which came to symbolize heroic martyrdom in the cause of freedom. If the Republic of Texas was born in the priming pan of a flintlock rifle, it was most certainly baptized with a dipperful of white lightning. The impact of alcohol abuse upon the opening stages of one of the most fateful conflicts in American history still carries useful insights for the Army Medical Department of today. (Sam Houston's struggle with alcoholism has been documented in a number of studies, two of which are referenced herein.[1,2])

"...send no more ardent spirits..."

The North American colonists who revolted against Mexican misrule of the province of Texas in late 1835 came from a society which was generally characterized by hard drinking. In 1830 the consumption of whiskey in the United States averaged five gallons per person per year. By 1835 it was estimated that excessive drinking figured in the deaths of 56,000 citizens each year even as a growing temperance movement began to find adherents in the populace. The Scots-Irish and Anglo-Celtic Southerners who comprised a large portion of those who settled in Texas from the early 1820s onward, and who initially took up arms in defense of the rights originally promised to them by Mexico, were even more culturally predisposed to tipple than the average American of the time.[3,4] Alcohol consumption among Southerners often exceeded the national norm, "if only because of the relative slowness of the temperance crusade to cut the rate as it did in the Northern states after 1830," noted historian Bertram Wyatt Brown. In the antebellum South from the Potomac to the Sabine the consumption of alcohol was viewed as a function of masculinity, an important social ritual enacted among males, intended to display virility and "show affection and group solidarity in permissible fashion," for the practice served to "validate male friendships and incorporation into the male tribe, so to speak, particularly in Celtic regions, of which the South was one."[3,5,6]

The proclivity for tapping the cask cut across social and economic class lines on the Southern frontier, where the rural patrician was just as likely to imbibe freely as the yeoman farmer or the "chaw-bacon" backwoodsman. A number of contemporary observers commented upon the Texian tendency to engage in rowdy drinking bouts. In 1822, young emigrant Robert Hancock Hunter and his family arrived at a new settlement on San Jacinto Bay (near modern Houston) to find a group of 31 men reeling about the shoreline, "all drunk on Pa's rum." Virginian Fairfax Gray was present 14 years later when a convention mustered in the hewn-log hamlet grandly named "Washington-on-the-Brazos" to provide political leadership for the restive Anglo-American settlers in their confrontation with the Mexican government. Gray sneered that the assembly was "run by besotted minds" after hearing provisional Secretary of War (and future US senator) Thomas Jefferson Rusk exhort his colleagues to "take one more drink of whiskey and then saddle up and go to the rescue of the boys in the Alamo." A leading

This article is derived from the monograph, "*Offensive to Humanity": Medical Issues in the Texas War for Independence, 1835-1836*.

social historian of the Republic of Texas has characterized it as "a masculine world, a hard place of toil occasionally relieved by rough carousing, an uninhibited place where most men often drank too much. Drinking inevitably exaggerated the obstinate streak of argument-prone Texans, which led to further uproar." A captured Mexican officer waspishly observed in the wake of the great Texian victory at San Jacinto in April 1836 that "The gatherings of those besotted people are invariably more or less influenced by mean liquors."[7-10]

The truth of the matter is that the troops who fought for Texas independence were an undisciplined and intractable lot, who were hard to keep under control even under the best of circumstances. A decade later during the Mexican War of 1846-48 a bemused General Zachary Taylor of the US Army confessed that "on the day of battle I am glad to have Texas soldiers with me, for they are brave and gallant, but I never want to see them before or afterwards, for they are too hard to control." Even in the midst of the 1836 struggle for independence a harried provisional Governor David G. Burnet lamented that the "intemperate and irrational" natures of his volunteer troops taxed the skills and patience of their commanders. Historian Paul D. Lack observed in his study of the revolution that

> No single manifestation of disciplinary problems among Texas soldiers attracted more condemnation from the authorities than alcohol consumption, [for among the ranks] the potential for excess increased substantially when the army found an opportunity to indulge its thirst for whiskey. Consumption of alcohol comprised such a regular part of camp routine that it attracted little comment except when it spilled over in the form of disorderly behavior.[11,12]

The existing cultural propensity for heavy drinking manifested itself among the earliest American volunteers to reach Texas as war fever grew during the waning months of 1835. On November 4, for example, a party of 30 men belonging to a larger contingent of volunteers recruited from the Ayish Bayou settlements in the Louisiana-Texas border country passed through the village of Gonzales on the Guadalupe River, east of San Antonio. There they punctuated a drinking bout by staging a riot which saw stores looted, men beaten, and women subjected to insult and abuse before more sober comrades intervened to restrain the drunken troops. "Savage Indians would not be guilty of such conduct," complained one angry resident.[13]

Gonzales had already been the scene of the first armed clash between angry Texians and Mexican troops during the preceding month, and by the following December its settlers had provided many members of the self-designated "Army of the People" which was besieging Brigadier General Martin Perfecto de Cos and his garrison in San Antonio. Led by the mild-mannered Stephen F. Austin, this volunteer force was soon drinking to the detriment of good order and discipline after encamping within sight of the enemy-held town and neighboring Alamo mission. "The army had been assembled only a few days before Austin began suggesting that whiskey be eliminated from its list of supplies," noted Lack. "Soon he wrote to the civil government: 'In the name of Almighty God send no more ardent spirits to this camp—if any is on the road turn it back, or have the head knocked out."[14,15]

Despite Austin's pleas for shattered kegs and strict sobriety, the liquor continued to lubricate the volunteers' vigil against Cos. "Many sought relief from their boredom by reaching to the bottom of a brown jug," Stephen L. Hardin observed in *Texian Iliad*. "Austin complained that drunks roared through camp, shooting off rifles and wasting precious powder and ball." The passage of little more than a month saw a combination of inaction, loose discipline and potent libations that very nearly destroyed the Texians' always unstable sense of unit cohesion.

> Between 250 and 300 volunteers departed for home; others berated their officers; and more than a few got blind drunk … the siege of Bexar, at last so close to success, was in danger of being abandoned. Texian volunteers had been encamped around the town for about seven weeks, during which time they had defeated the Mexicans in every engagement, switched commanders and consumed inordinate amounts of corn liquor…. For the first time since the fighting began at Gonzales, Texians had to admit that they were beaten, not by the enemy, but by their own disorganization and discord.[15(pp56,68)]

The prevalence of alcohol abuse among such undisciplined troops had served only to exacerbate all of the problems normally associated with maintaining units composed of such untrained citizen-soldiers on protracted active duty. None of Cos' cannon and muskets had done a fraction as much potentially fatal

damage to the Texian cause as had the numbing sluice of corn squeezings down the throats of the restless men who held the Mexican regulars besieged in San Antonio and the Alamo.

A Texian assault and two days of grim house-to-house fighting resulted in Cos' surrender on December 10, 1835. A boozy round of celebration followed the parole and release of the enemy troops, and then the majority of the volunteers departed homeward, leaving a small garrison of both newly enlisted "regulars" and fellow volunteers behind them to secure the Alamo and its artillery. As 1836 opened, a second Mexican expeditionary force was poised to invade Texas and crush the rebellion. Meanwhile, the Anglo colonists and their native *Tejano* allies struggled to form a standing army and organize a workable government to direct what was still simply a petition of rights by arms and not yet a formal bid for independence. The stage was set for that fateful progression of events which would come to form the great creation myth of Texas history—the siege and battle of the Alamo. Not surprisingly, alcohol abuse played a nearly decisive role in that action as well.[15(pp77-91)]

"...drunken irregularities..."

The alcoholic history of the Alamo highlighted the liquor abuse problems which afflicted both common soldiers and their commanders as the struggle with Mexico entered its fifth month of open warfare. The crumbling "mission fortress" hosted a garrison which was apparently prone to tippling at every opportunity, and at least one senior officer's drinking habits directly contributed to the internal dissension and slipshod discipline which threatened to fragment the defenders in the face of an impending Mexican invasion.

By early February 1836 command of the Alamo had devolved upon young Lieutenant Colonel William Barret Travis, who had formal charge only of the 50 "regulars" assigned to the post. The hundred-odd volunteers who comprised the balance of the station's strength had elected Colonel James Bowie as their commander. A renowned adventurer and duelist, he was by that time medicating an advancing case of tuberculosis by frequent recourse to the bottle.*

Irritated at Travis' attempt to assert overall command authority by virtue of his status as an officer of the regular Texian forces, the ailing Bowie actively interfered in the functioning of the command. On February 13 the post adjutant complained in official correspondence that Bowie had sought to assume overall command by his own authority, ordered the garrison to parade through the streets of San Antonio while under arms, and used their intimidating presence to compel the release of prisoners from the municipal *juzgado* (jail). The adjutant reported that Bowie and many of the troops were drunk at the time of these disturbances. An indignant Travis informed the provisional government that he refused to be "held responsible for the drunken irregularities of any man."†

The quick-tempered attorney-soldier was so disgusted with Bowie's drunken intrigues and rivalry that he assembled his 50 regulars and marched them out of the Alamo to establish a new camp located several miles distant on the Medina River on February 13. Although Travis and his men remained there only a day or two at most before returning to San Antonio, it was still an ill considered action on his part, for there had already been a spate of warnings concerning enemy activity along the Rio Grande. The division of the Alamo's garrison in the face of a possible invasion of Texas was itself an index to the virulency of the liquor-fueled antipathy between Travis and Bowie.[13(p82)]

Even after Travis' men rejoined the garrison the excessive drinking continued. Most of the troops were quartered in town in private lodgings and not within the walls of the post proper. This made it virtually impossible for their officers to maintain proper discipline and control their access to liquor. Such laxity came very close to destroying the Alamo's defenders before they could ever mount its ramparts. The speed of the Mexican advance northward into Texas took Travis and his superiors by surprise, for he had persistently discounted reports that enemy troops had crossed the Rio Grande as early as February 18 and were closing on San Antonio. A cavalry vanguard had reached the Medina River ford to the west of town (in the vicinity of modern Castroville and Lacoste) by the night of the 20th. When Santa Anna and the lead division of his army arrived at the river at 1:45 PM on the 21st, he found Brigadier General Joaquin Ramirez y Sesma and his horsemen awaiting further orders.[18,19]

Sesma might have already sent his cavalry forward to scout the town and its approaches, but he had

*References 13(pp52,56,60-61,71-72,76-78,80-81),16(pp62-63,119),17,18

†References 13(p82),15(pp119-120),17(pp55-56)

cautiously chosen to keep his dragoons on the west bank of the Medina. Soon after Santa Anna's arrival on the scene, he met with local sympathizers from San Antonio who informed him that the "Norte Americanos" were preparing to hold a grand fandango that night in celebration of George Washington's birthday. He quickly ordered Sesma to take his best mounted men across the Medina to mount a surprise attack upon San Antonio in a bid to catch the rebels by surprise. A heavy rain swept down on the ford that afternoon and rising water kept the cavalry from crossing until early on the morning of the 22nd. At that time the dragoons were barely 25 miles from the Alamo. Even when traveling on the muddy trace which served as a road, the cavalry force had time enough to stage a forced march and surprise attack upon the unsuspecting enemy.[18(p67),20]

When Sesma's dragoons finally cleared the flood-swollen ford and neared San Antonio in the predawn darkness of February 23, the Texians were either still carousing in the cantinas or seeking to sleep off the night's debauchery. An aggressive commander could have filled the streets with carbine and saber wielding troopers before the befuddled enemy could do so much as lift a powderhorn, but Sesma was anything but aggressive. The timorous cavalryman advanced no farther than the banks of Alazan Creek, a stream running hardly a mile and a half from town. There he halted to confer with local sympathizers. One of Santa Anna's senior staff officers lamented that when Sesma came within sight of the town,

> the enemy was still engaged in the pleasures of a dance given the night before.… Several (of the citizens) came to inform him, indicating to him the points through which he might enter and the orders he should give, and urging him earnestly.… At the very moment that General Ramirez y Sesma was advised to enter Bejar, there were only ten men at the Alamo, and it would have required an equal number to take it. Had he just placed himself at the bridge over the San Antonio that connects the fort to the city, as he was advised, he would have prevented the enemy from taking refuge there, thus avoiding the painful catastrophe that we witnessed.[18(pp67,70),20(pp67,70),21]

There can be no doubt that a surprise descent by Mexican cavalry early on that morning could have had catastrophic results for the Texians. Cut off from the sanctuary of the Alamo and finding the narrow streets of the town filled with enemy horsemen, the hung-over or still inebriated men would have faced several bleak prospects: barricading themselves in their lodgings; dashing into the streets to confront Sesma's troopers by ones and twos as they sought to escape to their walled post; or fleeing to the open plains, where they would have been ridden down and lanced or sabred like cattle. Capitalizing upon the element of surprise and the liquor-muddled wits of the enemy, Sesma could have butchered a fleeing rabble at his leisure. Conceivably, it would have been the worst defeat inflicted upon American troops by an enemy cavalry force since British Lieutenant Colonel Banastre Tarleton's horsemen had massacred 350 Continental troops at the Waxhaws, South Carolina in May of 1780.[22,23]

Sesma chose instead to hold his position on Alazan Creek and await the arrival of Santa Anna and a column of infantry at 12:30 PM. Even after their arrival it took another two hours to initiate their movement toward San Antonio. Even so, Sesma had enjoyed incredibly good luck that morning, despite his inexplicable squandering of the sort of opportunity of which all good cavalry men dreamed. Travis had prudently posted a sentinel in the belltower of San Fernando church that morning after daybreak, and at about 10 AM he had seen Sesma's cavalry moving through the brush along Alazan Creek and quickly gave the alarm. None of the enemy horsemen were still visible from the tower by the time Travis arrived at the lookout post, and most of the men who had been aroused by the alarm bell's strident peals went back to bed or bottle in disgust at what they dismissed as a false alarm.

Travis wisely sent two riders westward from town to scout the muddy road which led ultimately southward to the Rio Grande. It was nearing noon when they spurred their mounts eastward in a hasty retreat after nearly blundering into some of the breastplated enemy dragoons. Thus it was not until almost midday that the Texians finally took alarm at the presence of Mexican cavalry on the outskirts of town and began a precipitate retreat to the walls of the Alamo. Even then, Sesma's mere presence in the area helped to impair the ultimate effectiveness of the garrison's defense, for he later reported that upon entering town at 3 PM, his men seized 50 rifles which had been left behind by fleeing Texians in their haste to reach safety. Surely those weapons were a loss which the rebels could ill afford when faced with an enemy force

of such strength. Travis must have keenly felt their absence on the morning of March 6, when the Mexican assault columns came over the walls of the Alamo to finally end the contest.[13(p87),17(pp9-10,17-26),18(pp67-72)]

Sesma's failure to take aggressive action against the enemy on the fateful morning of February 23, 1836, had a profound impact upon the remaining course of Santa Anna's entire campaign. The unhindered assembly of the rebel garrison in the Alamo that afternoon presented the Mexican commander with the choices of either leaving a portion of his forces behind in San Antonio to contain and thus neutralize the garrison, or to mount an eventual assault upon it with the major part of his command before moving eastward to pursue and confront the rebel army being raised by Houston. That Santa Anna chose to waste 13 days and sacrifice the future services of an estimated 1,500 dead or wounded troops in order to destroy the Alamo garrison was his error. However, he selected that option as a result of Sesma's major failures—to capitalize on his commander's attainment of strategic surprise; to use his own army's superior tactical intelligence; and to exploit the enemy's lax discipline and ludicrous lack of security.[15(p155),21(pp42-56)]

Such potentially decisive action by Sesma would obviously have been successful against an enemy who had been rendered temporarily incapable of swift and concerted action following even minimal advance warning or initial contact with the enemy. What Sesma needed, and would have had, to make a successful cavalry strike into the streets of San Antonio was nothing less than total surprise. Otherwise, a battalion of even bleary-eyed Texian riflemen firing from behind hastily barricaded streets could have turned a cavalry charge into a bloody shambles in short order. The enemy's physical condition on that morning of February 23 would have clearly been the key to the operation's success. The exhaustion induced by two successive nights of aguardiente-laced celebration was enough to have put the odds solidly in Sesma's favor, had he struck at first light on the 23rd.

"...so far as it is possible to do so."

Suppose that a Mexican cavalry raid had destroyed the Alamo garrison while it was still in its collective cups on that midwinter dawn. Santa Anna would have been free to establish a base of operations in San Antonio without delay. On February 23 the overall Texian defense effort was still in serious disarray. Sam Houston, the nominal commander of all Texian forces, was not then with any assembly of troops, but rather far to the northeast in the vicinity of Nacogdoches, negotiating a treaty ensuring the neutrality of resident Indian tribes during the ongoing war. Perhaps 500 volunteers were mustering under different commanders in the Goliad-Copano Bay area at that time. When Houston arrived in Gonzales on March 11 (five days after the fall of the Alamo) to assume active command of the force being assembled, only 374 men were present for duty. Coupled with the approximately 500 men then serving with Colonel James Fannin at Goliad, the Texians had less than one-fourth as many troops in the field as did their adversary. By March 20 Houston was reduced to only the men under his immediate command, for on that day Fannin's force was defeated by a detachment of Mexican troops on the open plains east of Goliad, and a week later almost every one of them was executed on Santa Anna's personal order.[13(pp101-103,106-108),15(pp156-157)]

Had Santa Anna begun an advance eastward from San Antonio prior to the end of February, he would have caught the Texian forces in even more disarray than when he actually did commence such movement on March 10. Houston's force did not reach its peak strength of approximately 1,400 men until the week of March 24, when he spent a week confronting Sesma and a detachment of 1,200 troops across the rain-swollen Colorado River. He then resumed his retreat eastward to the Brazos and beyond. Within a few more weeks, disease and desertion had reduced his effective strength to a little over 800 men when he finally turned to confront the enemy in battle at San Jacinto (just east of what is now the city of Houston).[10(pp51,135),13(pp110-111)]

It was the high water which had allowed Houston to avoid battle on the Colorado, and which hampered the Mexican pursuit throughout so much of the campaign, but the rainy weather did not commence until March 18, with the wettest period falling between March 28 and April 14. Had Santa Anna commenced a pursuit of Houston in late February or early March, his troops would have enjoyed generally dry weather and firm roads by which to reach easily fordable river crossings. The Texian force might well have been overtaken and forced to stand and give battle amid three converging columns of the enemy army. Given such a scenario, the Texian bid for independence might well have been

crushed somewhere west of the Colorado in the vicinity of modern-day Flatonia or Schulenburg.*

Of course all of these scenarios remain conjecture only, for Sesma failed in his mission on February 23, and the liquor-addled Alamo garrison slept largely undisturbed through the critical hours of danger. Yet it had been a very close call, and in the struggle to come much less serious faults than drunken laxity would spell defeat and annihilation for commands far larger than that of Travis and Bowie. Sesma's vacillation and a benevolent fortune had saved the Texians in San Antonio on that brisk winter morning, and Santa Anna's myopic lack of strategic vision coupled with his leisurely sense of operational urgency further militated events in the rebels' favor as the conflict continued. Unfortunately, the enemy's errors proved serious enough only to delay the inevitable outcome for the defenders of the Alamo in the uneven confrontation in San Antonio de Bexar.

Neither the deaths of 185 men nor the occupation of a crumbling adobe edifice in distant San Antonio posed a potentially decisive threat to the main Texian war effort on March 6. If anything, news of the Alamo's fall and the butchery of its defenders galvanized public opinion in the United States in favor of the revolution and produced a flood of volunteers to fight for the Texian cause. San Antonio itself was the most populous town in Texas, but it was located well to the west of the main foci of Anglo-American settlement in the region, and Mexican possession of it had already been conceded by Houston as he planned his defense of the infant republic.

The defense of the Alamo assumed operational importance to the Texian war effort essentially because it was a fortuitous, if unplanned, diversion of enemy attention and resources on the cusp of an unusually wet spring. Santa Anna's fixation on a protracted siege of the Alamo served to delay the start of his offensive campaign against the Texian's main force until the weather intervened to work decisively to their advantage. The arrival of the Texas monsoon season fatally retarded the Mexicans' mobility when their pursuit of Houston's army finally commenced during the second week of March 1836. (Santa Anna's distraction with the Alamo defenders is not uncommon in military history. A parallel circumstance with similar disastrous consequences was Hitler's fixation on Greece and the Balkans (1940) to the detriment of the imminent invasion of Russia.[25])

The Alamo garrison, of course, had no way of knowing that any of this would ultimately come to pass. Their concern was with the immediate defense of their post, and in this they came within a whiskey glass of failing abysmally due to indiscipline and fondness for John Barleycorn's company. The question remains as to whether the ultimate fault for this lay with the post's commanders or was rooted in the essential nature of the revolutionary army in which they served.

Armed forces reflect the broader values and cultural characteristics of the societies which furnish their soldiery. The volunteers who comprised the backbone of the 1836 revolutionary army of Texas were largely (80%) newly arrived from the United States or Europe. They averaged 27 years of age and were typically (60%) unmarried. Roughly two of every three came from the South, and few owned any substantial amount of land or property. Men of such age, marital, socioeconomic status, and geographic origin were precisely the type who were most strongly predisposed to drink to excess, given the opportunity. Their resistance to discipline, unfamiliarity with conventional military life, and isolation from both the physical comforts and behavioral restraints of life at home produced an army which "had a manic-depressive quality," which obliged its earliest commander, Stephen F. Austin, to preface a general order with the remarkable explanation that "the interests of the Country, the success of the Campaign and the Safety and Honor of the Army require that order and discipline should be observed so far as it is possible to do so."[11(pp122-124,138-139)]

Austin's successor, Sam Houston, had served as an officer in the 39th US Infantry and had seen for himself over 20 years earlier how badly the indiscipline of volunteers and militiamen had impeded the conduct of Andrew Jackson's campaign against the Creek Indians in northern Alabama. His Fabian strategy of avoiding battle by trading space for time stemmed in large part from his own distrust of the volunteer troops he commanded. His refusal to hold a council of war until the very day of the climactic battle at San Jacinto demonstrated just how little confidence he had in the judgment of his own officers.[15(pp205-208),26,27]

References 10(pp25,46,52,65,69-70,75,80-81,93), 20(pp25-29),21(pp97,100,102-104,113-114),24.

The phrase, "so far as it is possible to do so" almost became the epitaph of the Republic of Texas. Austin's early injunction to "send no more ardent spirits" should have been stitched onto a banner and flown from the Alamo's jackstaff. Surely Travis and Bowie knew fully well the weakness of their men when it came to drinking. It was their solemn obligation as commanders to enforce discipline and curb drunkenness among their troops. In this they failed miserably. The key to this failure lay in James Bowie.

Beer in the Mug

James Bowie possessed unquestionable command presence and great physical vigor in his earlier years, having become a man of property and survived wounds in personal encounters which would have killed most men. By 1836 he was clearly in decline, but his reputation and force of personality were still such that most of the Alamo's garrison enthusiastically followed his lead instead of that of the younger and personally austere Travis. The loss of his wife and both young children in the cholera epidemic of 1833 had coincided with a lengthy spell of his own severe illness while on a trip to Mississippi, and the twin physical and emotional ordeals had taken a heavy toll upon him. He became a chronically heavy drinker, using the liquor to both dull his spiritual pain and ease the discomfort from his advancing tuberculosis. When he cast his lot with the revolution, he was undoubtedly an alcoholic.[17(p56)]

As Lon Tinkle observed in *The Alamo*,

> Whiskey was the standard frontier remedy against sickness—and everybody knew Bowie since the loss of his wife was a man sick unto death, now living on his nerves. There is a difference, however, between companionable gaiety and besottedness, as Travis well knew.[17(p56)]

The tension between the two commanders was essentially rooted in the alcoholic Bowie's declining self-image, for, as Tinkle analyzed his personality,

> All Bowie now had left was his pride—and his ability, he would have called it his manhood, for holding liquor. The entire quarrel had been no more than a middle-aged man's need to prove himself again at the threat of youthful competition.… and the loyalty of the men went out, not to the regular army man, but to the ailing, hard-drinking Bowie.[17(p56)]

Thus it was that James Bowie's individual flaws intersected with the ingrained cultural proclivities of the men he commanded. The tragic result was that the real commanders at the Alamo became Bowie's inner demons. The sober and conscientious Travis had set a perfect example of temperance for the men. But that was irrelevant, for the man who exercised the genuine reins of command by the power of his personality during this critical period at the Alamo was Bowie. His popularity and past reputation had won the troops' confidence, even as his failure to master his own appetites nearly spelled an early doom for both them and the cause for which they ultimately gave their lives.

Santa Anna's defeated army took home at least one trophy from its abortive campaign above the Rio Bravo del Norte. Stripped from its staff at the Alamo, the flag of the First Company of the New Orleans Greys was carried southward to eventually repose in the national museum in the castle of Chapultepec. In the center of its gold-fringed azure field, a rampant eagle spread its pinions in a militant stance, flanked by the black-lettered legends of "FIRST COMPANY OF TEXAN VOLUNTEERS! FROM NEW ORLEANS" and "GOD & LIBERTY." The men who had originally carried that flag to the Alamo had entered Texas while marching to the tap of a drummer's stick beating the rhythm to a popular tune of the day, *Beer in the Mug.* Given the Texians' often ill-timed and poorly considered thirst for liquor, that song might well have served as a fitting funeral dirge for the stillborn Republic of Texas. Had Sesma not halted to take counsel of his fears on the banks of Alazan Creek, and had Daniel Cloud, Travis' bell tower sentry, celebrated too enthusiastically at the preceding night's fandango, the Mexican-American border might today rest on the Sabine and not the Rio Grande, and the home of US Army medicine might be at Fort Sill (Oklahoma) or Fort Polk (Louisiana) instead of Fort Sam Houston.

Although the ashes of the Alamo's dead were cast upon the wind 174 years ago, and the arts of both medicine and war have changed greatly since then, human nature and frailty remain immutable. Alcohol abuse and the myriad physiological and psychological factors which precipitate its occurrence are still with us, and every unit in the United States Army contains Soldiers who suffer from this personally destructive and organizationally erosive practice. In 1836 a common soldier had little individual responsibility beyond keeping his musket clean and his cartridge box

dry. His officers fully expected him to get drunk at every opportunity, for that was one of the very few forms of recreation available to him at many posts. The ten doctors who served in the Alamo garrison were all doubtless familiar with a variety of hangover nostrums, but none of them would have found in their comrades' propensity for alcohol abuse an unusual pattern of behavior for the time and place. The average American Soldier of today, be he rifleman, computer operator, or laboratory technician, lives in an immensely more sophisticated world and regularly deals with concepts and technologies which would have staggered the best minds in the era of Travis and Bowie. The leaders of today's Soldiers carry the same essential burdens of command in an environment which demands incomparably more of them and their Soldiers, while remaining just as mercilessly unforgiving of error on the battlefield. There is no longer any place for the "traditional" vices of the soldier.

The US Army Medical Department (AMEDD) has waged a continuingly successful battle against disease, which has historically been the greatest killer of Soldiers until comparatively recent times. AMEDD surgeons have become so skillful, and the technology which supports them so effective, that since the days of Gettysburg and Belleau Wood wounds have been robbed of much of their traditional lethality. All too many of the injuries and losses suffered by the army which it serves today in peace or war are essentially self-inflicted. Perhaps some day we will be able to screen all personnel before induction and identify potential alcoholics so that they may be somehow inoculated against the effects of the drug forever. Concurrently, we must discover a way to terminate the existing addictions of all who are already afflicted with the disease. Until that time we can only seek to set the example by providing good leadership to blunt our Soldiers' desire to abuse alcohol. Unavoidably, there must also be the provision of compassionate and effective care for those who succumb to its attraction. The lessons of history warn us of the disasters which may overtake armies which tolerate old ills simply because they are common and enduring.

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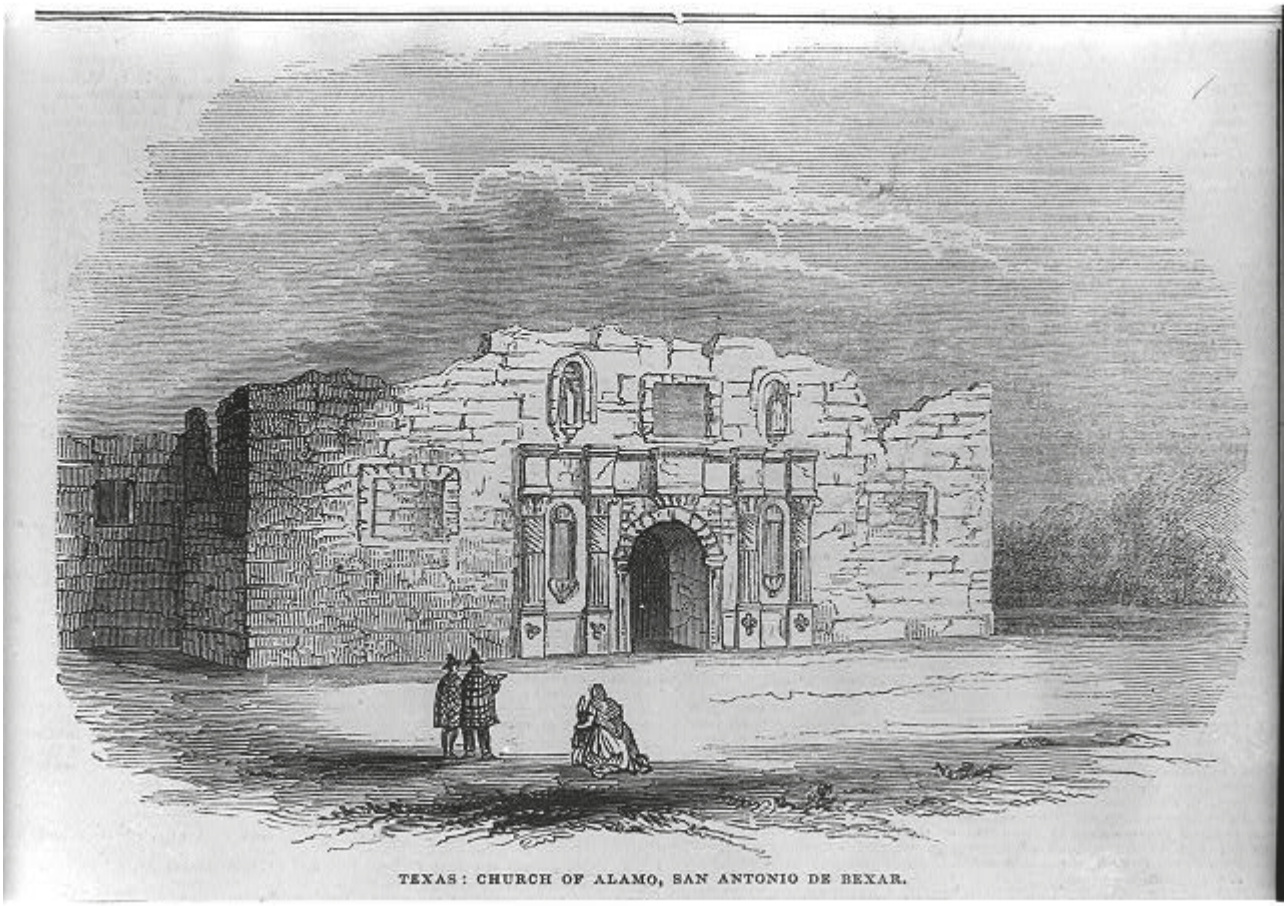

This drawing of the chapel the Alamo appeared in The Illustrated London News in 1844.
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