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Perspectives

Commander's Introduction

MG Steve Jones

The US Army and Public Health

Public health is a discipline concerned with protecting and improving the health of entire populations. Those populations may be a community, a nation, or a military force. Public health is practiced through recommendation of policies to elected leaders, administration of services, educational programs, promotion of healthy lifestyles, and research. Major focus areas for public health are prevention of disease and injury and the detection and control of infectious diseases. The Army Medical Department is responsible for protecting and improving the health of the Army, families and retirees. While executing these responsibilities it has made significant advances in the science of public health.

In April 1776, Dr John Morgan, Director General of the Hospitals and Physician in Chief to the American Army, recommended inoculation of the Continental Army against smallpox. Hundreds of Soldiers died from the disease which was a major factor in the failure in the Quebec Campaign, and fear of the disease discouraged recruiting. With implementation of the inoculation program, the US Army became the first military organization to immunize an entire Army. Over a century later in 1900, under the leadership of MAJ Walter Reed, the US Army Yellow Fever Commission established the mosquito as the vector for transmission of yellow fever. A control program implemented by MAJ William Crawford Gorgas effectively reduced the incidence of yellow fever and malaria in Cuba, and a similar program he later implemented in Panama allowed the Corps of Engineers to construct the Panama Canal. 1LT Bailey K. Ashford studied the severe anemia common in Puerto Rico and determined it was caused by infestation of the hookworm *Ancylostoma*. His work led to a worldwide campaign by the Rockefeller Foundation to control hookworm disease. MAJ Carl R. Darnall developed a system for the chlorination of drinking water supplies by treatment with anhydrous chlorine gas.[1]

World War II brought the discipline of public health to military government and civil affairs. Army leaders understood that disease in civilians could impede military operations, that public health is an integral part of government (including military government), and that providing medical care for civilians under their control could establish good will and cooperation of the civil population.[2]

The current campaign in Afghanistan demonstrates how the role of public health in military operations has evolved. Today the Army provides foundational capabilities to a team that includes US governmental agencies, international organizations, and nongovernmental organizations. In Afghanistan, 25 years of war and five years of drought produced major health problems. The physical infrastructure and human resource base had severely deteriorated, resulting in a health status that was the worst in Asia and among the worst in the world. One in four infants died before age five, and one in six women died in childbirth. Over 800,000 Afghans were disabled from war-related injuries, birth complications and weak preventive healthcare services. Each year, almost 300,000 children under the age of 5 died; 60% of those deaths were preventable, the result of diarrhea, respiratory infections, measles and pneumonia. After the collapse of the Taliban in the fall of 2001, the World Bank, Asian Development Bank, and United Nations Development Programme conducted an assessment of reconstruction requirements. They determined a major need was the development of a basic healthcare system to provide preventive and public health services. Implementation of a few vital but low-cost programs would provide the most benefit: basic immunizations, control of communicable diseases, maternal newborn and child health, nutrition supplementation, treatment of mine and war related injuries, and promotion of a healthy lifestyle. The US Agency for International Development led the reconstruction effort and Coalition forces played a supporting role. Despite ongoing conflict with Taliban forces, dramatic improvements were achieved and today life expectancy has increased from 42 to over 62 years, maternal mortality rates have declined by 80%, and child mortality rates by almost 50%.[3-5]

The global security environment is continuously becoming more complex and volatile, and the Army must prepare for the rapid emergence of new and increasingly dangerous threats. At the Army's Unified Quest Innovation Symposium on January 13, 2015, Dr Michael O'Hanlon, Senior Fellow at the Brookings Institute,

discussed potential conflicts for which the United States should plan.[6] Several scenarios he discussed present potentially significant public health challenges for the Army, such as the possibility of war on the Korean peninsula. For example, as more capable South Korean forces advanced, an always unpredictable and historically unstable North Korean regime could use a nuclear weapon on the battlefield as a negotiation tool, threatening to use another against Seoul. In this admittedly unlikely scenario, the Army would have to fight in an area where nuclear weapons had been employed, while responding to the accompanying civilian humanitarian disaster.

Future humanitarian disasters may be significantly larger and more difficult to manage than those of the past. This is partly due to the emergence of megacities with populations of 10 million or more. For example, a nuclear reactor meltdown near a megacity such as Karachi could affect 20 to 30 million people, and require a response far greater than that required after the 2011 disaster at Fukushima, Japan. Many large cities lack effective governance, basic infrastructure, public health services, and communication systems which would greatly complicate humanitarian relief efforts. Ongoing conflict makes relief operations more difficult. Today the US Army is supporting the fight to control Ebola in West Africa. In view of the instability that is endemic across the continent, it is not implausible that one day we may be contending with Ebola in the midst of a civil war. In that environment, the Army could be assigned the mission of both cordoning off an area of infection and administering health care. The public health challenges of such a mission would be immense.

Public health has been an important mission of the Army Medical Department since its establishment on July 27, 1775. We have responded to numerous humanitarian crises at home and abroad, and made significant contributions that improved the health of billions of people around the world. As the Army modernizes under *Force 2025 and Beyond*, Army Medicine will maintain its focus on this important mission.

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ARMY MEDICINE
Serving To Heal...Honored To Serve

US Army Public Health: One Health, One Medicine, One Team

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One Health is the concept for bringing together health promotion and delivery for humans, animals, and the environment (Figure 1).[1] The One Health concept recognizes that success in one profession such as human health often requires coordination with the other two. Failure to account for these relationships can have disastrous consequences.

Vector-borne disease control is an example of how the 3 disciplines are related. Over one million people die each year from diseases such as malaria, dengue, and yellow fever, which are transmitted by mosquito vectors.[2] When dichlorodiphenyltrichloroethane (DDT) was first identified as an insecticide in 1939, it was lauded as the solution to vector-borne diseases. It was inexpensive and persistent, and over the next few decades, DDT was widely used throughout the world with great success at reducing mosquitoes. For example, the *Aedes aegyptii* mosquito was eradicated from dozens of countries within the western hemisphere, which in turn led to significant reductions in the number of dengue cases. The vector control programs were so successful that some people soon began asserting that these diseases would be wiped out and no longer threaten the human race. Unfortunately, these assertions failed to recognize the negative impacts of DDT on the environment and animals. Bioaccumulation within the environment (a result of DDT's persistence) was linked to eggshell thinning and decreased reproduction rates in birds of prey.[3] Concern was also voiced that the birds were biosentinels and an early warning to potential human risks, which is supported by recent studies suggestive of possible adverse effects in humans.[4]

The negative animal and environmental effects of DDT eventually led to use restrictions and bans in the United States and many other countries. The bans in turn have been criticized as harmful to humans by increasing exposure to vector-borne diseases leading to increased mortality.[5] These criticisms may be partially responsible for the recent resurgence of DDT use. However, whereas DDT was indiscriminately used during the 1940s and 1950s, its use is more focused today. Perhaps the greatest change in DDT usage (as well as other pesticides) was the shift from widespread agricultural application to targeted indoor residual spraying. Indoor residual spraying takes advantage of the persistent tendencies of DDT to provide inexpensive protection against *Anopheles* species and other indoor feeding mosquitoes which transmit diseases,[6] while at the same time avoiding bioaccumulation in lakes, streams, and soils that harm the environment, animals, and humans. Used appropriately, such as treating bed nets and rotating insecticides to reduce resistance, indoor residual spraying saves human lives while protecting animal and environmental health.

The One Health Initiative recognizes the importance of an interdisciplinary medical team and "is dedicated to improving the lives of all species—human and animal—through the integration of human medicine, veterinary medicine and environmental science."[7] The One Health Initiative is supported by numerous organizations including the American Medical Association, the American Veterinary Medical Association, and the National Environmental Health Association. Multiple US government agencies, including the Centers for Disease Control and Prevention (CDC), the Department of Agriculture, and the Food and Drug Administration, have recognized the importance of One Health and are working together to improve health promotion cooperation across the 3 health disciplines.

For example, the CDC's Healthy Pets, Healthy People initiative seeks to improve human health through animal health.[8] Over 60% of the diseases affecting humans, and 75% of newly emerging diseases, are zoonotic.[9] Pets are an integral part of many US households and are often considered part of the family. Americans spend countless hours each day walking, grooming, and playing with their pets, and over 60% share their beds with the cat or dog. This close contact facilitates transmission of bacterial, parasitic, and viral infections such as plague, scabies, and rabies.[10] Ensuring pets are healthy and disease free protects human health. Of course, the reverse is also true; healthy people promote healthy pets as diseases can be transmitted from people to pets (zooanthroponosis).

Pet ownership can also be used to improve human health. Pets have been shown to decrease blood pressure,

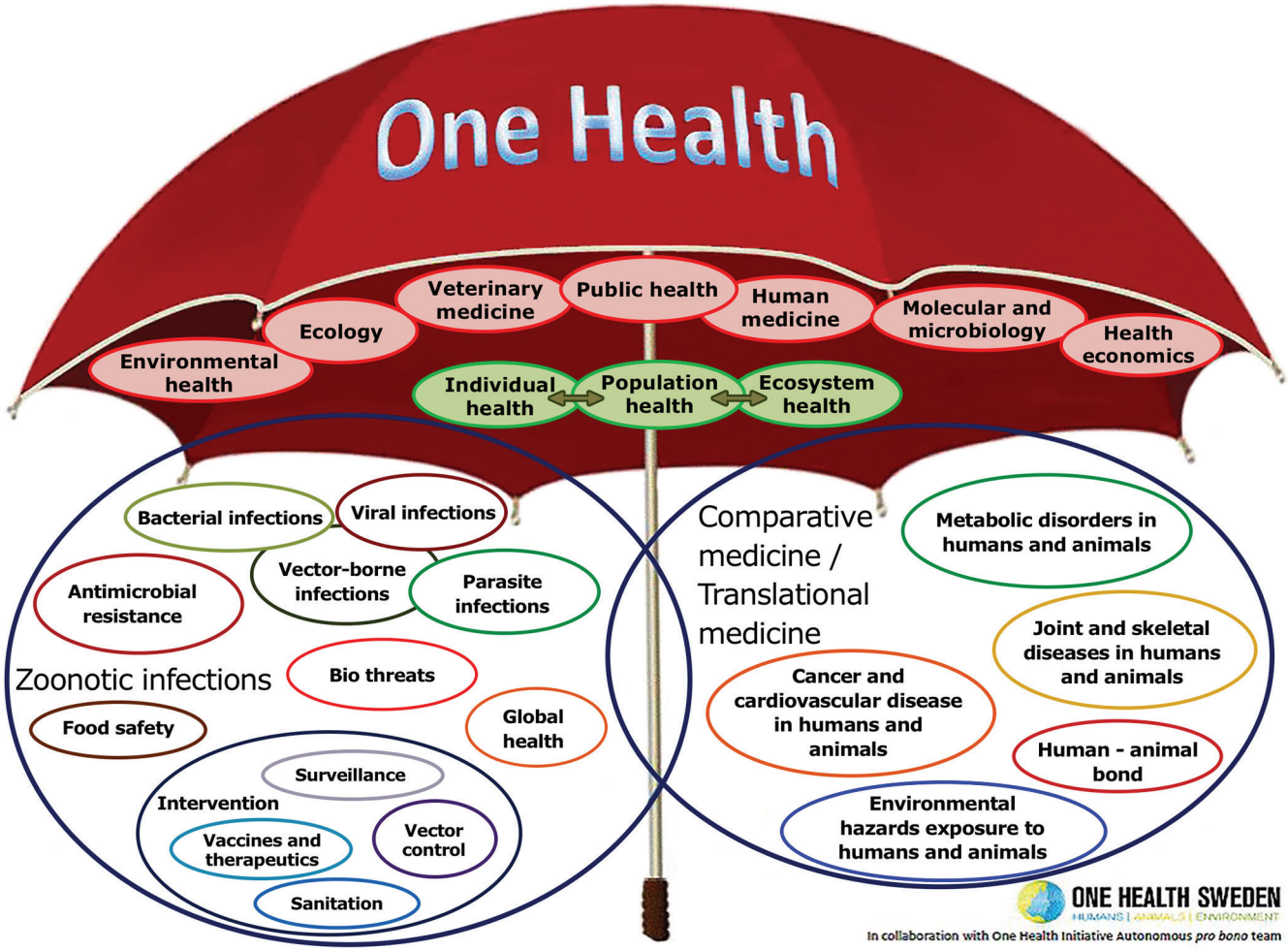

Figure 1. Pictorial representation demonstrating how human, animal, and environmental health are related under the One Health "umbrella" concept. Illustration courtesy of One Health Initiative, reprinted with permission.

and cholesterol and triglyceride levels, and increase opportunities for exercise and socialization.[11,12] An owner's desire to keep the pets healthy can impact their own behavior. Although obesity is not infectious, canine and feline obesity is associated with owner obesity. While some owners may be unconcerned or unwilling to address their own health, they may be motivated to improve the health of their beloved pets, even if it means making personal changes. Addressing canine obesity in particular is a potential method of improving human health, as exercise (walks, runs or playing in the park) will benefit both the dog and the owner. Similarly, addressing canine nutrition requirements may encourage the owner to examine their own eating habits.

US Army Public Health Command Region – West: Putting One Health Into Practice

The One Health initiative is also being implemented within the US military, particularly within the US Army Public Health Command (USAPHC). The USAPHC achieved full operational capability on October 1, 2011 with the mission to "promote health and prevent disease, injury, and disability of Soldiers and military retirees, their Families, and Department of the Army civilian employees; and assure effective execution of full spectrum veterinary service for Army and Department of Defense Veterinary missions."[13,14] The USAPHC distinctive unit insignia includes the One Health triangle representing the triad of human, animal, and environmental health, as well as the motto *Una Sanitas,* Latin for One Health (Figure 2). The USAPHC internal command publication is entitled "One Health," further evidence of the organization's commitment to the concept.

The Public Health Command provides technical oversight for its broad One Health mission through portfolio management. Functional specialties such as environmental health engineering, epidemiology and disease surveillance, health promotion and wellness, and veterinary services are managed within the Army Institute of

Public Health to ensure information is communicated and resources are coordinated effectively. Command and control is subordinated through 5 regional commands (North, South, West, Europe, and Pacific), which are aligned with the regional medical commands (Figure 3). Although this issue focuses on Public Health Command Region–West (PHCR-W) activities, the basic structure, functions, and missions are the same at the other regional commands. The PCHR-W is a multidisciplinary unit with Soldiers and civilians from each of the One Health professions (human, animal, and environment). The disciplines are assigned to divisions, which are aligned with the technical portfolios at the Army Institute of Public Health. This structure and alignment allows for communication and coordination of efforts at all levels.

One area in which USAPHC has a long history of coordinating interdisciplinary health efforts is the human-environment interface. The World Health Organization estimates that environmental hazards account for 25% of the total disease burden worldwide.[15] The environment is associated with communicable and infectious diseases, such as the previously discussed vector-borne diseases, but also noncommunicable diseases such as cancers, respiratory illnesses, and cardiovascular issues.[16] While these environmental hazards can occur naturally, they can just as easily be man-made. In other words, unhealthy human actions lead to unhealthy environments, which in turn lead to unhealthy humans—One Health at its worst. In recognition of the environment-human health connection, PHCR-W activities are directed towards both detecting environmental hazards and preventing them.

Figure 2. US Army Public Health Command Distinctive Unit Insignia. Each side of the triangle represents a component of the One-Health triad: people, animals, and the environment. The shield represents the mission of protecting the Army family. The green and maroon represent the past and current colors associated with the Medical Corps, respectively. The spear tip represents the organization's leading role in promoting Soldier health. Medicine and healing are represented by the twin serpents around the spear. The unit motto is Una Sanitas, Latin for "One Health.

An important tool for identifying environmental health hazards is the Defense Occupational and Environmental Health Readiness System (DOEHRS). It is a centralized system for storing and managing occupational and environmental health hazard (biological, physical, chemical) data.* Of course, DOERHS is only as good as the samples that are collected and the data which are entered into the system. While PHCR-W personnel have the ability to conduct environmental surveillance and enter the data, they cannot be at every Army installation, including those in deployed environments. Instead, PHCR-W personnel provide training to preventive medicine units on how to conduct environmental surveillance and enter the data into DOEHRS. Over the past several years PHCR-W has provided training to over a dozen garrison and deploying preventive medicine units annually. Each year approximately 200 individuals from Army, Navy, and Marine units have received training on environmental sample collection and data entry. The result is that deployed commanders are given accurate risk assessments for exposed personnel on the ground and recommendations to mitigate health risks, such as the elimination of burn pits. The DOERHS data repository can also be accessed by medical professionals for identification and management of human health concerns resulting from potential environmental exposures during past deployments.

More recently, the formation of USAPHC has led to new One Health collaborations. For example, the merging of Army preventive medicine and veterinary medical assets into a single organization has strengthened food and water safety at Army installations. Traditionally, Army veterinary personnel have been responsible for auditing commercial food and water suppliers and inspecting deliveries through receipt to ensure the subsistence is safe and wholesome. Inspection of food storage, preparation, and serving, as well as ensuring the safety of installation water treatment facilities, is performed by preventive medicine personnel. While these groups have worked well together, there was the potential for information loss during the handover of responsibility. Bringing expertise from both groups together under a single organization improves coordination, assists in the timely identification of issues or problems, and fosters cooperation to develop improved food safety product and measures. One example of this improved collaboration was evident in preparing and staffing the new revision of the Department of Defense (DoD) *Tri-Service Food Code*.[17]

Vector-borne disease surveillance is another aspect which has benefited from the formation of USAPHC. The Army, as well as the other military services,

*Restricted access: https://doehrswww.apgea.army.mil/doehrsdr/index.jsp

collects and tests arthropod vectors for pathogens such as *Babesia canis, Borrelia burgdorferi,* and *Rickettsia parkeri,* the causative agents for babesiosis, Lyme disease, and tidewater fever, respectively. The arthropods are generally submitted by clinicians following removal from patients or collected as part of environmental surveillance such as tick drags. These surveillance efforts capture 2 of the 3 populations (humans and environment), but they miss the local animal population. Ticks can bite and feed from dogs and cats as easily as humans, especially if pets are not treated with an acaricide, which can lead to infection and diseased pets. One of the ways PCHR-W has improved vector-borne disease surveillance is through coordination of the environmental health, laboratory sciences, and veterinary services divisions to collect, identify, and test ticks collected at installation veterinary clinics throughout the Region. This program not only identifies pets which should be prophylactically treated for infection, but also helps to better quantify the disease transmission risk to other animals, as well as their owners, which in turn shapes future risk mitigation strategies and communications at the installation. The information is also transmitted through the technical portfolio channels and analyzed in conjunction with other surveillance efforts (reportable medical events, for example) to prepare products like the monthly Army Vector-borne Disease Report,[18] available through the USAPHC website* or via e-mail subscription. The monthly report provides a quick snapshot of vector-borne disease activity within the United States as a whole, within the Army active duty and beneficiary medical populations, and environmental surveillance. Eventually, the vector-borne information may be combined with information from veterinary treatment facilities using the newly fielded Remote Online Veterinary Record (ROVR) to further quantify the risk of vector-borne disease transmission at Army installations. The ROVR is the DoD electronic animal health record system for both government and privately-owned animals and can be queried to identify disease trends and outbreaks.

Future Directions

One Health will continue to shape USAPHC's efforts to improve Soldier and family readiness through marketing and leveraging of public health in support of larger Army and DoD programs. For example, the DoD's Healthy Base Initiative seeks to improve the health and wellness of service members, families, and civilians through better nutrition. Several DoD installations have recently implemented local farmers markets to improve service members' eating habits by providing healthy alternatives to the traditional fast food options on military

*http://phc.amedd.army.mil

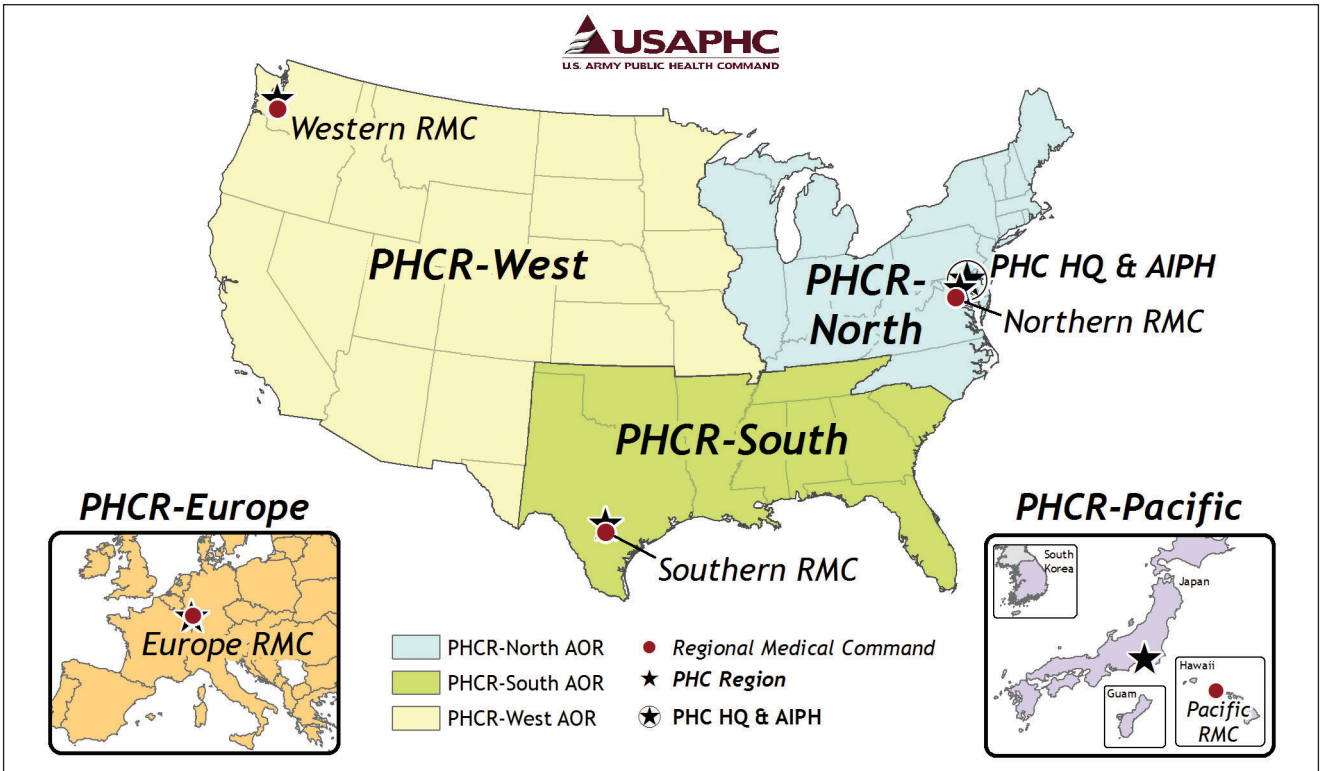

Figure 3. US Army Public Health Command Regions North, South, West, Pacific, and Europe. Image courtesy of the USAPHC Geographic Information Systems Branch (July 2014).

installations. However, while these farmers markets may have more nutritious fruits and vegetables in comparison to a burger and extra-large fries, there are health risks. One need look no further than the 2011 *Listeria monocytogenes* cantaloupe outbreak, with nearly 150 cases in 28 states, for evidence that even fresh fruits and vegetables can be linked to infectious disease transmission.[19] To minimize these risks, USAPHC personnel are developing food sanitation guidance material for consumers and food surveillance inspection programs for farmers markets to ensure food safety supports healthy eating behaviors.

One Health activities also support The Army Surgeon General's Performance Triad.[20] The USAPHC oversees Army Wellness Centers, which provide individual health assessments and information on physical fitness, nutrition, stress management, tobacco cessation, and general wellness to assist individuals in developing and reaching their health goals.[21] The program engages individuals in their "lifespace," their environment, to help them make lifestyle changes, which improve short- and long-term health. These health promotion efforts also extend beyond Army Wellness Centers into all aspects of the USAPHC mission. For example, the veterinary clinic is not a traditional setting for discussing human obesity, yet as previously mentioned, pet owners may be willing to make lifestyle changes for their pet's health that they would not make for their own health. These lifestyle changes are not limited to just nutrition either. Dog runs/walks are an excellent way to encourage owner and pet exercise and multiple veterinary clinics are partnering with their local medical treatment facilities or morale, welfare, and recreation activities to organize and promote these events.

Looking towards the future, the One Health concept will remain a fundamental element of public health. While the structure of USAPHC and its subordinate units will likely undergo significant changes as part of the Army Medical Department reorganization, the public health duty will remain a key component mission of the unit, its successor, and the Army Medical Department. As the world becomes more populated and increasingly interconnected, the interactions between human, animals, and the environment will only increase. The recent introduction of the Chikungunya virus into the western hemisphere and the ongoing outbreak of Ebola in western Africa are 2 examples of outbreaks which are reshaping our thinking. We cannot assume that the way things were will be the way things are in the future. Effectively preparing for and addressing these future health threats requires coordination across all health fields, human, animal, and environment. The 3 fields are inextricably linked and lasting success cannot be achieved unless the medical professions work together—One Health, One Medicine, One Team.

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Agroterrorism: The Risks to the United States Food Supply and National Security

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ABSTRACT

Agroterrorism is a collective term that describes an intentional criminal attack against crops or mankind using viral, bacterial, fungal, or insect-borne agents. Agroterrorism also includes attacks against animals using infectious pathogens such as *Burkholderia mallei* (glanders), *Bacillus anthracis* (anthrax), viral avian influenza, foot and mouth disease, and several equine encephalitis viruses. Agents that could be used against crops include the causative agents of wheat blast, rice blast, rice brown spot disease, and wheat stem rust. The primary goal of terrorists using agroterrorism is to spread fear and cause massive economic loss. Subsequent goals include causing disease and death to humans and animals. The use of bioterrorism agents is a much more practical approach than using explosives, for example, to achieve those results since many of these biological agents are commonly found naturally in the environment and are difficult to detect with modern technology. The effective use of biological warfare dates back centuries and can still can be employed by terrorist groups, lone wolves, and political and religious groups to cause death and mayhem on a grand scale.

When we hear the word "terrorism," we often think of weapons of mass destruction. However, agroterrorism is another, even more insidious threat to our way of life. The Oxford Dictionary defines agroterrorism as "Terrorist acts intended to disrupt or damage a country's agriculture, especially the use of a biological agent against crops or livestock."[1] The threat is real. Evidence of such was discovered when American forces uncovered documentation that demonstrated Al Qaeda and the Taliban had extensive knowledge of agricultural diseases and the effects an agroterrorism attack would have on our food system.[2] According to Tim Downs, author of Ends of the Earth,[3] terrorists would most likely use genetically modified organisms such as insects to spread pathogens to infest crops, kill livestock, and sicken or kill humans. Potential agents that terrorists may use include bacteria, viruses, fungi, and invasive or nonnative insect species.

Congress took action to protect our national food supply in the wake of the terrorist attacks on September 11, 2001, by passing the Public Health Security and Bioterrorism Preparedness and Response Act,[4] signed into law on June 12, 2002. Title III of the Act directed that the President's Council on Food Safety, in consultation with other federal and state agencies, the scientific community, the food industry, and consumer and producer groups, develop a crisis communication plan and an educational program that takes proactive steps to protect the national food supply from intentional acts of contamination. It directed that this strategy address "threat assessments; technologies and procedures for securing food processing and manufacturing facilities and modes of transportation; response and notification procedures; and risk communications to the public." Nearly 10 years later, the Government Accountability Office (GAO) found that, despite the best intentions of the Bioterrorism Act, the expenditure of billions of food defense dollars was not well coordinated. Testifying before a Senate committee on the matter, Lisa Shames, the GAO Director of Natural Resources and the Environment, stated "There is no centralized coordination to oversee the federal government's overall progress implementing the nation's food and agriculture defense policy."[5] This lack of centralized coordination of work by different agencies means that we as a nation are unsure that our efforts, and billions of our tax dollars are not being used wisely to counter agroterrorism. It also seriously hinders the implementation of effective, well-designed strategies to reduce the vulnerabilities of our nation's agriculture to terrorists attacks.[5] In testimony before a senate subcommittee on counter-terrorism on September 14, 2011, John Hoffman, a former senior adviser in the Department of Homeland Security, made this sobering assessment: "We may be blindsided by an intentional food-based attack on this nation sometime soon.... At present, our primary detection capability is the emergency room."[5]

The Food Safety Modernization Act of 2011 is the first legislation aimed at preventing an attack rather than responding to one.[6] The Food and Drug Administration now has the challenge of shifting the perspective of protection from unintentional (food safety) contamination to that of prevention of the intentional adulteration (food defense) of human food and animal feed. This approach is quite different in many ways and is a paradigm shift in how our nation protects its food supplies. The FDA

proposed rule on food defense would require that food facilities take a proactive, targeted approach within their establishments that focuses on the progression of food processes where the intentional contamination of product is most likely to occur. Effective efforts could then be implemented to best reduce those targets of opportunities. Finally, the proposed rule will require the largest food operations create and implement a food defense plan.[6]

Obviously, the US military is essential in defending this nation against threats from terrorists, whether in foreign environments or within our borders. As such threats have multiplied and evolved over the last decade, concerns about protection of the food supply of the US military have never been greater. Department of Defense (DoD) Directive 5200.08,[7] DoD Directive 6400.04E,[8] DoD Instruction 2000.12,[9] DoD Instruction 2000.16,[10] Homeland Security Presidential Directives 7[11] and 9[12], and Presidential Policy Directive 8[13] are the framework within which the US Army Veterinary Service designs, implements, and operates specific food protection programs to protect our military personnel and their families. These programs include:

- Commercial food protection audits
- Installation food vulnerability assessments
- Food and water defense assessments for special events
- Food and water risk assessments overseas

These directives and programs established global organizational policy and support for the prevention of intentional contamination of our food supply and provide a framework from which we can provide the best possible protection for our food systems.

Background

Production and distribution of the food supply in the United States is one of the most complex systems in the world. The United States imports food from many nations, some of which have ideologies that do not align with ours and may seek to do us harm. When this situation is paired with lax or nonexistent safety standards of some foreign countries, it clearly represents a potential threat to the US food supply. It is estimated that in 2010, more than 10 million food shipments were received from overseas manufacturers, and approximately only 1.6% received any type of federal inspection at the point of entry.[14] Imported foods make our food system vulnerable to terrorist attacks as these products may harbor disease or insect vectors that could spread and decimate our agricultural fields. One successful, grand scale attack on the US agriculture system could cause death and disease to Americans from coast to coast and result in devastating physical, economic, and, more importantly, psychological damage among our citizens. Terrorists realize that the strength of our nation is its economy, and they are focusing more of their efforts on attacks that yield the most economic damage.

The intentional contamination of food goes far beyond imported foods. To combat this threat, we must examine our food supplies from farm-to-fork. Farm-to-fork is the linear progression that food travels from the farm where it is grown and harvested, to the storage facilities while it waits for shipment, to the food manufacturers where it is processed and packaged, to retailers where it is sold, and finally to our dining tables.[15] Protecting such an extensive and complex system is a monumental task that requires diligence by professionals trained in food protection and hazard communications. Throughout this flow there exists the potential for contamination, and therefore the need for vigilance. In order to remain one of the safest food supply systems in the world today, we must employ at the local, state, and federal levels skilled professionals who are equipped to respond to and recover from the crisis of an agroterrorism event. Over the last decade, the federal government has launched numerous initiatives to provide enhancements to the defense of our national food supply.

The Threat

Agroterrorism is not flashy and does not generally produce immediate results, so terrorists have traditionally considered it to be a secondary tactic. It does, however, have the ability to spread fear and anxiety, produce large economics losses, create social instability, and result in foodborne disease outbreaks. It is most often used as act of economic sabotage rather than a violent act against animals or mankind. However, the use of agroterrorism is a much cheaper and easier alternative to building a "dirty bomb," and would capture the attention of the entire nation for a long time.[16] Several factors have contributed to the belief that terrorists could begin targeting our food supply. First, Al Qaeda leadership has been reduced dramatically over the last decade, leaving mostly low to midlevel terrorists who lack the ability to mount large-scale attacks. Second, economic harm to the United States remains one of the pillars of Al Qaeda's network. Third, microorganisms are inexpensive and can be cultured in clandestine labs by nearly anyone with a microbiology background.[2] Methodologies for culturing these pathogens can easily be found on the internet. Furthermore, many potential biological weapons occur naturally in the environment and do not require the use of laboratories.[16]

Motivation

Terrorists know that America's strength lies with its economy and a successful attack on our nation's food supply would be economically devastating for millions of its citizens. It could even affect our ability to project our military power abroad and lead to the overthrow of allied governments. Osama Bin Laden once bragged that the attacks on September 11, 2001, cost $500,000 dollars but caused more than $500 billion dollars in economic losses to the United States.[2] It is essential to understand what motivates an aggressor if we expect to generate effective risk mitigation strategies to stop acts of terrorism. The National Institute of Justice funded a research project to determine the extent a foot-and-mouth disease outbreak would have on the cattle industry in the state of Kansas.[17] The study found that those who would attack our agriculture fall into one of 4 categories[17(p24)]:

1. International terrorists
2. Economic opportunists
3. Domestic terrorists (including unbalanced individuals and disgruntled employees)
4. Militant animal rights groups

Terrorists are typically politically or ideologically motivated and they may work alone or in small organized groups. Economic opportunists use agroterrorism to manipulate markets and exploit the situation for their personal financial gain. Disgruntled employees are motivated by a sense of revenge for some real or perceived wrongdoing, and they actually pose a greater risk than most other aggressors as they are likely to be less scrutinized due to their legitimate reason for being on the premises. Militant animal rights activists, such as the Earth Liberation Front, are motivated by a moral obligation to prevent animal abuse and have committed more than 2,000 crimes costing an estimated $110 million dollars in damage. Militant animal rights activists (or eco-terrorists as they are often called) ranked number 1 on the FBI's domestic terrorism threats in 2004.[18]

Incidents of Agroterrorism

There are many recorded examples of agroterrorism in history dating from the sixth century BC when Assyrian forces poisoned well water with rye ergot. During World War I, German forces attempted to infect horses bound for Europe from the United States with glanders (*Burkholderia mallei*) and anthrax *(Bacillus anthracis)*.[2] While glanders is a bacterial disease that primarily affects horses, it and anthrax can spread to humans, donkeys, mules, and other mammals.[19] The single largest biological terrorist attack ever occurring on US soil was perpetrated in 1984 by a religious cult in Oregon who sought to influence the outcome of an election by poisoning their opponents and thereby causing a lower voter turnout. The cult did so by cultivating *Salmonella typhimurium* in a covert laboratory on their ranch and spreading the potentially dangerous pathogen on bathroom fixtures and salad bars in 10 restaurants in the local town of The Dalles. Just prior to election day, emergency rooms, hospitals, and clinics were overrun with people suffering from extreme nausea and diarrhea. The attack sickened 751 people, but fortunately there were no fatalities.[20,21]

In 1985, the USDA accused contract workers of intentionally introducing the Mexican screw worm (*Cochliomyia hominivorax*) to livestock farmed near the United States/Mexico border in an attempt to spread this parasitic problem and keep their jobs in a screw worm eradication program.[16]

In 1996, animal feed was the target of disgruntled workers at a rendering plant when a cow carcass was intentionally contaminated with the pesticide chlordane. The animal was ground with others to produce nearly 80,000 lbs of feed which found its way onto 4,000 dairy farms in 4 states, and resulted in a dairy food recall that cost the industry an estimated $250 million loss.[22]

In 1997, economic opportunists adulterated spent animal grease from local restaurants intended for chicken feed with a fungicide. This criminal act was perpetrated by a rival feed company owner, and the investigation and apprehension of the suspect required the concerted effort of law enforcement officials in 17 states.[22]

In 2003 a disgruntled meat department employee was arrested for intentionally contaminating an estimated 200 lbs of ground beef with a nicotine-based insecticide known as Black Leaf 40. The Centers for Disease Control and Prevention reported that 92 individuals became ill with symptoms including burning of the mouth, nausea, vomiting, and dizziness.[23]

In 2014 Japanese factory worker Toshiki Abe was sentenced to 3.5 years in prison for intentionally contaminating frozen food products with the pesticide malathion. Detected concentration levels of this poison were 2.6 million times higher than what is permitted by law. The processor of these frozen food products does not use the insecticide malathion, so the presence of this toxic substance at such a high concentration is proof of a deliberate act. Abe's actions sickened nearly 900 persons. This case is one of the largest proven acts of intentional food product contamination.[24]

Foot-and-Mouth Disease

The 2005 National Institute of Justice study categorized foot-and-mouth disease (FMD) as a "Primary threat to agriculture."[17(p18)] This viral disease is 20 times more contagious than small pox and causes painful sores on the hooves and mouths of cloven-hoofed animals such as cattle, pigs, sheep, goats, and deer. These sores are so debilitating that the animals are unable to walk, eat, and drink, until they finally succumb to the disease. Although humans are not affected by FMD, they can carry and transmit the disease for up to 48 hours from exposure, and the spread from animal to animal can extend as far as 50 miles. An outbreak of FMD in the United Kingdom in 2001 affected 9,000 farms and required the destruction and disposal of more than 4 million animals. That outbreak cost the United Kingdom an estimated $21 billion dollars. A similar outbreak in the United States would cost more than $60 billion dollars. Not only would such an event have a dramatic effect on the availability of meat products in the United States, it could also halt exports to other countries for years in the future. The loss of jobs would be devastating and result in billions of dollars in economic costs.[2]

The sequence for dealing with FMD as presented in the National Institute of Justice study[17(p23)] includes the use of law enforcement to establish a strict quarantine around the affected area, roadblocks established to exclude sick animals and prevent contaminated vehicles from leaving the area and spreading the infections, and sound crime scene investigation procedures. An outbreak of FMD would require a quarantine area 6 miles in radius and last at least 30 days. Roadblocks would have to be strategically placed along all thoroughfares leading from the point-of-origin of the outbreak outward in all directions. Law enforcement must conduct interviews with drivers to determine if the passengers had recently been in a contaminated area. If so, stations manned by trained personnel would have to be established close to the roadblocks to allow for the proper decontamination of both vehicles and persons. Crime scene investigators would be responsible for collecting tissue samples and identification of potential suspects. Finally, all cloven-hoofed animals in the affected area would have to be destroyed and disposed of properly.[25] This would be an enormous undertaking that not many of our local and state official personnel are properly prepared to execute. Clearly, the value of preventing FMD outbreaks using sound biosecurity measures far outweighs the monumental task of containing such an event.

Vulnerabilities

According to the National Defense Research Institute, there are several key factors that make US agriculture particularly vulnerable to attack.[26] First, the farms that produce our food have become ever more concentrated and rely on old fashioned farming practices. This concentration of animals into relatively small areas greatly increases the infection rate and creates a very difficult containment situation. Second, livestock are more susceptible to disease infection due to husbandry tactics and the overuse of antibiotics. Such tactics include sterilization programs, dehorning, and even hormone injections. The overuse of antibiotics causes many pathogenic bacteria to develop resistance to therapy. Third, most farms are devoid of any real, organized surveillance detection systems. Animal feed lots and barns are often left unguarded and therefore indefensible. Fourth, the passive reporting system that farmers are expected to use when they discover an animal suspected of having a communicable disease relies on the farmer to self-report the suspected diseased animal to authorities. Such a system puts farmers in an awkward situation which can negatively impact their livelihood and forces them into a "shoot, shovel, and shut-up" mindset in fear the government may condemn their entire livestock if they ever found out. The last factor is the lack of veterinarians in the United States that have a sufficient level of training to recognize and properly diagnose animal diseases that are not commonly found in this country.

Protection of the Military Food System

Ever since the terrorist attacks on the World Trade Center on September 11, 2001, our country's leaders recognized that an attack on our food supply could threaten our very existence. Much has changed to protect our national food supply since the then Secretary of Health and Human Services, Tommy Thompson, said in 2004 "I, for the life of me, cannot understand why the terrorist have not attacked our food supply, because it is so easy to do."[27] The Bioterrorism Act of 2002[4] supplied the impetus for *DoD Directive 6400.04E*,[8] which assigned to the US Army Veterinary Service the overarching authority to execute food defense programs within the DoD. *DoD Directive 6400.04E* also mandates the standardization of commercial food protection audits, installation food vulnerability assessments, food and water defense assessments, and food and water risk assessments. The Veterinary Services Portfolio of the Army Institute of Public Health is charged with providing a proactive approach to protect military food systems and deny terrorists the ability to attack those food supplies. It met this directive by creating specific procedures for assessing food establishments both on and off installations wherever military service personnel are stationed. These experts do so by working closely with the United States Department of Agriculture, Food and Drug Administration, local agricultural groups, contracting officers, and

installation garrison commanders to identify potential weak areas in food systems and offer simple and cost-effective strategies to reduce or eliminate such vulnerabilities. Further, standardized inspections of food deliveries and storage areas are conducted on a regular basis by personnel who have been specially trained in food defense by the Army Medical Department Center & School. This determined effort is integral in preventing and detecting the intentional contamination of food systems by terrorists using conventional chemical, biological, radiological, nuclear, or physical agents.

The threat of the intentional contamination of the military food supply is much more complex in deployed environments and presents an increased level of danger in terms of possible nonbattle injuries and potential mission failures. The major challenge to preventing terrorists from using agroterrorism is that food distribution systems are quite expansive and therefore food protection programs designed to protect them are very expensive, both in terms of personnel and dollars. Such systems must protect nodes along a sizeable geographical area and take into consideration susceptibilities of food transported over potentially hostile territory with numerous handlers. It must also take into account food processes such as mixing of large batches, short product shelf-life, and global distribution. This is quite ambitious, even in the relative safety of the United States, and as author Tim Downs says, "The concern about an agricultural act of terrorism is we just can't defend a thousand-acre farm," he explains. "You can put up a metal detector in an airport — but how do you protect a thousand acres of corn or wheat?"[3]

The DoD has several initiatives in place to improve the defense posture of our food supply such as commercial food protection audits, installation food vulnerability assessments, food and water defense assessments, and food and water risk assessments. The food protection audit was enacted to systematically evaluate the food defense programs of commercial food facilities supplying subsistence to the DoD. These approved food facilities provide a large portion of the subsistence in the military food supply. Of particular significance were the efforts taken to prevent adulteration at Meals Ready-to-Eat plants, as these rations are vital to the Warfighter.

Installation food vulnerability assessments provide installation commanders and their antiterrorism officers (ATOs) with an overall picture of the food protection posture of all food facilities on an installation at any given time. The assessments are directly tied to current force protection condition measures and results are briefed to ATOs and installation commanders using the deliberate risk assessment model. Additionally, these results are used to develop the Veterinary Service annex to the installation emergency response plan. Incorporation of these assessments into the installation emergency response plan helps all key players understand the vital role that food defense personnel play during an actual emergency.

Food and water defense assessments at special events were designed specifically to reduce the vulnerability of food and water during large gatherings of DoD personnel. Veterinary Service personnel work closely with other public health entities and the installation ATO to identity vulnerabilities at these events and make recommendations that will effectively mitigate those hazards.

Food and water risk assessments were developed to address the insufficient number of approved food facilities in foreign countries hosting military exercises. In these situations, access to foods from approved sources is extremely limited, yet contracting officers must meet the intent of regulatory requirements. Highly-trained DoD public health specialists assess the risks associated with consumption of food from caterers, restaurants, and local host nation food facilities. These assessments are not inspections and do not produce a "pass" or "fail" but rather determine for operational commanders the expected overall risk exposure for their personnel if these establishments are used.

Conclusion

Thanks to the cooperative efforts of multiple local, state, and federal agencies across the country, we still have the safest food supply in the world. These public health professionals provide technical expertise throughout the continuum of the food supply chain from farm-to-fork. The defense of our nation's food and agriculture resources is now fully integrated in the day-to-day mission of US Army Veterinary Service personnel. The DoD mission will continue to change and budget constraints will inevitably challenge these professionals in their mission to ensure that critical resources are protected from those who mean us harm. Our collective national effort to support the safest food supply in the world will remain highly effective utilizing the systemic approaches developed by US Army Veterinary Service personnel to anticipate, detect, and mitigate our enemies' attempts to strike our food supply.

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Evaluation of the US Army Institute of Public Health Destination Monitoring Program, A Food Safety Surveillance Program

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Abstract

The Destination Monitoring Program, operated by the US Army Public Health Command (APHC), is one component that supports the APHC Veterinary Service's mission to ensure safety and quality of food procured for the Department of Defense (DoD). This program relies on retail product testing to ensure compliance of production facilities and distributors that supply food to the DoD. This program was assessed to determine the validity and timeliness by specifically evaluating whether sample size of items collected was adequate, if food samples collected were representative of risk, and whether the program returns results in a timely manner. Data was collected from the US Army Veterinary Services Lotus Notes database, including all food samples collected and submitted from APHC Region-North for the purposes of destination monitoring from January 1, 2013 to December 31, 2013. For most food items, only one sample was submitted for testing. The ability to correctly identify a contaminated food lot may be limited by reliance on test results from only one sample, as the level of confidence in a negative test result is low. The food groups most frequently sampled by APHC correlated with the commodities that were implicated in foodborne illness in the United States. Food items to be submitted were equally distributed among districts and branches, but sections within large branches submitted relatively few food samples compared to sections within smaller branches and districts. Finally, laboratory results were not available for about half the food items prior to their respective expiration dates.

Background

Each year, foodborne diseases cause an estimated 48 million illnesses in the United States, with an estimated 9.4 million caused by 31 major pathogens.[1-3] Relatively few foodborne illnesses are associated with an outbreak, and even fewer can be attributed to a specific etiologic agent or food product. Given the potential impact of a foodborne illness outbreak and the resultant negative effect on mission readiness and national security, the military employs several programs aimed at protecting the food supply.[4] These programs operate on many levels from acquisition to consumption, with the objective of providing broad, overall protection from foodborne pathogens and contamination. As part of this overall goal, the US Army Public Health Command's (APHC) Destination Monitoring Program was developed as an active food surveillance program with the primary goal of verifying the effectiveness of food safety systems and providing primary prevention against foodborne disease.[4]

The Army Institute of Public Health Veterinary Services (AIPH-VS) is responsible for operating the Destination Monitoring Program, illustrated in Figure 1. The AIPH-VS determines, on a quarterly basis, what types and how many food items should be collected and submitted from all regions and districts within those regions (COL T. Honadel, oral communication, December 11, 2013). Leadership at the district level assigns sampling to each installation and facility within that district. Veterinary Food Inspection Specialists assigned to these installations then select, collect, prepare, and ship food samples to the Food Analysis Diagnostic Laboratory (FADL) at Joint Base San Antonio Fort Sam Houston, Texas. The FADL performs testing on the food samples according to published guidelines.[5,6] The FADL is accredited by the American Association for Laboratory Accreditation, and thus is capable of confirming positive microbial and chemical tests. Samples that test positive for zero tolerance pathogenic organisms are reported to the Texas State Department of Health for pulse field gel electrophoresis "finger-printing" (CW3 J. D. Mitchell, email, November 7, 2014). All laboratory results are then loaded into the Veterinary Services Lotus Notes database, an internal database used for tracking animal health and food safety within the APHC. Positive test results are sent back to the submitter, the region, and the AIPH-VS (Dr R. Benisch, oral communication, December 11, 2013). The district headquarters of the submitting branch is responsible for actively reviewing the final laboratory report within the database for verification of sampling accuracy, to include food processor name,

processing plant location, lot/production code, and product size.

A number of actions may occur in response to a positive test result, depending on whether the nonconforming result is due to a pathogenic organism such as *Salmonella* spp or *Escherichia coli* O157:H7, an indicator organism shown by total coliforms or psychrotrophic count, or another measure of food quality or safety such as mercury or pH. The AIPH-VS evaluates the potential risk to public health, and collaborates with DoD procurement agencies when determining if a product should be recalled or if the manufacturing plant should be suspended. The AIPH-VS also notifies the commercial establishment and appropriate regulatory agency in the case of a pathogen positive result (COL T. Honadel, oral communication, December 11, 2013). Nonconforming results typically will result in scheduling of a directed food protection audit of the commercial establishment, and additional food samples may be collected and tested. [7]

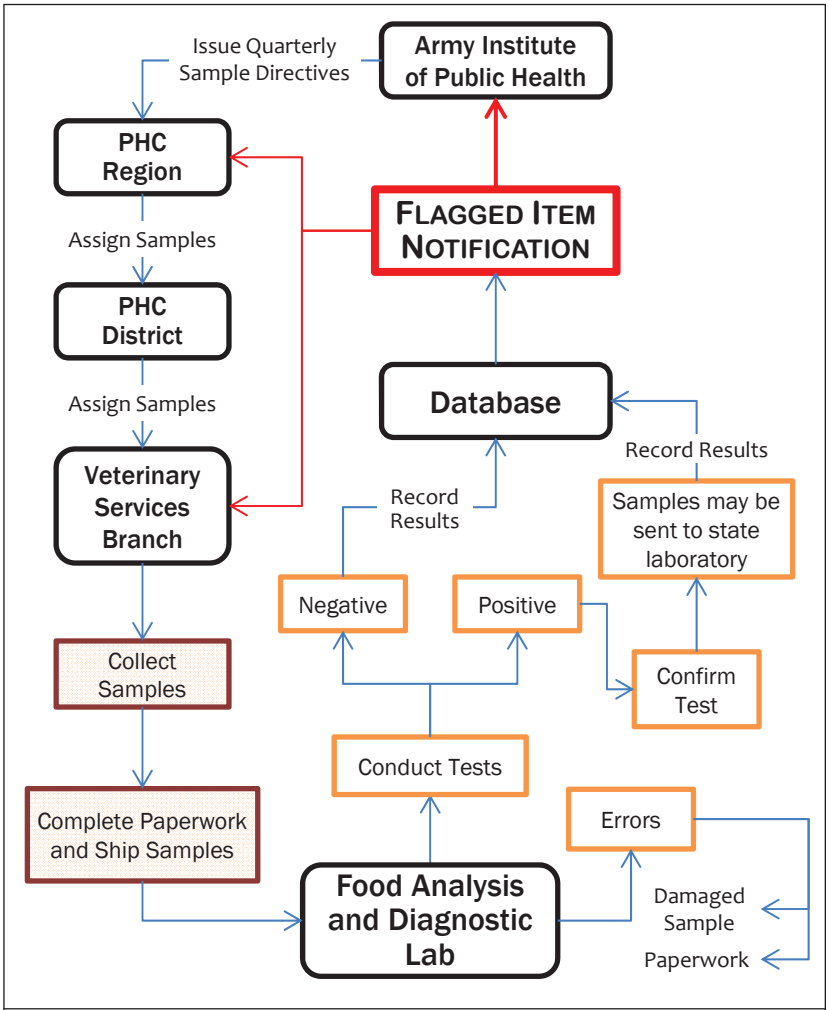

Figure 1. Overview of the Destination Monitoring Program - Sample selection and testing.

The Destination Monitoring Program has several goals, an important one of which is to ensure that food procured by the DoD is safe for consumers. With limited resources, this is best accomplished by testing the foods that present the greatest risk of contamination with pathogens that cause the most severe illnesses. As the DoD procures a wide variety of food items for consumption by military personnel and beneficiaries, a second objective is to ensure that many different items are tested to adequately represent all military installations. Finally, the program is enhanced when all personnel involved in food sampling and testing receive adequate training, especially considering the wide variety of food items procured by the DoD. This often influences the type of food items that are requested for testing, which may not necessarily reflect foods that present the greatest risk. All 3 goals were identified by AIPH-VS as important to the success of the program (COL T. Honadel, oral communication, May 6, 2014). However, achievement of all goals, especially in the context of limited resources, may not be possible, and prioritization will help determine the best methods to conduct the program. This assessment was focused on the goal of identifying and testing high-risk food items with the purpose of ensuring food safety and preventing foodborne illness.

The objective of this study was to evaluate the processes currently utilized by the APHC to identify, collect, and submit food samples for laboratory testing, and assess them for validity and timeliness. Focus was primarily on 3 processes: (1) assessment of sample size and discussion of how sample size relates to statistical power and level of confidence in the system; (2) identification of food samples to be tested and discussion of the risk of foodborne illness associated with different types of food; and (3) assessment of the timeliness of the program, especially regarding the timing of sample submission, reporting of results, and expiration of the food product.

The Uniformed Services University of the Health Sciences Office of Research approved this project.

Methods

Study Design

A descriptive analysis of the Destination Monitoring Program was performed to assess validity and

timeliness of the program. Assessment of the program occurred within the APHC Veterinary Services, which both implements the program and has oversight of the veterinary personnel who execute the program at the region, district, and branch levels.

Analysis was limited to existing data from the US Army Veterinary Services Lotus Notes database provided by the AIPH-VS, which consisted of laboratory results and administrative information on food samples collected, submitted, and tested from January 1, 2013 to December 31, 2013. The analysis was limited to samples collected from the veterinary branches that fall under the purview and command of Fort Belvoir, Fort Eustis, and Fort Knox Districts within APHC Region North (APHCR-N). The data consisted of sample request forms sent to the FADL, which list administrative information (district, branch, fiscal year, quarter), information regarding the sample collection (location, date collected/submitted), sample characteristics (brand, category of food, weight, number of samples, expiration, plant code), and information from the laboratory (date received, errors, laboratory results).

All data was manually extracted from the Lotus Notes database and compiled into Microsoft Office Excel 2010. IBM SPSS Statistics 22 was used for the descriptive analyses.

Evaluation of Sample Size

Descriptive statistics were obtained on the number of food samples collected and tested to determine the appropriateness of sample size and the level of confidence that could be expected. This information was used to develop an operating characteristic curve, which relates the probability of concluding a food lot is safe to the proportion of units in the lot that exceed a specified acceptable level based on sample size.[8] Operating characteristic (OC) curves are frequently used in development and assessment of sampling plans, and the process is well documented in the literature.[8-11] They are based on the probability of detecting a contaminated lot based on a number of factors, including level of contamination in the source lot, the number of positive samples desired in order to reject the lot, and the mean and standard deviation of the bacterial concentration in the source lot. In this assessment, the sample size (n) evaluated was based on the median number of sample units (c) selected from each lot. The maximum allowable number of sample units that could test positive for an organism before a lot was rejected was set to zero, as is typical for pathogens. Mean bacterial concentration was converted to a logarithmic scale, with a standard deviation of 0.8 colony-forming units per gram (cfu/g). This standard deviation was selected based on use in the literature to represent typical distribution of bacteria in a heterogeneous solid food.[9-11] *E Coli* is a common indicator organism, therefore, a hypothetical example using detection of *E Coli* in fresh fruits and vegetables, with an acceptable limit of less than 10 cfu/g (log 1 cfu/g) was considered. The desired acceptance level was designated at 5%, meaning that the sampling plan identified would be acceptable if it rejected a contaminated lot 95% of the time. For comparison, OC-curves were also constructed to depict the confidence in the sampling plan if the number of samples drawn from each lot was increased to n=2, 5, and 10.

Representative of Risk

To determine if the food items selected as part of the Destination Monitoring Program were representative of the risk of foodborne illness, the frequency and percentage of items tested were determined by food category, as defined by the FADL and APHCR-N, and the frequency and percentage of positive results were tabulated for each category. In addition to the food categories defined by APHCR-N, all food items tested were recategorized according to 17 food commodity groups, based on the nature of the food source and ingredient, as developed by Painter, et al.[1,12] Some items were categorized into more than one of the 17 food commodities if they contained more than one ingredient.[12] Frequency and percentage of food items tested by district and branch were also tabulated. Microbial and chemical testing was summarized by tabulating the number of food items that were tested for each organism or chemical.

Timeliness

Timeliness of the program was determined by using the median days that elapsed from when the food items were submitted to laboratory and when the results were available. Additionally, the median time from when laboratory results were available to when the food item expired was calculated. Median values were selected due to the skewed distribution of values as well as to minimize the effect of outliers.

Results

Evaluation of Sample Size

A total of 668 food samples from APHCR-N were collected and submitted to the FADL for the Destination Monitoring Program in 2013. Of those, 577 (86.4%) were actually tested by the FADL. Duplicate samples submitted for the same item were often not tested unless required by FADL, such as when needed for additional chemical testing or to meet minimum weight requirements for microbial sampling (R. Leo, oral communication, May 20, 2014). The submitted food samples

comprised 514 individual food items. The majority of food items submitted and tested contained one sample (73.5%, 89.2% respectively). The number of samples submitted and tested per item ranged from one to 8, with a median of one. Seven items were submitted but not tested at all. Of those not tested, 3 were not received and 4 were not tested due to lost integrity of packaging (broken, leaking). The distribution of number of samples submitted and tested for each food item is shown in Table 1.

Table 1. Comparison of Number of Samples Submitted and Tested by the Department of Defense Food Analysis Diagnostic Laboratory for the Destination Monitoring Program, January 1 - December 31, 2013.

	Number of Samples	
	Submitted	Tested
Total number of samples	668	577[a]
Median samples per item	1	1
Minimum samples per item	1	1
Maximum samples per item	8	8
	Number of Items	
Total	N=514	N=507[b]
	n(%N)	n(%N)
Items containing 1 sample	378(73.5%)	452(89.2%)
Items containing 2 samples	127(24.7%)	49(9.7%)
Items containing 3 samples or more	9(1.8%)	6(1.2%)

[a]Duplicate samples submitted for the same item were often not tested except in certain cases such as chemical analysis to meet minimum weight requirements for microbial testing.
[b]Seven items were not tested (not received or suspect package integrity).

As the median number of samples submitted and tested was one, the OC-curves were constructed using n=1 and c=0 (Figure 2). The probability of accepting a lot differed depending on the sample size (n) and the proportion of contamination within a lot. When n=1 and if the proportion of contamination within the lot was 10%, there is a 90% probability of accepting the lot based on the negative results of that one sample. This probability decreased in a linear fashion as the level of contamination increased. At 50% contamination, the lot is accepted 50% of the time with a sample size of one. In contrast, when the sample size was increased to n=5, and if the proportion of contamination within the lot was 10%, the probability of accepting the lot is 59%. At a contamination level of 50%, the probability of accepting the lot based on 5 negative samples is reduced to 3% (Figure 3). A comparison of the probability of accepting a lot based on a variety of levels of contamination and several hypothetical sampling plans is presented in Table 2.

Representative of Risk

The AIPH-VS requested food items from 14 food categories during 2013. The food groups represent categories of interest as they are considered potentially hazardous foods and give guidance to veterinary personnel in selecting items off the shelf (Table 3). Of the 507 food items collected and tested, the individual category with the most items tested was ground meat (n=78, 15.4%). When categories were collapsed based on food origin, 35.1% of the food items consisted of fresh fruits and vegetables. This included processed fruits and vegetables (12.2%), bagged salads (12%), and whole fresh fruits and vegetables (10.9%). Other categories with significant representation included prepared salad (9.5%), kimchee/tofu (5.7%), and raw seafood (5.5%). Over the period of one year, 3 food items tested positive for indicator organisms. This included one liquid dairy item, which represented 4.4% of all fresh dairy items tested, and 2 unprocessed fresh fruit and vegetable items, representing 3.6% of all items in that category tested.

The frequencies of microbial and chemical testing on food samples were determined. Of the pathogenic bacteria, tests for the presence of *Salmonella* spp were most frequent (n=350, 69%). Testing for other pathogenic bacteria included *Listeria monocytogenes* (n=323, 63.7%), *Staphylococcus aureus* (n=315, 62.1%), and *E Coli* O157:H7 (n=232, 45.8%). Tests for indicator organisms included *E Coli* (n=403, 79.5%), total coliforms (n=270, 53.3%), and psychrotrophic count (n=83, 16.4%). Three food samples tested positive for indicator organisms (Table 3), including whole bagged salad and dairy. The dairy food item tested positive for both total coliforms and standard plate count.

The total number of food items requested by AIPH-VS was similar for each district, and were evenly assigned across the branches and sections within each district.

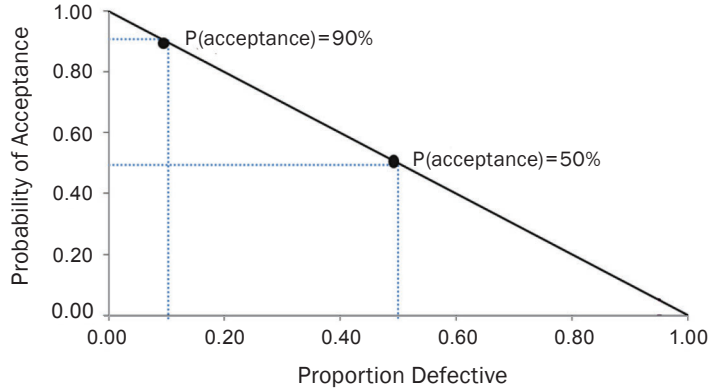

Figure 2. Based on sample size of one, the probability of accepting a contaminated lot decreases in a linear fashion as the level of contamination in the lot increases.

Some sections in large districts, such as Fort Belvoir District, were assigned a relatively small number of food items to collect compared to sections in smaller districts (Table 4). For example, the Fort Knox commissary collected a greater total number of food items (10.7%) compared to other larger commissaries in the region, such as Fort Belvoir (1.8%).

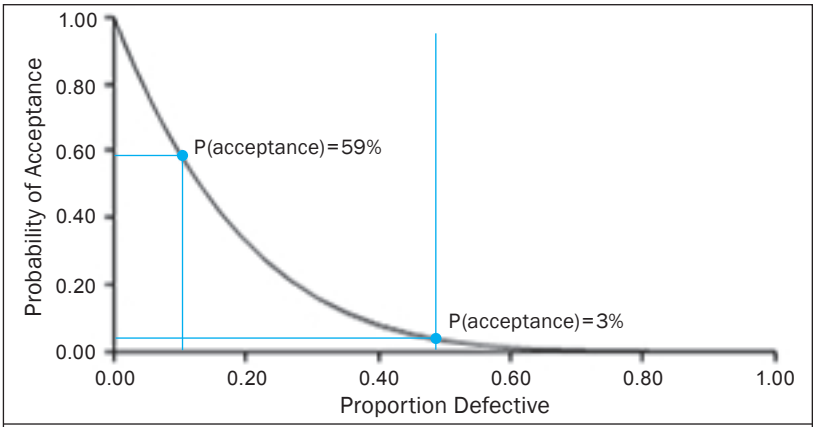

Figure 3. When 5 samples are tested, the probability of accepting a contaminated lot decreases drastically as the level of contamination increases, greatly reducing the risk of allowing a contaminated food item to remain available to consumers.

Timeliness

The median number of days elapsed between food sample submission to the FADL and availability of laboratory results was 9 days, ranging from 1 to 49 (Table 5). For those food items that had an expiration date (n=424), the median number of days between availability of laboratory results and expiration of the product was 2 days, and ranged from -26 (product expired 26 days before laboratory results reported) to 1,801. When considering items with an expiration date, 46.7% of food items expired before or on the same day that laboratory results were reported. In many cases, these items represent highly perishable foods with a short shelf life. Figure 4 depicts the distribution of days elapsed between date of submission and laboratory results.

Table 2. Probability of Accepting a Lot in Relation to Proportion of Contamination and Sample Size.

Proportion of Contamination	Sample Size			
	n=1	n=2	n=5	n=10
10%	0.9	0.81	0.59	0.35
20%	0.8	0.64	0.33	0.11
50%	0.5	0.25	0.03	0.01

Comment

The purpose of this evaluation of the APHC's Destination Monitoring Program was to determine the effectiveness, timeliness, and validity of the program and to inform stakeholders and policymakers on the strengths and limitations of the program.

Most food item submissions contained only one food sample. Even if two or more samples were submitted, often only one sample was actually tested. By selecting only one food sample to test, there is a significant potential to fail to detect a contaminated lot, even when the contamination is significant. As the level of contamination in a lot decreases, it becomes even more difficult to detect with a sampling plan that includes collection of only one sample. However, increasing the sample size even moderately would greatly increase the probability of correctly identifying contaminated lots. Taking a single sample, particularly if negative, affords virtually no ability to discriminate between conforming and nonconforming lots.[10] Recommendations include collecting more samples of each requested item from each commissary. If current inventory will not allow this, sample collection could be coordinated among commissaries in each branch, to allow for collection of samples from the same lot, or at least the same brand with similar production dates.

The program was also evaluated to determine if the food items selected for testing adequately represented the risk of foodborne illness. The AIPH-VS makes the decision on what categories of food to test based on a variety of factors, such as recent food recalls, reports of foodborne illness attributed to certain foods, past knowledge of contaminated food items, and training needs (Dr R. Benisch, oral communication, December 11, 2013). Although a formal, objective risk assessment process has never been developed to assist in determining what food categories pose the greatest risk to consumers, the food categories selected for testing in 2013 did appear to represent those food categories most often implicated in foodborne disease outbreaks, as assessed by Painter et al.[1] Only 3 food items tested positive for contaminants during the study period, which is too few to accurately assess or recommend what food categories are historically associated with increased risk of contamination within this system. A more extensive study reviewing several years and other regions globally would be beneficial to provide these recommendations. Development of a formal risk assessment plan could be beneficial, especially if based on publications such as those that track foodborne illness by food category, food items produced from commercial establishments with multiple major or critical findings during sanitation audits, data from the All Food and Drug Activities announcements released by the Defense Logistics Agency, etc.

Table 3: Distribution of Unique Food Samples Collected and Tested Based on Category, and Number of Items Positive for Indicator Organisms.

Food Category	Food Items Tested, N=507 n(%N)	Food Items Positive for Indicator Organisms, N=507 n(%N)	Proportion Positive Within Category
Ground meat	78(15.4%)	–	–
Processed fruits and vegetables	62(12.2%)	–	–
Bagged salad	61(12.0%)	–	–
Whole fresh fruits and vegetables	55(10.9%)	2(0.4%)	3.60% (n=55)
Prepared salad	48(9.5%)	–	–
Frozen dairy	30(5.9%)	–	–
Other PHF (kimchee/tofu)	29(5.7%)	–	–
Raw seafood	28(5.5%)	–	–
RTE meats	23(4.5%)	–	–
Fresh liquid dairy	23(4.5%)	1(0.2%)	4.40% (n=23)
Powdered infant formula	22(4.3%)	–	–
Cheese	21(4.1%)	–	–
Seafood fresh RTE	19(3.8%)	–	–
Seafood (canned RTE)	8(1.6%)	–	–
Total	507(100%)	3(0.6%)	

PHF indicates potentially hazardous food.
RTE indicates ready-to-eat.

Although each district in the study collected a similar distribution of products, there was a large difference when comparing individual sections. This was because some districts, such as Fort Belvoir, are comprised of many more sections responsible for more commissaries. The current program allows for representation of many facilities, but the proportion of samples collected at each facility is not based on the size of the facility nor the population served at each facility. Re-adjusting the number of samples requested from each section to better reflect the risk of contamination and proportion of people served at each facility would improve the representation of samples requested. This would require information on the relative size of each facility, number of patrons served, and number of veterinary personnel assigned to support each facility.

Finally, this evaluation examined the timeliness of the program. Most laboratory results were reported within 15 days. Food items typically arrived at the FADL within one business day, and FADL personnel did not indicate an overwhelming burden of samples. In fact, the majority of the time lapse between sample submission and reporting of results was likely due to typical processing associated with conducting laboratory tests. Due to the nature of some perishable food items, almost half of items sampled expired before results were reported. Many of the highly perishable food items are also considered a higher risk, potentially hazardous food. Thus, they should continue to be included in the program, with the recognition that if a positive laboratory test is reported, the food lot from which the sample was taken will no longer be available for purchase, and may in fact already be consumed or discarded. Procedures should be developed to inform military public health personnel of the potential health threat. Further, program managers should consider the value of additional laboratory support through the use of satellite facilities or contracted civilian laboratories. This may allow for more rapid testing of highly perishable food items, and may be considered if a significant increase in sample collection is pursued.

Analysis of the destination monitoring program revealed several strengths. First, although the program does not employ a formal risk analysis process to determine what food items should be collected, the data suggest that the informal process based on current trends and subject matter expertise resulted in selection of a variety of food items representing a moderate to high potential for contamination. Second, the shipping and processing of food items happened quickly, and results were reported in a timely manner. Lastly, recent accreditation of the FADL

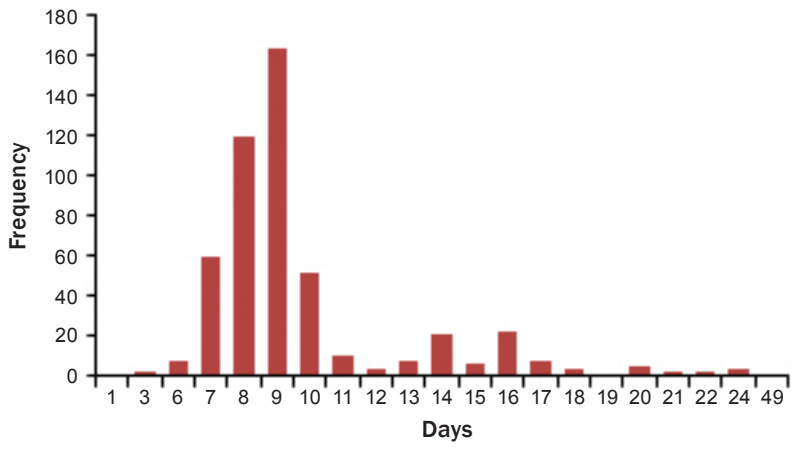

Figure 4. Days from the date of sample submission to the date results were available.

confirms the high quality of laboratory procedures used to determine contamination in submitted food items.

Several limitations of the program were recognized. Perhaps the most significant limitation was the reliance on small sample sizes to make decisions about the safety of food lots. Additionally, although the Lotus Notes database was functional, it was difficult to navigate and did not provide an easy method to extract data for analysis. All records had to be individually accessed and transcribed to an Excel worksheet for analysis. Currently, the database does not provide an easy way for users to evaluate data from an epidemiologic perspective. The program is also not well integrated with other surveillance systems, such as the Armed Forces Reportable Medical Events passive surveillance system[14] or the Centers for Disease Control and Prevention FoodNet[15] or PulseNet[16] systems. It should be noted that while FADL does not directly communicate with other surveillance systems, it does send samples from food items testing positive for zero-tolerance pathogens to the Texas State Department of Health, which communicates with PulseNet (CW3 J. D. Mitchell, oral communication, November 7, 2014). Improving the communication and integration between the AIPH-VS and other foodborne disease surveillance systems as well as other military public health infrastructure may be vital in linking human disease cases to potential foodborne pathogens detected within the Destination Monitoring Program. Although this analysis was limited to the APHC Region North, many conclusions will likely apply to APHC Regions South and West, because the same type and number of food items are typically requested from each region, and food samples are all processed at FADL. However, one would expect the distribution of sample collection to vary between individual sections. Additional research may give more information as to how the program functions in other regions, especially APHC Pacific and Europe.

Table 4. Frequency of Food Item Submissions by District, Branch, and Section of the APHC Region-North, January 1 - December 31, 2013.

District	Branch	Section	Frequency	% of District Submissions	% of Total Submissions
Fort Belvoir					
	Fort Meade	Andrews/ Annapolis	5	3.0%	1.0%
		Forest Glen	5	3.0%	1.0%
		Carlisle Barracks	4	2.4%	0.8%
		Fort Detrick	4	2.4%	0.8%
		Fort Meade	4	2.4%	0.8%
	Branch Total		22	13.0%	4.3%
	New London	Groton	12	7.1%	2.3%
		Newport	9	5.3%	1.8%
	Branch Total		21	12.4%	4.1%
	Dover	Aberdeen Proving Ground	21	12.4%	4.1%
	Fort Belvoir	Fort Belvoir	9	5.3%	1.8%
		Quantico	8	4.7%	1.6%
		Patuxent River	3	1.8%	0.6%
	Branch Total		20	11.8%	3.9%
	McGuire/ Dix	Fort Dix	20	11.8%	3.9%
	Fort Drum	Fort Drum	20	11.8%	3.9%
	West Point	West Point	13	7.7%	2.5%
		Tobyhanna	6	3.6%	1.2%
	Branch Total		19	11.2%	3.7%
	Fort Myer	Fort Myer	17	10.1%	3.3%
	Hanscom	Portsmouth	9	5.3%	1.8%
District Total			169	100.0%	32.9%
Fort Eustis					
	Fort Bragg	Fort Bragg	35	20.5%	6.8%
	Norfolk	Norfolk	17	9.9%	3.3%
		Portsmouth	17	9.9%	3.3%
	Branch Total		34	19.9%	6.6%
	Fort Lee	Fort Lee	27	15.8%	5.3%
	Fort Eustis	Fort Eustis	26	15.2%	5.1%
	Camp Lejeune	Camp Lejeune	25	14.6%	4.9%
	Cherry Point	Cherry Point	24	14.0%	4.7%
District Total			171	100.0%	33.3%
Fort Knox					
	Fort Knox	Fort Knox	55	31.6%	10.7%
		Harrison Village	10	5.7%	1.9%
	Branch Total		65	37.4%	12.6%
	Great Lakes	Great Lakes	38	21.8%	7.4%
		Rock Island	7	4.0%	1.4%
		Fort McCoy	16	9.2%	3.1%
	Branch Total		61	35.1%	11.9%
	Wright-Patterson	Selfridge ANGB	29	16.7%	5.6%
		Kelly Support	19	10.9%	3.7%
	Branch Total		48	27.6%	9.3%
District Total			174	100.0%	33.9%
Grand Total			514		100.0%

Table 5. Days Elapsed from Submission to Results, and Results to Product Expiration Date.

	Submission to Results (Days)	Results to Expiration (Days)
Number of food items	507	424[a]
Median	9	2
Minimum	1	-26.0[b]
Maximum	49	1801

[a]Data only available for food items that had an expiration date.
[b]Negative numbers indicate that product expired prior to reporting of laboratory results.

The purpose of the Destination Monitoring Program is to assess and validate producer compliance with good hygiene practices, good manufacturing practices (GMPs), and implementation of food safety risk management systems such as Hazard Analysis Critical Control Point (HACCP). Increasingly, it is recognized that preventive measures such as GMPs and HACCP are much more effective food safety management tools than end-product testing.[8,13] Some suggest that while microbial monitoring has its place, particularly in high-risk situations like intentional botulinum toxin poisoning in milk, a better return on investment might be realized through increased funding of foodborne disease surveillance systems.[13] However, the Destination Monitoring Program has the potential to yield important information, serves as an additional level of protection against foodborne pathogens, and is used to verify safety and wholesomeness of food purchased by DoD.

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Environmental Requirements Related to Patient Care and the Team Working to Ensure Compliance

Diane Roberts

Abstract

Healthcare providers are often surprised that regulations promulgated by the US Environmental Protection Agency (EPA) apply to patient care settings. Many find it strange that processes meant to heal have the potential to harm human health and the environment, and are, therefore, regulated by federal and state environmental agencies. The importance of compliance is emphasized by the fact that both the EPA and individual state agencies have the authority to impose civil and criminal penalties if they discover violations. The Joint Commission considers compliance important enough to include it as an element of performance in the Environment of Care standard.

The US Environmental Protection Agency (EPA) was established in 1970 to protect the environment, which has the attendant effect of protecting people's health. This correlates with one goal of the US Army Public Health Command (USAPHC):

> To protect Soldiers and Army communities, worldwide, from environmental conditions that could adversely affect human health.[1]

One example of an environmentally regulated process frequently used in patient care is cervical cancer screening. Historically, samples of cervical cells were manually smeared directly on a glass slide which was then sent to a lab for processing and review. This screening procedure was not reliable. Sometimes the cells were smeared too thick or too thin, commonly resulting in false positive or false negative results. In 1996, the Food and Drug Administration approved the ThinPrep Pap System (Hologic Inc, Bedford, MA)[2] which suspends the cervical cells in a methanol-based solution, then uses an automated process that places the cells uniformly on a slide. The new process has improved accuracy for cervical cancer screening, but generates a hazardous waste (HW) in the process. Personnel ordering and using this equipment and its reagents were not initially aware this process generated a HW. Since chemical and pharmaceutical manufacturing companies are not required to communicate disposal requirements for their products, the person generating the waste must make the determination. In this as in most cases, the process is simple and personnel are available to assist. Each medical activity (MEDDAC) has personnel within the logistics and preventive medicine divisions who can assist in determining which wastes are hazardous and which are not. Logistics and preventive medicine personnel can seek assistance, if needed, from their USAPHC regions. Determining which regulations apply can be tricky, and collaboration is often required to ensure the facilities are in compliance.

There are 22 regulatory acts and 3 executive orders under the jurisdiction of the EPA. Although all of the acts and executive orders can be applied to healthcare facilities, the most significantly relevant are the Resource Conservation and Recovery Act (RCRA)[3] and the Clean Water Act.[4]

The Resource Conservation and Recovery Act

The RCRA was first enacted in 1976 and amended in 1984.[5] According to the US Department of Agriculture, the objectives of the RCRA are:

> …to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner. RCRA regulates the management of solid waste (eg, garbage), hazardous waste, and underground storage tanks holding petroleum products or certain chemicals.[6]

The RCRA requirements are not industry-specific. Any industry generating HW or storing petroleum, oils, and lubricants is regulated. Patient care, including dental and veterinary care, generates HW. Hospitals store petroleum to power emergency generators, dining facilities generate used oil from cooking, and facilities maintenance generates used oil during regular maintenance activities. The RCRA relates to patient care, both directly and indirectly.

The RCRA divides HW into 2 broad categories, Characteristic and Listed. The Characteristic subcategories are

Ignitable, Corrosive, Reactive, and Toxic. The Listed categories are F, K, P and U. All HWs are given a 4 digit EPA HW Identification Number.

Ignitable HW includes, but is not limited to, liquids containing at least 24% alcohol with a flashpoint of 60°C/140°F or higher. With a flashpoint of 60°C, the methanol-based waste generated from cervical cancer screening becomes an ignitable HW upon disposal. The EPA HW number for ignitable HW is D001. The characteristic of corrosive HW (D002) include liquids having a pH of 2 or lower, or 12.5 or higher. These pH ranges apply to many acids and bases used in clinical laboratories. Reactive (D003) HW includes wastes reactive with water, capable of detonation if heated or under confinement, or items that can undergo violent change without detonation. Lithium batteries and non-empty aerosol cans are waste that can fall into this category upon disposal.

Table 1. Toxic Hazardous Waste Generated in Patient Care

Constituent	EPA HW Number	Regulatory Level (mg/L)	Sources of the Waste Stream in Healthcare	Concentration Range
m-Cresol	D024	200.0	Insulin (m-Cresol is a preservative)	1800mg/L and up
Lindane	D013	0.4	Lice and scabies treatment	10,000 mg/L
Mercury	D002	0.2	Thimerosal preserved vaccines	200 mg/L
			Ophthalmic solutions	200 mg/L
			Amalgam	Up to 400 mg/L
Selenium	D010	1.0	Topical or shampoo	250 mg/L and up
Silver	D011	5.0	Silver nitrate cauterizing sticks	200 mg/L

The toxicity characteristic is based on the type and concentration of specific chemical constituents such as silver or mercury that may be present in waste. These constituents are harmful or fatal when ingested or absorbed; can enter the environment as leachate from improperly discarded waste; and pollute ground water. Toxicity is defined through a laboratory procedure called the toxicity characteristic leaching procedure (TCLP). The TCLP helps identify constituents in items such as silver nitrate sticks (see illustration) that are likely to leach into the environment. Table 1 provides a list of constituents commonly found in patient care settings, with the associated EPA HW Number and the regulatory level that, when reached or exceeded, makes the item a HW.

The K-list consists of specific industrial processes. Examples include pressure treating wood or developing explosives, such as trinitrotoluene or TNT. The wastes generated from these processes are HWs. This category is not applicable to patient care.


Silver nitrate sticks

The F-list consists of waste generated from processes common to multiple types of industrial processes. Acetone, xylene, and methylene chloride are used as solvents in paint, leather, and pesticide manufacturing, as well as by the auto industry for degreasing. In cases when these are used for their solvent properties, they are F-listed HW. The hospital may not seem "industrial," but xylene is used in a histology laboratory during tissue processing to dissolve paraffin and tissue-based fats. Because xylene is used in this process as a solvent, RCRA characterizes it as an F-listed HW upon disposal. Various chemicals with solvent properties are often used in facilities maintenance, which would be the only other activity that may regularly generate this waste.

The P-list and U-list consist of commercial chemical products such as formaldehyde, methanol, xylene, and warfarin (Coumadin). If such products require disposal, they will be a P or U-listed HW only when unused and if the product has only one active ingredient which is on the P or U-list. For example, an unused, expired bottle of phenol used in physical therapy would be a U188 RCRA HW because the item is an unused commercial chemical product and phenol is its sole active ingredient. In contrast, yellow fever vaccine preserved with phenol is not a U188 HW because phenol is not the sole active ingredient in the vaccine. Similarly, xylene used in a histology laboratory for its solvent properties would not be a U-listed waste for disposal. However, if the xylene is expired and cannot be used, it would be managed as a U239 HW upon disposal. Table 2 lists additional items used in patient care that would be P or U-listed HW upon disposal.

The difference between the P and U-lists is that P-listed chemical products are acutely toxic. Acutely toxic refers to HW that could pose a threat to human health and the environment even when properly managed. Toxic HW is considered capable of posing a threat to human health and the environment in the absence of special handling and storage procedures. Because P-listed wastes are acutely toxic, the containers that hold them are also considered acutely toxic. A container that held Coumadin would therefore be a P-listed HW. The same categorization applies to wrappers that contained nicotine patches and blister packs that contained nicotine gum.

Table 2. Listed Category P and U Hazardous Waste Generated from Patient Care.

P or U Listed Chemical	EPA HW Number	Trade Name	Areas Where Commonly Generated
Cyclophoshamide	U058	Cytoxan Neosar	Inpatient, outpatient, and oncological pharmacies
Lindane	U129	Gamen Kwell Scabene	Inpatient and outpatient pharmacies
Methanol	U154	N/A	Laboratories
Mitomycin-C	U010	Mutamycin Mitosol	Oncology, ophthalmology, and dermatology
Nicotine and salts	P075	Nicorette Gum Thrive Gum Nicoderm CQ Patch Nicotrol Patch	Obstetrics and inpatient behavioral health
Phenol	U188		Physical therapy

The Clean Water Act, RCRA, and Petroleum, Oils and Lubricants

The majority of petroleum, oils, and lubricants (POL) associated with hospitals are stored in above ground storage tanks (ASTs), underground storage tanks, or 55-gallon drums. Fuel for emergency generators is stored in ASTs with capacities ranging from 500 to 12,000 gallons. Used cooking oil generated in a dining facility is commonly stored in 55-gallon drums or in 400-gallon leak proof ASTs that look like dumpsters.

Sites with POL storage in containers with a capacity of 55 gallons or more are regulated by EPA under 40 CFR §112–Oil Pollution Prevention which mandates a spill prevention, control, and countermeasures plan (SPCCP). The SPCCP must be updated by DPW every 5 years. Additionally, anything stored in underground storage tanks is also regulated by the RCRA. Each regulated containment system must be documented in the installation's SPCCP. The SPCCP prescribes inspections, spill response, and spill reporting requirements. Facilities Maintenance and dining facility personnel are required to comply with the SPCCP as this document is effectively the regulation to which the facility must comply, or be cited. In 2014, one Army installation paid $158,700 for RCRA violations related to improper management of underground storage tanks.[7] The site had 20 tanks storing gasoline, diesel, used oil, jet fuel, and anti-freeze for use in vehicles, aircraft, emergency generators, and maintenance carts. The EPA found 19 tanks out of compliance.

Characterizing Hazardous Wastes

By regulation, any person or entity generating waste is required to determine if their waste is hazardous. The process commonly begins with a review of the materials safety data sheets, which provide information such as pH or flashpoint, or package inserts which are commonly provided with pharmaceuticals. When a process mixes various chemicals, such as in a laboratory, a waste may require chemical analysis. This is accomplished by taking a sample of the waste and contracting with an EPA or state certified laboratory for analysis. If the analysis indicates the waste fits within one of the Characteristic subcategories, it must be managed and discarded as a HW. The Army Institute of Public Health (AIPH) and the USAPHC Regions are available to assist with this process.

Managing Hazardous Waste

The EPA requirements for management of HW are straightforward. At a minimum, the person generating the waste must store the waste at or near points of generation, and the storage site must be under the control of the waste generator. These storage sites are commonly called satellite accumulation points or areas. Containers at the accumulation point must be closed and marked "Hazardous Waste," or with words indicating the contents. Containers must be in good condition, compatible with contents, closed when not adding or removing waste, vapor tight, and spill proof. The quantity of HW permitted at satellite accumulation points or areas is 55 gallons of nonacute HW, or 1 quart acute HW (ie, P-listed). If either limit is reached, the generator must remove the waste in excess of 55 gallons or 1 quart within 3 days. The waste is normally removed by the installation's Directorate of Public Works (DPW) and stored at a DPW maintained facility before being sent to a HW disposal contractor. In some cases, patient care facility personnel will transfer waste to the DPW storage facilities. This is allowed only when the DPW storage facility and the patient care facility are on the same installation. Medical personnel may not transport HW off the installation or bring HW onto the installation unless specific conditions are met. This is relevant for personnel who generate HW at off-post clinics. Under most conditions, transport off the installation is allowed only by personnel who have formal permits and required certifications to transport HW on public roadways. The regional USAPHC must be contacted to confirm legality if HW generated at off-post clinics is to be transported by medical facility personnel to a HW storage or disposal facility. Transport (off post), treatment, and disposal of HW are contracted through the Defense Logistics Agency – Disposition Services (DLA-DS), formerly the Defense Reutilization and Marketing Office.

As a tenant on an installation, the hospital will reimburse the DLA-DS, via DPW, for HW disposal. The conditions and costs will be outlined in an interservice support agreement between the hospital and DPW. The

hospital reimburses DPW using environmental program requirement funds disbursed by the US Army Medical Command, and managed by the MEDDAC Environmental Science and Engineering Officer (ESEO). The ESEO is normally the Chief of Environmental Health within the Preventive Medicine Division. Although the ESEO manages the funding for disposal, *Army Regulation 40-3*[8] designates Medical Logistics as responsible for the hospital waste program. Waste management programs are successful when the ESEO and Medical Logistics have a close working relationship. Each role has the support of the installation DPW, with higher level support available from the regional USAPHC.

State and Host Country Requirements

Because our uniformed personnel move from state to state, it is important to understand that with the exception of Iowa, Alaska, and Hawaii, individual states have the jurisdiction to enact more stringent environmental regulations. For example, the state of Washington defines Sodasorb, a corrosive salt used to absorb carbon dioxide from anesthetized patients, as a corrosive D002 HW. The Washington regulations require any caustic solid that causes a liquid to have a pH of 2 or lower or higher than 12.5 (when exposed to an equal volume of liquid) to be disposed of as a corrosive HW. In contrast, the EPA only regulates liquids.

Pharmaceutical waste is another area where states have applied more stringent requirements or regulatory interpretations. The DLA-DS has contracted with a pharmaceutical reverse distributor that picks up unusable/unwanted pharmaceuticals directly from MEDDAC pharmacies. The process provides credit for the pharmacy to use for future purchases, so this system is utilized Army wide. The contractor will take opened, unopened, expired, unexpired, uncontrolled, and controlled pharmaceuticals from animal and patient care. The dilemma, as indicated earlier, is that some pharmaceuticals are a HW upon disposal. Colorado, Connecticut, California, Kansas, Kentucky (except for Ireland Army Community Hospital), Missouri, New Mexico, New York, Oklahoma, South Carolina, and West Virginia will not allow a pharmacy to return expired or unusable (such as opened containers) HW pharmaceuticals through the reverse distributor. These states require HW pharmaceuticals to be managed and disposed of from the site they were deemed nonusable.

We cannot forget that we have installations and bases overseas. Although host nation environmental agencies do not have the jurisdiction to impose penalties like the EPA, requirements exist overseas., In those locations where the US military is well-established, requirements are published in Final Governing Standards. These exist for Germany, Korea, and Kuwait, for example. Final Governing Standards are a consolidation of status of forces agreements, host nation laws, and *DoD Publication 4715.05-G*.[9] These differ from US requirements, but not significantly. In the absence of Final Governing Standards, personnel follow DoD Regulation DoD Publication 4715.05-G.

The Joint Commission

The 2014 Joint Commission EC Standard EC.01.01.01 EP 1[10] requires a hospital to have "a written plan for managing the following: Hazardous Materials and Wastes." The Standard EC.02.02.01[10] requires the hospital to:

> maintain a written, current inventory of hazardous materials and waste that it uses, stores, or generates. The only materials that need to be included on the inventory are those for which handling, use and storage are addressed by law and regulation.

Compliance with environmental laws is required for conformance with The Joint Commission. Most hospitals have an Environment of Care Committee, a team of personnel that performs internal audits for conformance with the Environment of Care Standard. Personnel conducting a review of a waste management program will be successful only if they have adequate training. On many occasions, the knowledge of personnel assessing the hazardous material and waste programs is limited to hazardous material requirements of the Occupational Safety and Health Act (Pub L 91-596, 84 Stat (1970)). There are several ways to remedy this. The AIPH provides an online waste management course that includes training on the EPA waste management requirements as they relate to patient care. The USAPHC Regions provide training to hospital personnel during assistance visits provided for the ESEO. Local classes are often mandated by the installation. Although those classes normally do not cover hospital wastes and commonly focus on maintenance activities of field units, they are useful to understand local procedures for waste management.

Relevant Army Regulations

Army Regulation 200-1[11] directs compliance with environmental legal mandates. Installation tenants are required to comply with federal, state, and local laws as well as installation policies.

Army Regulation 40-61[12] assigns operational responsibility for waste collection and disposal to the MEDDAC's chief of logistics. The ESEO acts as the principal advisor for the waste management program per *Army Regulation 40-11*.[13] In most cases, the ESEO is not trained for this responsibility. Therefore, MEDCOM has tasked

Table 3. Civil Penalties Incurred by Federal Facilities for Violations of EPA Rules and Regulations.

Agency/Installation Type	Year	Description	Actual Penalty: Settlement Agreement
Joint Army/Air Force Installation[14]	2013	Failure to: • conduct weekly inspections of HW facilities and containers for leakage or deterioration • ensure staff participation in annual HW management training • submit HW tracking reports	$21,000
Air Force Base[15]	2012	Improper labeling to clearly identify HW, improper management of fluorescent lamps containing mercury, and failure to: • determine if a waste was hazardous • have adequate training plan in place for facility workers handling HW • conduct regular inspections of HW containers	$45,700: Make improvements to standard operating procedures and management controls to comply with federal hazardous waste laws.
Army Installation[16]	2011	Failure to: • have adequate release detection with respect to piping associated with underground storage tanks • operate an incinerator at adequate temperatures • maintain adequate service records regarding appliances containing 50 or more pounds of ozone depleting refrigerants	$33,000: Agreement to purchase environmental friendly refrigerants for $310,000.
VA Medical Center[17]	2011	Improper disposal of hazardous waste through the biological waste system and failure to: • make HW determinations • inspect, label, date, and close HW containers • make arrangements with emergency responders for spill response support • label used oil containers	$18,000: Agreement to spend $62,000 to erect an HW accumulation building.
VA Medical Center[18]	2009	Unlawful shipping of HW, unpermitted on-site incineration of HW, and failure to: • perform proper HW determinations • properly manage HW satellite accumulation containers • keep proper emergency information posted near telephones • conduct weekly inspections of HW storage areas • make proper advance arrangements with local fire and police departments and other emergency responders for responding to emergencies • develop a proper emergency contingency plan • document a personnel training plan • store incompatible wastes without proper segregation	$52,000: $482,000 to develop and implement a program to properly manager pharmaceutical and chemical wastes.
Army Installation[19]	2009	Accumulated hazardous waste in an area with a floor drain without taking measures to prevent a leak or spill, and failure to: • determine whether numerous containers held HW • properly label HW containers	$89,500
Coast Guard[20]	2008	For operating a hazardous waste storage facility without a permit or interim status and failure to label universal waste batteries.	$9,280: $89,290 to purchase a new digital x-ray machine for its dental clinic.
VA Hospital[21]	2008	For: • storage of HW without a permit • open containers • inadequate facility maintenance • ignitable waste within 50 ft of property line • failure to make a HW determination	$32,500
Army Medical Center[22]	1999	For improperly storing laboratory chemicals without a permit, and failure to notify the EPA prior to receiving a shipment of hazardous waste from a US Army facility in Thailand	$50,400: Agreement to complete a $1.6 million project to purchase and implement a hazardous material management system.

AIPH, through the USAPHC Regions, to provide on-site assistance to ESEOs. Each region provides such assistance to each MEDDAC ESEO within 6 months of the ESEO's arrival. This process is part of the framework established to help the facility avoid potential liabilities from noncompliance.

Internal and External Inspections

A variety of inspection programs internal to the Army, installation, or MEDDAC exists to ensure that hospitals maintain compliance. The inspections, led by MEDCOM assets, include the Organizational Inspection Program conducted by regional medical commands, and

the Command Logistics Review Program conducted by MEDCOM Logistics and augmented by AIPH, which reviews the waste management program. The installation's DPW Environmental Division normally has personnel who inspect units and tenants. Some installation DPW programs inspect weekly, others annually. Another type of internal inspection is the Army Environmental Command Environmental Performance Assessment System (EPAS) which audits the entire installation, including tenant organizations. An installation undergoes an EPAS audit every 2 to 3 years.

Inspections external to the Army include EPA and state inspections. These agencies can impose notices of violations upon the installation that can result in civil or criminal penalties. A listing of violations resulting in civil penalties is provided in Table 3. The funds to pay these penalties do not come from the environmental funds managed by the ESEO. The penalties are paid for by the hospital's operating costs, and payment means less money for patient care.

Thankfully, Army MEDDACs have not received a fine since 1998. This is comforting because in the past 3 years, Walgreen's, Target, Walmart, and CVS Pharmacy, paid fines ranging from $800,000 to $22.5 million due to failure to implement successful compliance programs, such as those in the Army.[23]

The Waste Management Assistance Visit

Within 6 months of an ESEO's arrival, USAPHC Region personnel provide a Waste Management Assistance Visit (WMAV). The visit introduces the ESEO to key personnel of the MEDDAC and installation environmental programs (MEDDAC logistics, DPW HW manager, The Joint Commission team, resource management), provides formal training, assists with a facility walk-through with the ESEO, reviews EPR funding, coordinates waste analysis if necessary, etc. The walk-through identifies instances of noncompliance, but rather than reporting them to a higher echelon, they are used as training aids to teach the ESEO to implement corrective actions based on root causes. If the root cause is systemic, AIPH will engage MEDCOM for a solution. The entire process works to help the hospital attain and maintain compliance.

The USAPHC Region personnel coordinate formal training opportunities, based on the patient care area/activity prior to the site visit which include state and local regulations, and are catered to personnel. Examples of classes USAPHC Regions provide: Waste Characterization and Management in the Laboratory, Pharmaceutical Waste Management, Environmental Requirements of Joint Commission, and Environmental Liabilities for Commanders and Chiefs.

The assistance team also ensures required waste analysis is completed. All of this provides an effective assistance visit that equips the ESEO to oversee the program and ensures they are introduced to the key players so they may work as a team. The program allows the ESEOs to have direct contact with the respective USAPHC Region, which provide support during their tenure as a MEDDAC ESEO. Compliance is not always simple or straightforward. All parties involved fully support MEDCOM's efforts in the area of environmental stewardship.

Conclusion

Patient care encompasses a wide variety of processes and procedures regulated by a variety of federal, state, local, and host nation requirements. Although these requirements are in place to ensure the health of people and their environment, they can be challenging to understand. The ESEO, with the help of the WMAV, is trained to assist MTF personnel to comply with these requirements. In turn, the ESEO can, at any time, contact the USAPHCR Region for support.

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Preventive Medicine Oversight of Splash Pads on Military Installations

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Abstract

Over the past several years, an increasing number of military installations have installed splash pads that provide fun, recreational water entertainment for Soldiers and their families. The addition of splash pads brings added responsibilities for medical treatment facility preventive medicine oversight and installation facilities maintenance to ensure a safe and healthy environment. Currently, there are no consistent standards or detailed guidance for military installations to follow when installing and maintaining splash pads. The central issues associated with splash pads on military installations are water quality and risk for waterborne illnesses, responsibility for safety and health oversight, and federal energy and water sustainability mandates. This article examines the importance of implementing a standard for design and oversight to ensure the health and safety of Soldiers and their families.

For many years, splash pads have been constructed all over the world and are growing in popularity in the Unites States as a fun, economical way to entertain children and adults. There are an estimated 1,200 water parks in North America and about 720 in other countries around the world. In North America alone, water park attendance for 2012 was estimated to be approximately 85 million people, with an anticipated annual attendance growth rate of 3% to 5%.[1]

A splash pad is a recreational play structure that sprays treated or recycled water above the ground and is independently operated from another recreational water facility such as a pool.[2] Splash pads are also referred to as recreational spray parks, spraygrounds, spray pads, splash pads, spray pools, water parks, splash deck, interactive fountains, and wet decks (Figure 1).

Figure 1. A typical splash pad layout.

Medical Concerns

A splash pads features equipment that is designed to spray or splash patrons with water that then flows into a drain and is either filtered, disinfected, and recirculated through the spray feature or discharged into a wastewater system. A major advantage inherent in the design of splash pads is the elimination of standing water, which significantly reduces the risk of drowning. In the United States, drowning is the number one cause of injury related death in children aged 1 to 4 years.[3]

Despite the very low risk of drowning and seemingly benign nature of these parks, there remains a very real public health risk from bacteriological infections. Splash pads have the potential to become a breeding ground for communicable diseases due to 3 problems: poorly or inadequately disinfected water sources, poorly or inadequately disinfected skin contact surfaces, and poorly designed and engineered park structures.

Since 1978, the Centers for Disease Control and Prevention (CDC), the US Environmental Protection Agency, and the Council of State and Territorial Epidemiologists have maintained the Waterborne Disease and Outbreak Surveillance System (WBDOSS) for the collection of waterborne disease outbreak (WBDO) information associated with recreational water activities. When a WBDO is suspected, the state and local public health departments are expected to investigate it and voluntarily provide this data to the CDC for inclusion in the WBDOSS.[1]

Outbreaks at splash pads are the result of nonhygienic behaviors which contaminate the surrounding water. Patrons ingest the contaminated water and illness can ensue if the infective dose is high enough. Common nonhygienic behaviors include exposing buttocks to splash features, drinking water directly from a splash feature,

not showering prior to using the splash pad, and allowing diapered children to sit in the water puddles that other children then intentionally or inadvertently ingest.[4]

From 1995 to 2004, exposure to recreational water in the United States resulted in more than 255 WBDOs, 18,500 illnesses, and 24 deaths. Seventy-six of the 255 WBDOs were linked to treated water venues (pools, spas, hot tubs), with cryptosporidiosis being responsible for 61.8% of the illnesses.[5] During this same time period, there were 6 outbreaks linked to recreational use of splash pads. *Shigella* infection resulted in 3 of the outbreaks, *Cryptosporidium* caused 2 outbreaks, and a coinfection of both *Cryptosporidium* and *Shigella* was the cause of one outbreak.

Data collected from the WBDOSS from 2005 to 2006 indicated a total of 78 WBDOs, resulting in 4,412 illnesses, 116 hospitalizations, and 5 deaths. Three-quarters of the outbreaks (58 of the 78) occurred at treated water venues. Gastroenteritis was associated with 48 outbreaks and accounted for 4,015 of the 4,412 total reported illnesses. Of the 48 gastrointestinal outbreaks, *Cryptosporidium* was associated with 31 outbreaks, and all but 2 of these outbreaks were related to treated water.[1]

In 2005, the state of New York reported a massive outbreak associated with the use of splash pads.[6] This event resulted in more than 3,000 people reporting as ill from their exposure to the water fountain and at least 425 confirmed cases of *Cryptosporidium hominis*. Although the interactive fountain water was filtered and chlorinated, it was determined that the residual chlorine level was inadequate to inactivate *Cryptosporidium* in the water holding tanks. This outbreak likely occurred as a result of fecal contamination of the water by an infected individual.

In 2006, an outbreak of gastroenteritis was epidemiologically linked to a splash pad in Orange County, Florida.[5] Forty-nine individuals became ill from infections caused by *Cryptosporidium* (9 cases), and *Giardia* (38 cases). Two individuals were found to have a coinfection with both *Cryptosporidium* and *Giardia*. Multiple breaches of proper sanitation which resulted in several contamination incidents were identified. The cause of the outbreak could not be determined conclusively, but is presumed to have been from asymptomatic carrier(s).

In 2007, an outbreak of cryptosporidiosis occurred from a municipal splash pad in Idaho, sickening 50 people.[7] Samples from the splash feature's sand filters and nearby drinking water fountains identified *C hominis* in both water sources. The initial cause of this outbreak was assumed to be from an ill patron that frequented the park and the subsequent illnesses were due to the ingestion of the fecally contaminated splash features and drinking water. It was also determined that the 2 drinking water fountains that shared a water line with the splash pad had faulty backflow prevention devices that may have led to the contamination of the drinking water and further contributed to the number of sick people.

From 2009 and 2010, the WBDOSS identified 81 recreational water-associated disease outbreaks from 28 states and Puerto Rico. These outbreaks resulted in more than 1,326 illnesses and 62 hospitalizations. Of the 81 total outbreaks, there were 57 outbreaks associated with treated recreational water venues and 24 associated with untreated recreational water venues (lakes, oceans). Of the 57 treated water recreational water venues, 24 were caused by *Cryptosporidium*.[8] Large outbreaks are more frequently seen in the summer months and are usually due to problems maintaining proper water quality, structural design, improper usage, and inadequate facility maintenance.[1]

These examples demonstrate why *Cryptosporidium* has become the leading concern for outbreaks of gastrointestinal illness associated with disinfected recreational water venues[6] (Figure 2). The number of confirmed cryptosporidiosis cases each year in the United States is approximately 748,000, with an estimated annual health care cost of $45.8 million.[8]

The features of *Cryptosporidium* that make it so menacing are its high resistance to normal water disinfection concentrations, its small size, its low infective dose, the high number of oocysts that are shed, and the extended duration of time that they can be shed.[8] Shedding of the parasites begins at the onset of symptoms and may continue for weeks after the illness stops. Infection spreads by ingestion of the parasite. The incubation period averages 2 to 10 days and the illness usually lasts 1 to 2 weeks. Although an infection can be asymptomatic (no symptoms), typical signs and symptoms of infection are stomach cramps and pain, dehydration, nausea, vomiting, fever, weight loss, headache, joint pain, and profuse diarrhea. Young children, pregnant women, and individuals who are immune deficient have a higher chance of contracting cryptosporidiosis and may suffer more severe symptoms.[8]

Military Regulations and Guidance

Technical Bulletin MED 575[2] governs splash pads on all military installations. However, it only regulates splash pads designed to recirculate water. In addition, *TB MED 575* does not include guidance specifying who on an installation has operation and maintenance oversight of

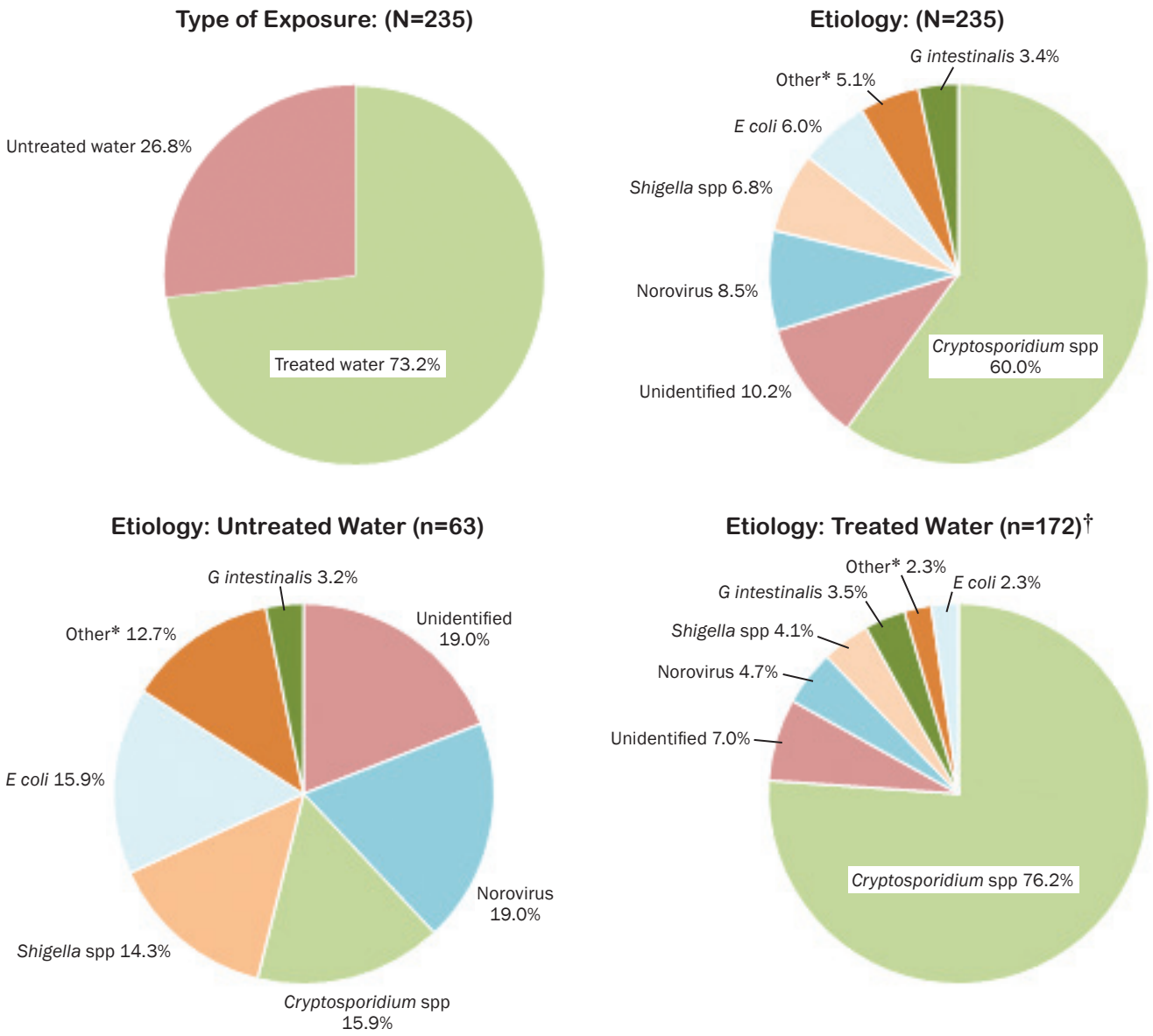

Figure 2. Recreational water-associated outbreaks of gastroenteritis, by type of exposure and etiology – United States, 2001-2010. Data from CDC (http://www.cdc.gov/healthywater/surveillance/recreational/figures.html).

*Other includes outbreaks caused by *Salmonella*, *Campylobacter*, *Plesiomonas*, cyanobacterial toxin(s), or multiple etiologies.

†Sum of percentages does not total 100.0% due to rounding.

splash pads. In response to these shortcomings, the document is currently being updated by the US Army Public Health Command. The proposed updates to *TB MED 575* refer to the Model Aquatic Health Code (MAHC)[3] for information on design, construction, operation, and maintenance of recreational facilities not addressed in the current version.

The MAHC was developed by CDC through a national partnership approach as a guidance document for state and local agencies to use as a model of public health standards for swimming pools and other aquatic facilities. However, like *TB MED 575*, the MAHC does not address nonrecirculating splash pads. The CDC elected to remove language regarding nonrecirculating splash pads from the draft MAHC. Based on comments received from the public, primarily through local governments, the general concern with nonrecirculating splash pads appeared to be economic.[3]

In addition to *TB MED 575* and the MACH, military installations must comply with Executive Order 13123[9] when installing splash pads. Under that order, military installations will reduce water consumption and energy

use throughout the installation to reach goals established by the installation. Under the Army's Net Zero initiative, Army installations are focused on limiting use of freshwater resources and returning water to the same watershed in an effort to preserve the ground and surface water resources.[10]

Generally, most designs for military installation buildings and facilities are based on Department of Defense (DoD) Unified Facilities Criteria:

> Unified Facilities Criteria documents provide planning, design, construction, sustainment, restoration, and modernization criteria.[11]

Unfortunately, design, operation, and maintenance documents containing specific guidance have not been created for recirculating and nonrecirculating splash pads.[11]

Design Recommendations

In order to limit the occurrence of waterborne illnesses and ensure the health and safety of Soldiers and families, military installations should follow the following design recommendations:

- Use the best available water source.
- Use and maintain the best available technology for water treatment.
- Consider energy and water sustainability measures.

To ensure installations are using the best design recommendations, installation medical treatment facility (MTF) preventive medicine (PM) personnel should have oversight of the design of the splash pads.

A study by de Man et al[12] found that higher concentrations of *E coli* have been measured at splash parks using rainwater or surface water as compared to sites using potable water, independent of the routine inspection intervals and disinfection method used. To mitigate such risk, Army installations should use potable water. Any other alternative sources of water use would be subject to applicable state law.

Untreated or inadequately treated water at splash parks may allow waterborne pathogenic organisms to survive and infect users. Best available technology water treatment can remove and/or destroy these organisms. For example, while cryptosporidium cysts are resistant to chlorine, ultraviolet (UV) is an effective best available technology. Recirculating splash pads should have treatment that includes pH adjustment, filtration (sand or cartridge), UV, and chlorination. Water treatment systems should be Underwriter Laboratories Listed and incorporate chemicals listed by NSF International (NSF)/American National Standards Institute (ANSI) Standard 60, and NSF/ANSI Standard 61 components or equipment in contact with potable water.[13,14] Nonrecirculating facilities should consider booster chlorination when the background level of free available chlorine from the public water system is not to recreational water standards. Higher levels of disinfectant will sanitize the splash pad which is often used interactively by the youngest, highest at-risk population. Highly chlorinated water may require dechlorination before discharge to sanitary sewers or to a stormwater detention ponds in accordance with local and/or state governing authorities. Not properly maintaining or using water treatment equipment in accordance with standard or standing operating procedures and/or manufacturer's specifications can result in waterborne illness outbreaks, such as the outbreaks in New York in 2005[15] and Idaho in 2007.[7]

Health considerations and safety practices must be incorporated into the design during planning of a splash pad on an installation. To that end, it is important to seek advice from representatives of the installation PM staff. When feasible, planners will also include morale, welfare, and recreation representatives during concept discussions and planning charrettes. In addition to ensuring that splash pad designs take into account health and safety concerns, installation planners should consider energy and water conservation measures.[16]

In accordance with multiple Army requirements, MTF PM personnel provide technical assistance and support on the requirements and methods of water conservation.[17] Recirculating systems use more energy at the facility (for booster pumping), but conserve more water overall than one-use, pass-through potable water splash parks. They also eliminate the extra energy cost of supplying more water to a nonrecirculating system. Variable frequency drive pumps are typically more energy efficient than standard pumps and should be included as a design element, even though the initial cost may be higher. Also, instead of dumping filter backwash and underground recycle water from recirculating systems, the installation could further conserve overall water use by collecting, storing, and pumping such water to irrigation systems. Some states have reuse standards which must be satisfied before reclaimed water can be used. Overall, when possible, all splash pads should be recirculating to conserve water in accordance with federal executive orders and water conservation mandates of DoD and the Department of the Army.

Best Management Practice Recommendations

After design and construction, military installations should properly operate and maintain the facility, conduct baseline audits and routine inspections, and

perform quality assurance monitoring to ensure Soldiers and families continue to enjoy splash pads without risk of illness. The installation MTF PM personnel should continue to have oversight on splash pads after construction to ensure such best management practices are employed and health risks are minimized.

The health and safety of children using splash pads depends largely on the operation, maintenance, and inspection of the facility. It is important that trained personnel such as lifeguards and pool operators who are responsible for the water play areas understand their role in protecting child health and safety. The personnel responsible for the splash pads should be trained to conduct inspections and how to handle contamination by bodily fluids, especially blood, excrement, and vomitus. Preventive medicine personnel should assess environmental and public health planning considerations, including but not limited to capacity (number of children allowed per square foot), daily water use, chemical requirements, seating, shade, drinking fountains, restroom and diaper changing access, foot and body showers, signage, trash receptacles, and safety and security concerns.

It is important that all installation organizations involved in oversight of splash pads, including but not limited to the directorate of public works; installation safety office; morale, welfare, and recreation; installation housing; and MTF PM personnel, have a clear understanding of inspection and maintenance program procedures and requirements, including child safety requirements in the outdoor play area. Water quality monitoring and maintenance of water treatment equipment is essential. Without clear guidance and current regulations, installations should follow the same procedures for sanitary control and operation of other recreational facilities outlined in *Army Regulation 420-1*,[18] *Technical Manual 5-662*,[19] and *Technical Bulletin MED 575*.[2]

Unfortunately, splash pads are not often inspected by state or local health authorities or MTF PM personnel. An inspection program is necessary to identify hazards and ensure deficiencies are corrected. The MTF personnel should perform preopening, annual, baseline, and routine sanitary inspections on all splash pads, recirculating and nonrecirculating, located on the installation, whether or not the state or local health authorities perform inspections. Nonrecirculated pools are typically unregulated and therefore not included in any sanitary inspection. They are also more likely to be operated by untrained personnel. Although risk for illness appears to be greatest at recirculated treated systems, safety and health issues could quickly become a rapidly escalating public health problem if personnel operating nonrecirculated splash parks do not handle incidents of animal or human bodily fluid contamination appropriately. Therefore, sanitary inspections should also include nonrecirculating splash parks. Further, the draft update to *Technical Bulletin MED 575*[2] assigns to MTF PM the responsibility to ensure state and/or local public health jurisdictions are aware of and have access to privately owned water recreational facilities and/or public natural swim areas. It should be reemphasized that state and local health authorities do not always come onto military installations to conduct these inspections, making it even more important that MTF PM personnel conduct the sanitary inspections on a regular basis.

Children will inadvertently or intentionally drink water emitted from water features at a splash pad. Water quality records should be regularly reviewed by MTF PM who should also perform quality assurance sampling representative of the quality of water coming from the water features, including pH, free available chlorine, presence/absence of coliform, and heterotrophic plate count. Particularly in the case of recirculating systems, heterotrophic plate count monitoring can be used as a tool to optimize treatment and ensure water use efficiency.

Army regulations and guidance are currently available or being updated to address recirculating splash pads. However, there is still no regulation or guidance that addresses nonrecirculating splash pads. While nonrecirculating splash pads may inherently be less of a risk for contamination, there is still a risk of contamination because individuals responsible for the facility may be untrained in sanitation practices when a contamination event occurs (ie, blood, fecal). Furthermore, nonrecirculating splash pads, even if less costly to maintain, are not in compliance with Federal, DoD, and Department of the Army mandates to conserve water. To ensure installations are properly maintaining the correct operations and maintenance of already existing recirculating and nonrecirculating splash pads, there must be clear regulation and guidance standards. The MTF PM personnel should be involved with the installation planners on the design of all splash pads and continue to maintain oversight of the splash pads during operations to ensure the health and safety of Soldiers and their families.

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Fluoridating Army Community Water Systems in the US Army Public Health Command Region-West Area of Responsibility

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All government-owned Army community water systems (CWSs) serving a population larger than 3,300 should be optimizing fluoridation, in accordance with Department of Defense (DoD) and Department of Army directives. Existing privately-owned CWSs serving Army installations are instructed to fulfill this fluoridation requirement as circumstances allow. All future water utilities must meet the fluoridation requirements.[1,2]

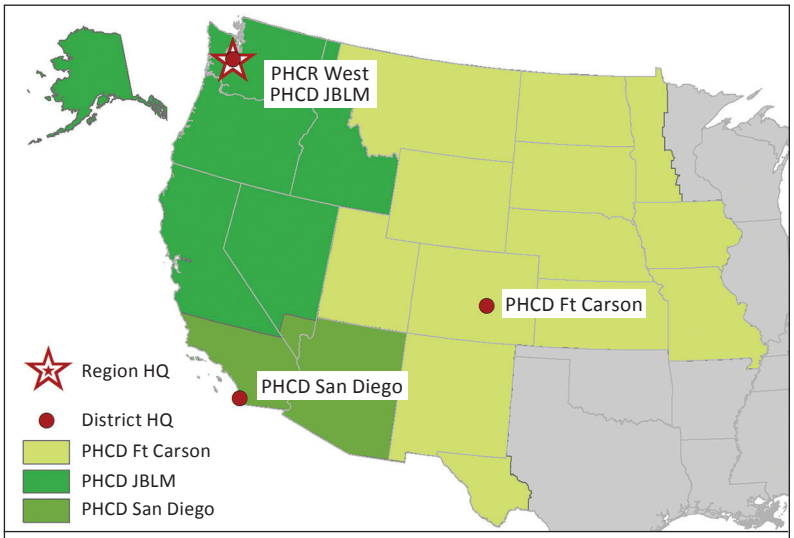

Figure 1. Map illustrating the US Army Public Health Command Region-West Area of Responsibility and its 3 districts. Note: PHCR indicates Public Health Command Region; PHCD indicates Public Health Command District; JBLM indicates Joint Base Lewis-McChord; HQ indicates headquarters.

In the Public Health Command Region-West (PHCR-West) Area of Responsibility, shown in Figure 1, none of the CWSs serving more than 3,300 people that adds fluoride does so at optimal levels, based on 2013 water quality data reported in annual consumer confidence reports (CCRs).* However, some CCR data appear to be incomplete for CWSs practicing fluoridation. Some CCRs do not include annual water treatment plant fluoridation minimum and maximum levels, nor do most include average annual value or running annual average value. Evaluation in this article is based solely on CWSs in the PHCR-West Area of Responsibility.

Background

Fluoride is a naturally occurring compound derived from fluorine. It is found in rocks, soil, and both fresh and ocean water. Though a nonessential nutrient in the human diet, fluoride is present in varying levels naturally in almost all foods and beverages (Figure 2). It is a tasteless, odorless, and colorless element added to drinking water to protect the public from dental caries (cavities), although some areas in the United States and other countries naturally have high levels of fluoride.[3]

Some communities in the United States and some countries have elected not to fluoridate CWS supplies. In the last few years, Portland, Oregon, and Wichita, Kansas, have rejected fluoridation.[4,5] This past August, Israel stopped mass fluoridating its drinking water due to potential health concerns.[6] There are also a number of alternative fluoridation practices that are practiced whether or not CWSs are fluoridated, including medical supplementation and dental treatments. For example, some countries have introduced fluoridated edible salt which is conceptually similar to iodized salt.[6,7]

The US Public Health Service and the Centers for Disease Control and Prevention (CDC) began, in 1945 and 1975 respectively, tracking the number of persons in the United States receiving fluoridated water. According to the CDC, in 2012 approximately 79.6% of the US population, or a total of 210,655,401 people, had access to fluoridated water.[8] Water systems that add fluoride to their potable water supply are regulated by the Safe Drinking

*Federal regulation requires public water suppliers that serve the same people year-round (community water systems) to provide consumer confidence reports to their customers by July 1 annually. These reports summarize information regarding sources used (rivers, lakes, reservoirs, aquifers), any detected contaminants, and compliance and educational information.

Water Act (SDWA) (Pub L No. 93-523, 88 Stat 1660 (1974)). Fluoride levels in these systems must be monitored daily and reported monthly to state agencies with SDWA primacy. The SDWA also requires all CWSs to report fluoride levels in the annual CCRs,[9] This article uses data in these CCRs to analyze compliance with fluoridate level mandates and optimum fluoride guidance.

Benefits and Concerns

> Fluoridation of community drinking water is a major factor responsible for the decline in dental caries (tooth decay) during the second half of the 20th century. The history of water fluoridation is a classic example of clinical observation leading to epidemiologic investigation and community-based public health intervention. Although other fluoride-containing products are available, water fluoridation remains the most equitable and cost-effective method of delivering fluoride to all members of most communities, regardless of age, educational attainment, or income level.
>
> Centers for Disease Control and Prevention[10]

Studies have shown that fluoridating water in CWSs, the food supply chain, and bottled water can reduce caries in nonfluoridated communities. However, there are risks involved in the use of fluoride. A major concern with CWSs treating with fluoride is that an intentional misuse or unintentional overfeed can result in consumer overexposure to fluoride, and too much fluoride exposure can lead to dental fluorosis (mottled teeth), bone loss, and even death (Figure 3). Additionally, according to the EPA:

> Exposure to excessive consumption of fluoride over a lifetime may lead to increased likelihood of bone fractures in adults, and may result in effects on bone leading to pain and tenderness. Children aged 8 years and younger exposed to excessive amounts of fluoride have an increased chance of developing pits in the tooth enamel, along with a range of cosmetic effects to teeth."[10]

Some proponents, including the Fluoride Action Network, Citizens for Safe Drinking Water, and some medical and environmental professionals, do not consider fluoridation of drinking water supplies necessary, and equate adding fluoride to CWS supplies to be a form of mass medication. In 2007, the Fluoride Action Network reported more than 4,000 medical and environmental professionals have signed a petition urging an end to the fluoridation of CWS.[11,12]

Furthermore, reports from the CDC and the National Research Council indicate fluoride effect is predominantly posteruptive (teeth after surfacing) and topical, not systemic.[13,14] Several Journal of Public Health Dentistry studies indicate similar findings, namely that the benefits of fluoride are topical and that intake has more of an effect on dental fluorosis than on preventing cavities.[15-17] These studies challenge the proponent benefits of fluoride exposure through drinking water.

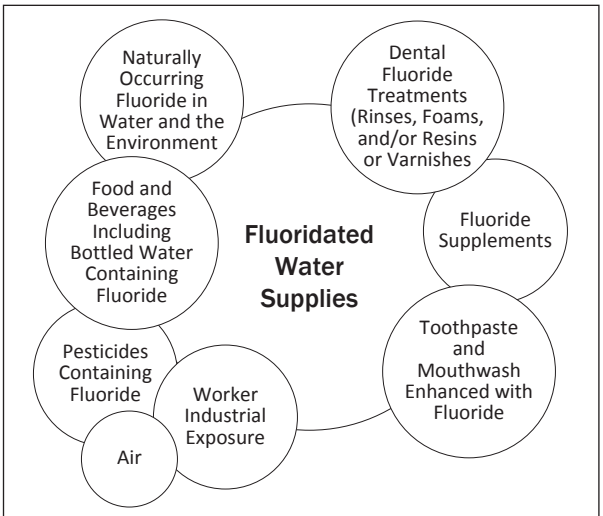

Figure 2. Illustration of the sources of fluoride in the environment, both natural and manmade.

Despite concerns regarding water fluoridation, the majority of public health officials have concluded that water fluoridation at optimal levels is safe and effective. Past US Surgeons General have endorsed water fluoridation and encourage communities to add fluoride to the optimal level for oral health. The American Dental Association, the CDC, the American Medical Association, the American Water Works Association, and the World Health Organization, as well as many state and local public health agencies, all advocate fluoridation of CWSs.[18-20]

There is a significant difference between fluoridated and nonfluoridated CWS. Fluoridated communities show 18% to 40% fewer caries among children and nearly 35% fewer in adults than those living in nonfluoridated communities. Also, fluoridation is very cost-effective

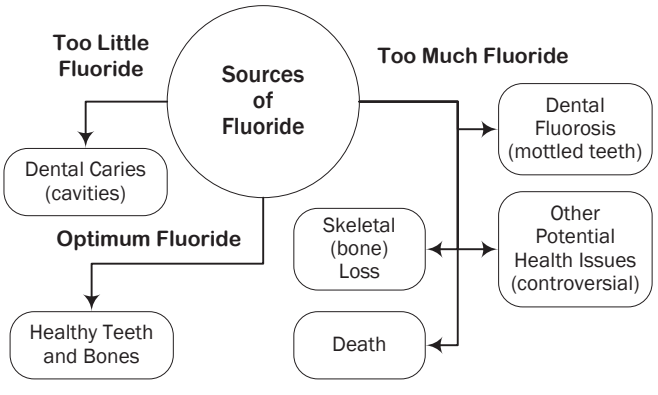

Figure 3. The physiological effects of each of the 3 general levels of ingested fluouride: insufficient, optimum, and excessive.

for most large communities. Drinking water costs to consumers increase by less than 1% for large CWSs, and up to $3.90 a year per person for small communities (2004 dollars). Every dollar spent on water fluoridation avoids $38 in dental treatment costs.[21]

CWS Drinking Water Fluoridation Regulations

The EPA and the majority of states do not mandate fluoridation, and fluoridation when practiced is strictly regulated by state and local health departments. Furthermore, approval to add fluoride, or make any modification to a public water system generally requires state drinking water agency approval.

Under the SDWA Amendment of 1986, the EPA set a maximum contaminant level goal (MCLG) and a maximum contaminant level (MCL) for fluoride at 4.0 mg/L for drinking water for public water systems. The MCLGs are unenforceable health goals, based solely on possible health risks and exposure over a lifetime with an adequate margin of safety, whereas the MCLs are enforceable standards set as close to MCLGs as considered feasible based on factors such as available analytical methods, treatment technologies, and cost. For fluoride, the EPA's MCL equals the MCLG because no feasibility factors pose any limitations. States, however, may set more restrictive drinking water quality standards. California standards, for example, are more stringent; the public health goal (MCLG) is 1 mg/L and the MCL is 2 mg/L.[22-24] In addition to the MCL and MCLG, the EPA has also set a secondary maximum contaminant level (SMCL) standard of 2.0 mg/L. The level of the SMCL for fluoride is based on a balancing of the beneficial effects of protection from tooth decay against the undesirable effects of excessive exposures leading to discoloration.[4,25] The federal regulations establishing the respective fluoride standards for drinking water are shown in Table 1. A variance in treatment may be granted in accordance with 40 CFR §142.61[26] if the EPA or the appropriate state authority determines the treatment method to control fluoride is not "technically appropriate and technically feasible" for a CWS.

For SDWA public notification, a CWS with a source that exceeds the fluoride secondary MCL of 2.0 mg/L but does not exceed the fluoride primary MCL of 4.0 mg/L must provide notice in accordance with the form, manner, timing, distribution, and content requirements of 40 CFR §141.208.[30,31] In accordance with 40 CFR §141.203(b) under Tier 2 public notice requirements, water suppliers must notify their customers as soon as practical, but no later than 30 days after the system learns of the violation.[31,32] Fluoride in excess of 4 mg/L is a major violation and would require the water supplier to take action to reduce fluoride levels below the MCL in addition to the issuance of a Tier 2 public notice in most states. In California, a Tier 2 violation occurs when fluoride is in excess of 2 mg/l (California's MCL).[22-24]

Table 1. Federal Safe Drinking Water Act Fluoride Drinking Water Standards.

Standard	Fluoride Level (mg/L or ppm)	Regulatory Citation
Secondary MCL	2.0	40 CFR §143.3[26]
MCLG	4.0	40 CFR §141.41(b)[27]
MCL	4.0	40 CFR §141.62(b)[28]

MCL indicates maximum contaminant level.
MCLG indicates maximum contaminant level goal.

The regulating authority with primacy must be consulted to determine the appropriate resolution for violations that result from fluoridating public water systems operating outside the optimal range. For example, if a water system in California operates 0.1 mg/L or more above the control range, up to 10.0 mg/L, the water supplier must notify the California Department of Public Health (CDPH) within 3 business days. If the fluoride overfeed exceeds 10.0 mg/L, the water system must notify the CDPH by the end of the same business day, or within 24 hours if the office is closed. Water suppliers must notify the consumers, local health departments, pharmacists, dentists, and physicians in the area served by the water system of the status of fluoridation treatment when fluoridation is suspended and when fluoridation is resumed following 90 days of suspension.[33]

Bottled Water Fluoridation Regulations

Sales of bottled water have nearly tripled in the last decade.[34] Many individuals who drink bottled water are replacing tap water, either partially or completely, as a source of drinking water. And while some bottled waters marketed in the United States contain an optimal concentration of fluoride, whether naturally or added, not all do. Thus, individuals substituting a bottled water source for fluoridated CWS tap water may be receiving the full benefits of CWS fluoridation. Additionally, bottled water does not have the same rigorous sampling and consumer right-to-know requirements as CWSs.[35] This is just one of the key differences between SDWA drinking water regulations promulgated by the EPA, and the US Food and Drug Administration's (FDA) Bottled Water Rules.

The EPA and the FDA have a memorandum of agreement, originally signed in 1979, specifying that the EPA regulates safe drinking water in accordance with the Safe Drinking Water Act, and that the FDA regulates bottled water as a consumer beverage under the Food, Drug, and Cosmetic Act (21 USC, Chp 9 §301 et

Table 2. Bottled Water Maximum Fluouride Content (based on where the bottled water is sold).

Annual Average of Maximum Daily Air Temperature (°F)	No Fluoride Added (mg/L or ppm)	Fluoride Added (mg/L or ppm)
53.7 and below	2.4	1.7
53.8-58.3	2.2	1.5
58.4-63.8	2.0	1.3
63.9-70.6	1.8	1.2
70.7-79.2	1.6	1.0
79.3-90.5	1.4	0.8

Note: The values in this table do not take into account the US Public Health Service proposal that optimum fluoride levels be set at 0.7 mg/L when fluoride is added. Furthermore, the maximum permissible level for annual average maximum day temperatures below 63.8°F for nonfluoridated bottled water exceeds the secondary maximum contaminant level for drinking water under the Safe Drinking Water Act. Specifically, if this same water came from a CWS water tap, public notice would be mandated. This is an example of more stringent standards for CWS drinking water than for bottled water.

seq (1938)).[36,37] Water is classified as "bottled water" if it meets all applicable federal and state standards, is sealed in a sanitary container, is intended for human consumption, and has no added ingredients except that it may optionally contain safe and suitable antimicrobial agents.[38]

For water bottled in the United States, FDA regulations require that fluoride be listed on the label only if the bottler adds fluoride during processing. The concentration of fluoride is regulated but does not have to be stated on the label. Few bottled water brands have labels listing the fluoride concentration. The FDA has approved labeling with the statement, "Drinking fluoridated water may reduce the risk of dental caries or tooth decay," if the bottled water contains from 0.6 mg/L to 1.0 mg/L and is not for infants.[36,39]

The allowable values for fluoride added and naturally occurring fluoride levels for bottled water are established in 21 CFR §165.110[38] and are a function of ambient temperature (Table 2). The FDA standards of quality state that domestic bottled water with no added fluoride may contain between 1.4 and 2.4 mg/L of fluoride, depending on the annual average daily air temperatures at the location where the bottled water is sold, which exceeds not only optimal levels, but the SDWA secondary MCL level for fluoride. Domestic bottled water with added fluoride may contain between 0.8 and 1.7 mg/L, again depending on the annual average daily air temperatures where the bottled water is sold. Imported bottled water with no added fluoride may not contain more than 1.4 mg/L of fluoride, and imported bottled water with added fluoride may not contain more than 0.8 mg/L of fluoride.[39]

Military Requirements for CWS Fluoridation

Noting that "the most effective preventive program for preventing dental decay is water fluoridation," a Memorandum from the Assistant Secretary of Defense (Health Affairs) dated July 18, 2011, directed all DoD facilities operating a water system that serves more than 3,300 personnel to provide optimal fluoridation and ensure ongoing education for DoD water treatment plant (WTP) personnel with appropriate surveillance by state and local health officials.[2] This requirement was reiterated and expanded to include both existing and future privatized water systems on all DoD installations by a Memorandum from the Under Secretary of Defense (Acquisition, Technology, and Logistics) dated March 18, 2013.[1] The *Unified Facilities Criteria 3-230-03*[40] further emphasizes the fluoridation requirement of DoD water treatment systems serving 3300 people or greater. Treatment systems serving fewer people will be considered on a case-by-case basis.

Army Regulation 40-35[41] requires commanders of US Army medical activities and US Army medical centers to provide water quality reports that include fluoride concentration to the dental activities, dental clinic commands, or dental unit commander (or designated representative) on at least a quarterly basis. The dental readiness officer will then interpret the results regards to fluoridation treatment on children and adults and provide expert guidance on fluoride practices to health care providers, water engineers, and preventive medicine personnel. *Army Regulation 40-35* also states the condition when the fluoridation of post water supplies should occur is when "the level of natural fluoridation is less than one-half the optimal concentration for that climate," and "the fluoridation process is otherwise considered practical and feasible."[41] When natural fluoridation exceeds acceptable levels, defluoridation measures should be considered. Other regulations that mention CWS fluoridation requirements include *Army Regulation 40-3*,[42] *Army Regulation 40-5*,[43] and *Army Regulation 600-3*.[44]

Specific guidance for preventive medicine (PM) personnel can be found in *Department of the Army Pamphlet 40-11*.[45] Accordingly, PM personnel provide drinking water medical oversight and technical assistance support to fixed Army installations that produce or purchase drinking water from another regulated supplier. Under this guidance, when either the initiation or discontinuation of fluoridation is sought, the action should receive approval from the functional proponent for PM. Preventive medicine responsibilities include review and recommendations for concentration and type for any chemical additive, including fluoride, to a potable water system.

Table 3. The US Army Recommended Fluoride Levels in Drinking Water.

Annual Average of Maximum Daily Air Temperature (°F)	NIPDWR Recommended Control Limits Fluoride Concentrations in mg/L (maximum allowable)			
	Low	Optimum	Upper	Maximum Contaminant Level
50.0 to 53.7	1.1	1.2	1.3	2.4
53.8 to 58.3	1.0	1.1	1.2	2.2
58.4 to 63.8	0.9	1.0	1.1	2.0
63.9 to 70.6	0.8	0.9	1.0	1.8
70.7 to 79.2	0.7	0.8	0.9	1.6
79.3 to 90.5	0.6	0.7	0.8	1.4

Source: *Technical Bulletin MED 576*[50]

Note: The values in this table precedes the finalization of the Safe Water Drinking Act. It is based on the National Interim Primary Drinking Water Regulations. *Technical Bulletin MED 576* is being revised by the US Army Public Health Command.

What is Optimal Fluoridation?

In 1962, the US Public Health Service established the "optimal level" for fluoride content in drinking water to be in the range of 0.7 to 1.2 mg/L.[46] In 1994, a World Health Organization committee suggested a level of 0.5 to 1.0 mg/L, depending on the climate.[47] In January 2011, the US Department of Health and Human Services published a proposal recommending that water systems practicing fluoridation adjust their fluoride content to 0.7 mg/L, as opposed to the previous temperature-dependent optimal levels ranging from 0.7 to 1.2 mg/L.[47,48] This revision was aimed at minimizing the chance that children develop dental fluorosis, a typically mild condition that causes a discoloration of the teeth. It was also based on more updated studies that shows a lack of association between daily temperature and children's water intake such as the one conducted by the CDC's Division of Oral Health, National Center for Chronic Disease Prevention and Health Promotion that used data ranging from 1999-2004.[49] The earlier, temperature-dependent guidance is still the standard for most states and/or local jurisdictions, as well as the Army in *Technical Bulletin MED 576*,[50] shown in Table 3.

Since the late 1970s, the CDC has provided guidelines and recommendations for fluoridated water supplies to help water systems maintain appropriate concentrations. The last revision to these guidelines was published in 1995 and is average ambient temperature-based (Table 4). Because it may be difficult to maintain an exact level of fluoride at a WTP, the CDC recommends a control fluoride range of 0.1 mg/L below to 0.5 mg/L above optimum.[51] As an example, if the optimal level for a state is 0.8 mg/L, the control range would be 0.7 to 1.3 mg/L. This varies from state to state. The state of Washington, for instatnce, has established a range of 0.8 mg/L to 1.3 mg/L.[52] Therefore, the WTP operator should consult with state or local water fluoridation program for specific requirements.

Community Water Systems should maintain fluoride concentrations in drinking water at optimal levels to achieve effective caries prevention and to avoid measurable changes in the prevalence and severity of enamel fluorosis that can occur with changes in fluoride concentration as low as 0.2 mg/L.[53] The benefits of water fluoridation decline as the concentration falls below optimum. As it exceeds 2.0 mg/L, there is very little additional tooth decay prevention benefit and a greater potential for fluorosis.[54]

Fluoride Overfeeds

Although the risk of overfeeds has declined, inherent risk is still present to this day. Between 1976 and 1992, the CDC documented 15 cases of nationwide fluoride overfeed events. Of the 15 total cases documented, 6 episodes were from CWSs and 9 involved school water supplies. The root cause identified was mechanical failure in 6 cases, electrical failure in 3 cases, and operational/installation error in the remaining 6 cases. In 1993, an overfeed event occurred causing acute fluoride poisoning in Mississippi. This event was due to a faulty feed pump that allowed saturated fluoride solution to siphon from the solution tank to the ground reservoir.[55] The 1995 CDC Engineering and Administrative Recommendations for Water Fluoridation have recommendations for a CWS to follow in the event of an overfeed.[51] However, state primacy regulations and guidance should always take precedence in the event that an SMCL or MCL is exceeded.

One recent overfeed occurred on a military installation. On April 28, 2010, fluoride levels at Joint Base Elemendorf-Richardson (JBER), Alaska, were found to

Table 4. Optimum Fluoride Levels and Operational Variability.

Annual Average of Maximum Daily Air Temperature (°F)	Optimum Fluoride Level (mg/L or ppm)	Recommended Control Range (mg/L or ppm)
50.0 to 53.7	1.2	1.1-1.7
53.8 to 58.3	1.1	1.0-1.6
58.4 to 63.8	1.0	0.9-1.5
63.9 to 70.6	0.9	0.8-1.4
70.7 to 79.2	0.8	0.7-1.3
79.3 to 90.5	0.7	0.6-1.2

Source: Centers for Disease Control and Prevention[51]

Note: The data in this table is the current standard. The current US Department of Health and Human Services proposal of an optimum level of 0.7 for all of the United States is not ambient temperature dependent.[46,48]

be excessive.[56,57] They exceeded the EPA's MCL for a period of 40 hours; the water was not declared safe to drink until 2 days later.[57] According to the 2010 CCR, the fluoride injector malfunctioned and the highest fluoride daily level was 19.8 ppm, exceeding the MCL/MCLG for fluoride.[58] According to JBER Air Force Bioenvironmental Engineering,

> the excess fluoride levels were caused by human error when a fluoride injection feeder control was adjusted improperly. Within hours the excess fluoride was detected by the operator in charge at the WTP and immediate action was taken to notify JBER residents of the issue while activating a response team effort to flush the water distribution mains and individual services.[59]

Fluoridation did not resume operation until December 1, 2010, after a number of administrative and physical controls were implemented to correct the problem and prevent reoccurrence.

Fluoridation Status of Contiguous United States Army Installations with Community Water Systems

A 1993 study by the US Army Medical Department (AMEDD) Center and School showed that 70 military installations reported 58 water systems (8 within the PHCR-West AOR) with fluoride levels within the optimum range (0.7 to 1.2 mg/L or ppm), 16 water systems with fluoride levels below 0.7 mg/L, and 3 water systems with fluoride levels above 1.2 mg/L. Two of the 70 military installations had treatment systems to defluoridate.[60] The study reported only one day of sampling in 1993 for each installation and civilian water source, with the one exception of the Fort Bliss installation sample that was collected in 1991. On the one day in 1993 examined in the study, 8 of the 11 areas served in the PHCR-West AOR were within optimal fluoridation levels.[60]

There are 19 installations with 22 active CWSs in the PHCR-West AOR. Of these 22 CWSs, only 15 CWSs (8 government-owned and 7 privately-owned) serve more than 3,300 people. Most of these installations add fluoride, a few have naturally high fluoride levels, and two need defluoridation (one serving a population less than 3,300). Most of the installations that fluoridate based on CCR data appear to be suboptimally fluoridating, meaning the water system operators are keeping fluoridation levels below 0.7 mg/L, as shown in Table 5. Only 2 of these CWSs (one privately-owned and one government-owned at Fort Bliss, TX) are within the optimal fluoride ranges based on the CCRs reviewed, both of which are due to naturally occurring background levels.

Based on its annual CCRs, one government-owned CWS (serving Fort Irwin, CA) continually violates the state and federal MCL for fluoride for one of its water distribution systems that currently does not have a WTP to remove naturally occurring excessive fluoride (and arsenic). This installation is the only one within the PHCR-West AOR that reports the annual average fluoride level provided to military personnel and families. However, this installation has also been ordered to do so to be in compliance with the SDWA by the California Department of Public Health for excessive fluoride since 2012.[9] A second reverse osmosis WTP is currently under construction with a projected date to be in operation in 2016.

Fluouride levels considered suboptimal according to the CDC's 1995 guidelines and recommendations (Table 4) appear to be the most common problem in the PCHR-West AOR for Army CWSs that fluoridate. This assessment is based on fluoride ranges reported in the 2013 Army CWS annual CCRs published in 2014. In our opinion, the method of data reporting may be problematic.

One government-owned CWS (serving Fort Leonard Wood, MO) CCR indicated that only the highest measured fluoride level was reported, 0.75 mg/L in 2013, and 2.5 mg/L in 2012, the latter of which exceeds the secondary MCL. According to the installation drinking water program compliance manager, those were the only reported values provided by the state laboratory. Those values were from grab samples—single samples taken which are not necessary indicative of the state of fluoridation of the water system. According to this installation, the surface water WTP provides 98% of the installation's water and is within the operating range of 0.8 to 1.2 mg/L, the optimum being 1.0 mg/L. They also report these are typical operating levels for the WTP process, although on occasion levels can fall outside of this range.[45]

A privately-owned CWS (serving Fort Leavenworth, KS) indicates suboptimal fluoridation on its CCR, but these data are based only on 4 quarterly samples collected for regulatory purposes. According to the company's utilities manager, the operational goal for fluoride is 0.7 mg/L. They measure daily at the WTP and once per week in the distribution system.[3] This CCR data may also not be sufficient for reporting to the medical and dental community.

One privately-owned CWS (serving JBER, AK) that fluoridates its drinking water supply exceeded the secondary MCL of 2.0 mg/L in 2013 and the MCL of 4.0 mg/L in 2010, based on its CCR records. The 2010 MCL exceedance was due to an accidental overfeed of the chemical caused by a fluoride injector malfunction.

Obviously, suboptimal fluoridation levels on installations directly affect the benefits of fluouridation for residents on those installations. However, an even larger potentially affected population may be those service personnel and families who do not live on military installations. Depending on the community in which they reside, they may or may not have access to fluoridated water. For example, both CWSs serving Joint Base Lewis-McChord (JBLM) in Washington closely maintain optimal fluoridation based on 2013 annual water quality data. However, according to Washington State Department of Health Drinking Water Program data, among the communities nearby JBLM, only the cities of Fircrest and Tacoma fluoridate their drinking water supplies. Other CWS in serving nearby communities do not, including but not limited to the cities or towns of Dupont, Gig Harbor, Lacey, Olympia, Lakewood, Puyallup, Steilacoom, and Yelm where many JBLM soldiers and their families reside.[62]

Table 5. Flouride Levels in PHCR-West AOR of Community Water Systems Serving More than 3,300 People.

Installation or Facility	Number of Regulated CWS		1993 Report Data		2013 CCR Data	
	GO	PO	Level (mg/L)	Optimally Fluoridated	Range (mg/L)	Optimally Fluoridated
Fort Wainwright, AK		1	1.12	Yes	0.29-0.69	No (low)
Joint Base Elmendorf-Richardson, AK		1	0.63	No	0.2-2.08	No
Fort Hunter Liggett, CA	1		0.3	No	Not reported	No (low)
Fort Irwin, CA	1		0.55	No	RO: 0.3-3.3 Avg. 1.06 Other DW: 2.4-16 (Avg. 8.75)	No
Ord Military Community, CA		1	1.00	Yes	ND-0.25	No
Fort Carson, CO		1	1.20 and 0.54	Yes	0.13-1.36	No
Fort Leavenworth, KS		1	0.98	Yes	0.4-0.56	No
Fort Riley, KS	1		0.98	Yes	0.51-0.58	No
Fort Leonard Wood, MO	1		1.08	Yes	0.75 (High)	Yes
White Sands Missile Range, NM	1		Not reported	N/A	0.4 (High)	No
Fort Bliss, TX: Main Post (MP), Biggs Army Airfield (BAAF), East Biggs (EB)	1	2	0.8 and 1.08	Yes	MP: 0.954-1.04 BAAF: ND-1.30 EB: 0.76-0.80	MP: Yes BAAF: No EB: Yes
Joint Base Lewis-McChord, WA	2		1.10 and 1.10	Yes	0.38-1.29 and 0.4-1.4	No
TOTAL	8	7	0.3-1.20	Yes: 8 of 11	Low: ND High: 16	Yes: 2 of 12

Sources: Army Medical Department Center & School study, 1993[60]; EPA drinking water database[61]; 2013 PHCR-West AOR community water system community confidence reports distributed in 2014.

Glossary

CWS – community water system
GO – government-owned
PO – privately-owned
RO – reverse osmosis
DW – domestic water
ND – nondetectable

Conclusion and Recommendations for Future Action

The report from the 1993 AMEDD study indicated most installations were at or near optimum fluoridation, but the data was only for single, specific date in time. The 1993 AMEDD report concluded:

> The dental fitness officer and/or community health dental hygienist need to carefully review the fluoride status of post drinking water and advise the preventive medicine officer if the concentration is not within the optimal range.[60]

An annual conference for all dental fitness officers and community health dental hygienists was also recommended to provide updates on the most current preventive dentistry techniques. A conference or other training application would be valuable to ensure dental caregivers remain current regarding the wide variety of fluoridation methods now available and proposed new fluoride optimal standards.

The Assistant Secretary of Defense (Health Affairs) Memorandum of July 18, 2011[2] included the results of a survey* of the level of fluoride in drinking water at DoD installations in the United States. The survey, which used CCR data, indicated that many CWSs that fluoridated were within optimal fluoridation ranges. In contrast, the 2013 CCRs reported within the PCHR-West AOR in 2014 indicate suboptimal fluoridation for privately-owned and government-owned CWSs providing water to installations serving more than 3,300 people. However, inconsistencies in the methodologies used by water utilities and/or installations in obtaining and reporting fluoridation data raise questions of the validity of the conclusions.

Ultimately, drinking water below optimal fluoridation levels will reduce the effectiveness of water fluoridation,

*The survey conducted by the Pew Charitable Trusts and the Tri-Service Center for Oral Health Studies examined CCRs for 189 water systems on 158 military installations.

while those supplies above optimal levels may contribute to dental fluorosis. Both scenarios should be considered by medical and dental personnel when prescribing fluoride supplements or when the effects of fluoride overexposure (eg, dental fluorosis) are observed. Therefore, it is important that dental and medical personnel are knowledgeable about fluoridation on and off installations.

Installation preventive medicine departments should encourage government-owned CWSs (via the chain of command) to optimally fluoridate in accordance with DoD and Army directives, and ensure fluoride information in annual CCRs includes the running annual average (RAA). If this data is not reported in the CCR, the preventive medicine department should collect this data directly from WTP records, and/or sample for fluoride as part of its drinking water quality assurance monitoring. It is not necessary for preventive medicine personnel to measure fluoride throughout the distribution system unless there are multiple treatment entry points, as fluoride does not dissipate in a distribution system like disinfectants such as chlorine.

Military personnel and military families can request copies of the latest CCRs from their local water utility or the environmental division of the installation's department of public works if residing on the installation. The CCRs, if prepared correctly, should include the natural fluoride found in sources required to be sampled with other organics, but should also include the operational range of fluoride (ie, low and high), along with a RAA for all CWSs that add fluoride. The RAA should be at or near 0.7 mg/L for optimal fluoridation based on the most current published guidance, although most local and state standards still fall within the 0.6 to 1.7 mg/L range depending on the locality if still based on the ambient temperature recommendations.

Although fluoride overfeeds are rare, the 2012 overfeed at JBER shows that due diligence in design, operation, and management is still important. Fluoride system design, operation, and maintenance, including water quality records, should be assessed during preventive medicine water system sanitary surveys, and water/sanitation assistance visits. State primacy agencies will also be evaluating fluoridation treatment systems and practices during SDWA water system sanitary surveys. The US Army Public Health Command should provide fluoridation design, operation, maintenance, and reporting details in the next update to *Technical Bulletin MED 575*,[63] as well as adopt the most current US Department of Health and Human Services recommendation for optimal fluoride.

For any drinking water supply with excessive fluoride levels, other sources of drinking water should be considered, especially for children in teething forming years. Individuals can use bottled water that is lower in fluoride content. Individuals can also install point of use reverse osmosis filters in their homes. These filters should be NSF International/American National Standard Institute (ANSI) for Drinking Water System Components - Health Effects (Standard 61) certified for fluoride removal.[64]

Since consumption of bottled water has been on the rise, medical and dental personnel should consider it as well. Depending on the brand and type of bottled water, it may or may not contain optimal fluoride levels. Like CWS drinking water supplies, bottled water may have suboptimal or excessive fluoride levels. The FDA regulations allow higher levels as described above. It is always best to check with the manufacturer's website.

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Tick-borne Disease Surveillance

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Tick-borne diseases (TBDs) represent some of the world's most rapidly expanding arthropod-borne infectious diseases.[1(p1)] In the United States, ticks are responsible for more human disease than any other arthropod group. The incidence and the number of pathogens transmitted by ticks are increasing. For example, Lyme disease is now the most commonly reported arthropod-borne illness in the United States.[2] Anaplasmosis, ehrlichioses, and rickettsioses are also on the rise.[1(p1)] In most parts of the world, TBDs are potentially serious health threats to troops, civilian employees, and residents at military installations.[2(p6)] Companion animals and military working dogs (MWD)are also at risk in areas where ticks and TBDs are endemic or emerging.

Risk of TBD increases with the introduction of exotic tick species into new areas and the expansion of historical tick ranges. One example of exotic ticks that effects the United States is *Boophilus annulatus* and *B microplus*, also known respectively as the cattle fever tick and the southern cattle tick, that were imported here by Spanish colonists who brought tick-infested cattle and horses with them. These ticks transmit a severe disease to cattle called Texas fever or cattle fever that caused enormous losses to the US cattle industry in the past. Present efforts to keep this tick out of the United States exist as the Cattle Fever Tick Eradication Program.[3] Nilgai antelopes, native to India, Nepal, and Pakistan, that were released into southern Texas are also hosts to the cattle fever ticks, posing a threat as maintenance hosts of cattle fever.[4] There are many other examples of exotic tick introductions from migratory birds, exotic and wildlife species, and domestic animals.[5]

Changes in climate may also alter the geographic distribution of tick vectors, and in turn, cause a change in the currently recognized demographic patterns, seasonality, and incidence of TBDs.[1(p61)] For example, the range of the Gulf Coast tick (*Amblyomma maculatum*) has historically been along the Gulf of Mexico and southern Atlantic coast as far north as South Carolina, and extending approximately 100-150 miles inland. However, resident populations of these ticks are now established in Arkansas, Oklahoma, and Kansas,[6] and they have been collected on the east coast as far north as Delaware and Maryland.[7] Another example is the lone star tick (*A americanum*) which has moved northward as far as Maine and westward into central Texas and Oklahoma.[8] Incidental introductions of these ticks, and the diseases they carry beyond endemic regions, occur with increasing frequency. This is likely due to the feeding of immature ticks on migrating birds, and the transportation of tick-infested livestock and wildlife into new areas.[6] These introductions may also come from pets belonging to people who move from one area to another.

In addition, suburbanization has contributed to the increase in TBD transmission in North America by bringing people and their pets close to ticks and by creating new tick habitat.[9] In the northeastern United States, the highest risk for Lyme disease occurs around the homes of those who have been infected.[10] As communities continue to expand into tick habitat, and people are encouraged to enjoy outdoor recreation and pursue activities such as urban farming, the risk for peridomestic exposure to ticks and TBDs may increase.

The National Notifiable Disease Surveillance System (NNDSS) of the Centers for Disease Control and Prevention (CDC) maintains a list of diseases that are considered to be of public interest by reason of their contagiousness, severity, or frequency. The 7 TBDs on the NNDSS list are shown in the Table.

Many of these diseases, which are caused by closely related tick-borne pathogens, can also be acquired internationally. There are also many TBDs that can be acquired abroad that do not occur in the continental United States. In addition to transmitting disease, ticks can cause irritation, pain, and swelling at attachment sites, otoacariasis (invasion of the auditory canal), paralysis, allergic reactions, and anaphylactic reactions.[11] Heavy infestations of ticks on animals can cause debilitation due to blood loss.

Direct effects from TBDs include troop and MWD morbidity and mortality. There are also many indirect effects, such as illness of dependents or Department of Defense (DoD) civilian personnel, and related healthcare costs. Both types of effects can be mitigated through aggressive surveillance, public education, and

Tick-borne Diseases Listed in the National Notifiable Disease Surveillance System.

Disease	Agent	Vector	Symptoms	US Region
Anaplasmosis	*Anaplasma phagocytophilum*	*Ixodes scapularis, I pacificus*	Fever, headache, muscle pain, chills, malaise, nausea/abdominal pain, cough, confusion, rash (rare)	Northeastern and upper midwestern states, northern California
Babesiosis	*Babesia microti, B. divergens, B. duncani*	*Ixodes* spp	Fever, fatigue, headache, body ache, chills, nausea, loss of appetite	Northeast and upper midwest
Lyme Disease	*Borrelia burgdorferi*	*Ixodes scapularis, I pacificus*	Fever, fatigue, headache, chills, muscle and joint aches, swollen lymph nodes, erythema migrans (red, expanding rash)	Northeast and upper midwest
Ehrlichiosis	*Ehrlichia chaffeensis, E. ewingii, E. muris-like*	*Amblyomma americanum*	Fever, fatigue, headache, muscle aches	Southeast and south-central US from the eastern seaboard extending westward to Texas.
Spotted Fever Rickettsiosis	*Rickettsia rickettsii, R. parkeri, R. philippi*	*Dermacentor andersoni, D variabilis*	Fever, fatigue, headache, muscle aches, eschar at bite site, rash	Throughout the US but primarily in North Carolina, Oklahoma, Arkansas, Tennessee, and Missouri
Tularemia	*Francisella tularensis*	*Dermacentor andersoni, D variabilis, Amblyomma americanum*	Fever, fatigue, headache, swollen and painful lymph glands, ulcer, chills	Tularemia has been reported from all states except Hawaii, but is most common in south-central states, the Pacific northwest, and parts of Massachusetts
Powassan Disease (Deer tick virus)	Powassan virus lineage I & II	*Ixodes* spp	Fever, headache, vomiting, weakness, confusion, loss of coordination, speech difficulties, seizures	Northeastern states and the Great Lakes region

prevention/control programs, together with prompt diagnosis and treatment.[2(p6)]

Tick Biology and Disease Transmission

Ticks are grouped into 2 separate families. Family Ixodidae, also called hard ticks, have 4 developmental stages: egg, larva, nymph, and adult. The latter 3 each take one large blood meal and then molt to the next stage, or lay eggs in the case of the adult. Hard ticks have mouthparts with recurved teeth that allow them to firmly anchor themselves to hosts while feeding with the assistance of a cement-like substance secreted by the salivary glands. This allows them to feed for extended periods of time that can vary from 2 to 12 days or longer, depending on species, life stage, and gender. Family Argasidae, also called soft ticks, have the same 4 developmental stages, but most have multiple nymph stages. Soft ticks have mouthparts that allow them to hold fast to their host, as hard ticks do, but they do not secrete cement. Although some soft ticks can remain attached to the host for several days,[11(p501)] others can complete a meal within minutes to hours.[12] This is still much longer than other blood-sucking arthropods such as mosquitoes, and is one of the factors that contribute to their high vector potential because it increases the likelihood of pathogen ingestion and allows them to secrete large amounts of host-derived fluid and salivary secretions, which contain pathogens, back into the host.

Other factors that make ticks efficient disease vectors include a highly sclerotized body that protects them from environmental stresses, high reproductive potential, and a long life span (compared to other blood feeding arthropods). Although the majority of TBDs are transmitted during normal feeding activity, they can be transmitted by other routes as well, including through regurgitation and feces. Argasid ticks can also release pathogens through excess liquid excreted from the coxal glands located adjacent to the first segment (coxa) of the front legs.[11(p512)] Adding to their efficiency as vectors, the larvae and nymphs are very small. The presence of an immature tick on a host often goes unnoticed, enabling the tick to feed to repletion and drop off without detection, which increases the likelihood of pathogen transmission.

Ticks can also transmit more than one pathogen at a time. For example, *Ixodes* ticks can simultaneously or sequentially infect their hosts with *Borrelia burgdorferi*, *Anaplasma phagocytophilum*, and *Babesia microti*.[1(p61)] Co-infections with these pathogens have been reported from wild and domestic animals, including dogs, as well as humans. These infections can result in more severe and longer illnesses and can complicate diagnoses.[1(p493)]

Ticks are also effective disease reservoirs. In some species, pathogens can be transmitted from the adult female to its offspring (transovarial transmission) and from one developmental stage to the next (transstadial transmission). Infected ticks can also transmit viruses to uninfected ticks while feeding simultaneously on an uninfected host.[11(p512)] Therefore, they can maintain and transmit infections even if they have not fed on an infected host.

Surveillance

Surveillance is the process of determining the presence of vectors and pests, estimating their general population levels, and determining if pathogens of concern are present in the population. It gives quantifiable data on which to base control and education programs and is the starting point in the prevention of any arthropod-borne disease. The analysis and interpretation of information gained from surveillance is the basis for developing quantitative and qualitative risk assessments that can be used to predict the occurrence of pest outbreaks or vector-borne diseases.[13(p7)] Various methods can be used to describe disease risk. One commonly used index is called the Entomologic Risk Index (ERI), an indicator of the number of infected ticks that a person might come into contact with over a set distance. The ERI is calculated as the number of infected ticks collected over a 1,000-meter drag (described below). Accurate ERIs are obtained by testing ticks for pathogens to determine tick infection rate. Public health officials can use indices like the ERI in public education efforts and to determine if, when, and what control measures should be implemented.[13(p7)]

Information on vector quantity, type, and infection rates obtained from environmental sampling can be combined with human case data to help predict risk of acquiring vector-borne diseases. Ticks are active year round in some of the warmer areas of the continental United States. In fact, 31% of the ticks received at US Army Public Health Command (USAPHC) Region-West between the years 1944 and 2013 were collected in the months of November, December, January, and February. Therefore, surveillance and pathogen testing should occur throughout the year.

Surveillance Types

Surveillance for ticks and TBDs can be accomplished both actively and passively. Public health personnel who go into the field to collect ticks directly from animals or brush, as described in the following paragraphs, are conducting active surveillance. Passive surveillance depends on the voluntary submission of ticks to public health entities for identification and pathogen analysis. Passive surveillance also includes the gathering of TBD data from sources such as the *CDC Morbidity and Mortality Weekly Report*,[a] the *USAPHC Vector-borne Disease Report*,[b] or the *Armed Forces Health Surveillance Center Medical Surveillance Monthly Report*.[c] This type of passive surveillance is important as it can give military public health personnel a rough picture of tick and pathogen presence or activity in a broad area. No single surveillance method can give a complete picture of TBD risk; therefore, it is important to employ as many techniques as possible.

[a] http://www.cdc.gov/mmwr/

[b] http://phc.amedd.army.mil/whatsnew/Pages/PeriodicPublications.aspx

[c] http://www.afhsc.mil/

Surveillance Methods

Tick Drags. Tick drags are typically constructed of a one meter square sheet of light colored, soft material, such as muslin or flannel. A 1.2 meter dowel is attached to the leading edge of the material to keep it spread apart as it is pulled through the tick habitat and a two meter cord attached at both ends of the dowel can be used to pull the drag. Tick drags are conducted by passing the cloth over likely tick habitat, with the goal of collecting ticks that are questing (seeking a host). This method collects representative samples of Ixodid ticks present, and generally mirrors the actual exposure that a person might experience in a given area.

Tick Flags. Tick flagging is similar to tick drags. A flag is made by attaching a one meter square piece of cloth to a stick or dowel so that it resembles a flag. The flag is then waved back and forth under, in, and over vegetation or leaf litter, taking advantage of those areas where ticks are most likely to quest for their preferred host.

Tick Walks. A tick walk is accomplished by walking in a sampling area and collecting ticks that cling to the walker. This is the best estimate of the tick threat to humans. Precautions must be taken when using this method to protect the walkers. Coveralls should be worn with tube socks pulled over the leg openings and wrist openings sealed with tape. Coveralls and socks should be white or some other light color in order to better see any ticks that may be crawling on the clothing.

Traps. Traps vary in design. Their basic construction consists of a collecting device that attracts ticks using carbon dioxide. Effectiveness of this method differs by species. For instance, *A americanum* may be collected effectively with this method. *Ixodes scapularis*, on the other hand, are slower moving and are not effectively collected using traps.[2(p29)]

Wildlife Trapping and Examination. Various methods are used to collect ticks from wildlife hosts. Ticks can be removed from harvested deer that are brought to check stations during hunting season. This method allows for the collection of both the tick for testing for pathogens, as well as blood and tissue from the deer. Small mammals, including mice, chipmunks, voles, and ground squirrels are primary hosts for immature stages of ticks and can be trapped and then examined for ticks. Small mammal trapping, while labor intensive, is the most

sensitive method to detect immature stages of ticks and to detect pathogens in host populations. Small mammal host tissues or blood samples may be collected to determine if pathogens are circulating in wildlife reservoirs. Nesting material can also be placed in Berlese funnels (traps used for extracting arthropods from soil and litter samples) to extract ticks.

Ticks Collected at Veterinary Treatment Facilities. Ticks removed from pet dogs, stray animals, and MWDs can enhance public health surveillance because they can be tested for animal and human pathogens that may circulate in the area. Pets often frequent the edges of trails or wooded areas and may come in contact with tick-infested habitats more often than people. They may, therefore, play an important role in bringing disease-transmitting ticks into close proximity to their owners or handlers. Pets and MWDs are compliant and easily sampled. In addition to dogs, horses can be hosts to ticks that can transmit disease to humans. Clearly, surveillance of domestic animals may assist in determining whether TBD is present. Common commercial tests, such as TickChek (TickChek LLC, East Stroudsburg, PA), Lyme-Aid (Lyme-Aid, East Stroudsburg, PA), and ProTickMe (Mainely Ticks Inc, Sanford ME), can determine infection with several common TBDs. There is some evidence that canine tick infestation precedes the onset of human tick-related health events and could possibly be a useful sentinel for human diseases.[14] Moreover, owners are often motivated to have their animals tested. Most military bases have veterinary support that can coordinate on- and off-base surveillance. When dogs are brought in for examination, ticks should be collected and forwarded to public health entities for identification and pathogen testing. This type of surveillance can be facilitated through the use of preconstructed submission kits. The kits include instructions on how to submit a tick, a collection container (such as a plastic vial), a standardized submission form, and a preaddressed padded envelope for shipment.

Ticks Collected From People. Ticks removed from people can be sent to the USAPHC Army Institute of Public Health Entomological Sciences Program through the DoD Human Tick Test Kit Program, which is a free tick identification and testing service for DoD healthcare facilities. More information can be found at the Human Tick Test Kit Program web site.* Care should be taken to remove ticks promptly and properly to prevent infection with TBD, to ensure mouthparts are not left in the skin, and to allow for tick identification and testing. The proper methods to remove ticks are listed in the inset.

*http://phc.amedd.army.mil/topics/envirohealth/epm/Pages/HumanTickTestKitProgram.aspx

Importance

The geographic ranges of many tick species are expanding, and the serious diseases transmitted by ticks are becoming more common.[15] Due to overlapping tick and host ranges, this expansion may also lead to more co-infections and areas with multiple pathogens and vectors. As previously discussed, co-infections are not unusual and can result in more severe illness than infection with a single pathogen.[1(p243)] In the United States alone, TBDs produce tens of thousands of illnesses every year, many of which are severe and result in hospitalization, long-term illness, disability, and death.[1(p155)]

Tick surveillance is the starting point for effective TBD prevention. Surveillance establishes species and densities of tick populations present in a given area, and provides data for establishing the potential TBD risk. This data provides leaders, preventive medicine personnel, pest management professionals, and individuals the information they require to promote proactive measures, including behavior change such as using personal protective measures and avoiding tick habitat, and tick-targeted strategies (tick checks or tick population reduction measures)[1(p155)] to prevent TBDs.

Tick surveillance will be most effective when multiple entities are involved. The USAPHC personnel can visit installations and collect ticks. Given the limited scope of this method, it alone will not be sufficient to accurately assess the risk of TBDs. Limited budgets also make this a less than cost-effective way to address TBDs. Local entities, most notably from installation preventive medicine and veterinary personnel, should make efforts to augment the work currently performed by USAPHC personnel. For example, Public health Command Region-West (PHCR-W) personnel collected ticks from 8 installations during 2014 while only 2 installations

Proper Tick Removal

Do:

Use fine-tipped tweezers to grasp the tick as close to the skin as possible, then pull straight out with a slow, steady motion. This will ensure the mouthparts do not break off in the skin.

Wash the wound after removal and apply antiseptic.

Do Not:

Squeeze or smash the tick.

Burn the tick.

Cover the tick with petroleum jelly, sport creams, alcohol, nail polish, or any other substance.

collected and sent a significant number of ticks. If all of the installations within our 20-state region would collect and send ticks for analysis, the knowledge of TBD risk in the region would be greatly improved.

Analysis of TBDs should be expanded to include all tick species that are considered vectors as well as the pathogens they transmit because the epidemiology of newly emerging TBDs is not well known. For example, in 2008, the first human infection with *Rickettsia* 364D was confirmed in a patient from northern California.[16] Illness caused by this pathogen is now a reportable disease under the California Code of Regulations Title 17.[17] It is also listed on the CDC web site as a source of Rickettsial infections.[10] Because *R rickettsii* (the causative agent of Rocky Mountain spotted fever) is rarely identified in human-biting ticks in CA, it has been suggested that *Rickettsia* 364D, provisionally named *Rickettsia phillipi*, is responsible for many of the illnesses in this region that resemble and are misdiagnosed as Rocky Mountain spotted fever.[18(p671)] *Dermacentor occidentalis*, the Pacific Coast tick, is the vector of *Rickettsia* 346D and occurs throughout California and in parts of Oregon. Both immature and adult stages of this tick are relatively indiscriminant feeders and will readily bite humans.[19] *Rickettsia* 364D has been detected in up to 11% of *D occidentalis* from 8 California counties.[16(p542)] Without diligent surveillance and pathogen testing, changes in tick distributions and the risk of acquiring TBDs will remain unknown, especially for newly emerging TBDs.

Two other recent examples of newly described, emerging TBDs include Heartland virus[20] and *Ehrlichia* muris-like infection. The *Ehrlichia* muris-like organism was isolated from *I scapularis* ticks during an outbreak investigation in Wisconsin in 2009.[21] Previously, only *Ehrlichia chaffeensis* and *E ewingii* were thought to cause tick-borne Ehrlichiosis in humans in the US, and neither is endemic in Wisconsin or Minnesota. When patients in these states, without travel to endemic areas of the United States, began to present to their healthcare providers with symptoms of Ehrlichiosis and were further investigated, blood samples submitted for polymerase chain reaction (PCR) screening identified the previously undescribed *Ehrlichia* species. Field surveys and retrospective testing of *I scapularis* ticks further established that *Ehrlichia* muris-like is present in tick and wildlife populations.[22,23]

In 2012, Heartland virus became the first phlebovirus associated with human infection described in the United States.[24] Two hospitalized patients with a history of exposure to lone star ticks, *A americanum*, presented to hospitals in northwestern Missouri in June 2009. Both patients, males over 55 years-old, presented with fever, fatigue, anorexia, nausea, low white-blood-cell count, low platelet count, and elevated liver enzymes. The patients were thought to have Ehrlichiosis, but failed to improve upon treatment with antibiotics. Further blood tests including PCR, sequencing, and electron microscopy eventually identified the causative virus as Heartland, which is classified as a distinct virus, but phylogenetically similar to the severe fever with thrombocytopenia syndrome virus. In 2012, ticks were collected from 12 sites including both patients' farms, and infection rates in *A americanum* nymphs were found to range from 0.47 to 3.91 infected ticks per 1,000 throughout the tick season. These examples highlight the importance of TBD surveillance as the collaboration between the medical, laboratory, and public health entomology communities led to the discovery early in the course of disease emergence of both of these pathogens.

Public Health Command Region-West conducts surveillance and testing for military installations in the western region of the United States including Missouri, Minnesota, Iowa, and parts of Texas and was the first governmental agency to detect Lyme disease from ticks or rodent biopsies in Santa Barbara and San Louis Obispo County, California. Once the detection techniques for Lyme disease were perfected, PHCR-W expanded its capabilities to test ticks and rodent tissue for other TBDs to include *Ehrlichia chaffeensis, Anaplasma phagocytophilum*, and Spotted Fever group *Rickettsias*.

We have since detected *Ehrlichia* from 4 installations in Missouri and *A phagocytophilum* in Minnesota and California. Several *Rickettsia rickettsia* and *Ehrlichia chaffeensis* tick pools were detected among ticks from dogs at Fort Leonard Wood, Missouri, in 2011. These surveillance activities have led to installation awareness and TBD risk assessments at numerous installations. Several installations have mandated briefings to field sanitation teams, environmental science officers, medics, and leaders prior to training operations in tick habitat to increase awareness and personal protective measures needed to minimize the transmission of TBDs.

The surveillance activities initiated by PHCR-W have also detected ticks transported on pets from other areas of the world, including German ticks on MWDs arriving at Joint Base Lewis-McCord (JBLM) and Beale Air force Base, an African tick off a tortoise in Washington state, a Missouri tick off of a MWD to JBLM, and a tick from the state of Georgia transported to Arizona during a PCS move. These examples highlight the importance of maintaining active surveillance and expanding tick testing capabilities for newly emerging TBD pathogens.

Equally important to increasing laboratory capabilities for the detection of TBDs is the assurance of reasonable but quick turnaround times for laboratory results. The public health value of any information gained from laboratory tests diminishes quickly over time. Further, customers who receive reports weeks or months after submitting specimens will be less likely to continue to make the effort to collect and send ticks to public health entities. Promptly detecting pathogens in submitted ticks is important in making determinations of the risk of TBD in military personnel, dependents, companion animals, and MWDs. It is also crucial in the planning and timing of disease control efforts, including vector control and educational activities. Public Health Command Region-West provides TBD laboratory analysis results in pathogen-specific reports that include tick collection data (species, site, collection date), laboratory analysis findings (positive or not detected), and recommendations on continued surveillance.

The prevention of TBDs is based on personal protective measures, landscape and environmental measures, and preventive treatments to ensure that infected ticks do not bite people or animals.The determination of disease risk and the employment of environmentally and economically sound tick control methods effectively result from TBD surveillance. Possibly of even greater importance, information acquired through tick surveillance can bolster public education and improve the awareness and health literacy of the military community regarding TBDs. Properly informed and aware personnel make more intelligent decisions about activities that put them at risk of TBD exposure and the personal protective measures that can be taken to reduce that risk. Clinical, preventive medicine, veterinary, pest management, and Army Public Health Command personnel must work cooperatively to improve the knowledge of tick species distributions and the incidence of the diseases they transmit. Liaisons with these entities and with state and local public health departments should also be established.

Conclusion

Ticks are one of the major vectors of disease that threatens military personnel, families, and civilian employees on US military installations.[25] The presence of tick-borne disease in military personnel, including our military working animals, may result in the loss of training days, decreased force strength, and may adversely affect unit readiness and effectiveness. Tick-borne disease also affects DoD civilians and the families of our troops. Soldier and unit readiness may be affected when family members and companion animals are sickened by TBDs. The information gained from tick surveillance regarding tick vectors, disease incidence, and pathogen prevalence is invaluable. It allows medical personnel to educate personnel regarding tick-bite and TBD recognition and prevention. Tick surveillance information also enables leaders to make decisions regarding the application of safety and control measures during training and operations to prevent TBDs. As with any disease, prevention of TBDs is highly preferable to treating the short- and long-term consequences once they occur.[1(p155)]

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Managing Your Differential Diagnosis List: Considering Bias and Recognizing Unexpected Infectious Agents

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Many recent veterinary school graduates will recall 2 pieces of advice; "when you hear hoof beats, think horses, not zebras," and "the simplest explanation is usually the correct one." In any medical field, these "tidbits" are crucial to keeping providers' differential diagnosis list concise and making sure it is prioritized correctly. When teaching new veterinary or medical students, it is logical that one should not spend as much time on diseases that they are less likely to see in practice. For example, veterinary students outside of the Pacific Northwest may only learn about Salmon Poisoning Disease (SPD) in the theoretical sense as they may never see a case during their studies, let alone treat a patient while in school. SPD is a disease caused by the bacterium *Neorickettsia helmintheoca* which is carried by the fluke, *Nanophyetus salminocola*. The fluke is found most classically in salmon, which is why the disease is so common in the Pacific Northwest. Thus, veterinary students in that area will be far more likely to see and treat the disease while in school than their colleagues in other locations. It causes a sudden onset of vomiting, diarrhea, decreased appetite and lethargy, and is often fatal without appropriate treatment.[1] The importance of this geographic bias is illustrated by the experiences of a recent Veterinary Corps officer (VCO) at Joint Base Lewis-McChord (JBLM) who saw a 3-year-old female spayed Labrador presenting for vomiting, diarrhea, and decreased appetite of about 5 days duration. The VCO considered the typical differentials; foreign body, gastroenteritis, infectious causes, nongastrointestinal signs, but did not consider SPD as she went to school in another area and was thus unfamiliar with the disease. Luckily a senior clinician at the clinic brought SPD to the VCO's attention. The diagnosis was confirmed and the dog was treated successfully. This example serves as a reminder to clinicians that geographical bias can preclude the correct diagnosis.

Army VCOs must ensure they account for their regional biases when seeing patients. Due to the international and mobile nature of the Department of Defense and its members, these geographic "zebras" are even more likely to walk into our exam rooms. Recognizing and addressing these biases is important, not only for treating the individual patient but also for general public health. Many of the diseases discussed below are communicable and potentially zoonotic. When we are asking questions about a pet's history and performing our physical exam, we must recognize our own biases and remind ourselves to use a problem-oriented approach to our patients. In doing so, we can remind ourselves that while those biases might be valid in certain situations, they may hinder an accurate diagnosis in another. Furthermore, we must consider diseases that are endemic in the patient's previous geographic location or areas to which the pet may have traveled. Remembering our biases and considering travel will help practitioners manage their differential diagnosis list.

Recognizing Bias and Uncovering "Zebras"

As explained above, certain diseases are not discussed in detail at veterinary schools in different geographical locations because they are absent or have a very low prevalence which may lead to a basic geographical bias preventing us from considering different causative agents. Veterinary clinicians may leave certain diseases off of their differential diagnosis list because they have not considered travel (whether international or within the United States). This travel may be by the presenting animal, disease vectors, owners, or other domestic and wild animals with which the patient had contact. Failure to account for this geographic bias may result in numerous diseases not considered, although those diseases could be the cause of the patient's clinical signs.

One source of bias is failure to account for the international movement of humans and animals from areas with different endemic diseases. For example, rabies has been around for thousands of years and has great public health significance, but it is often not included on differential diagnoses lists for neurologic canine patients within the United States. International travel allows rabies to enter new geographic regions, and should make it mandatory to include on the differential diagnosis list for any animal with neurologic symptoms. The canine rabies virus variant, associated with dog-to-dog

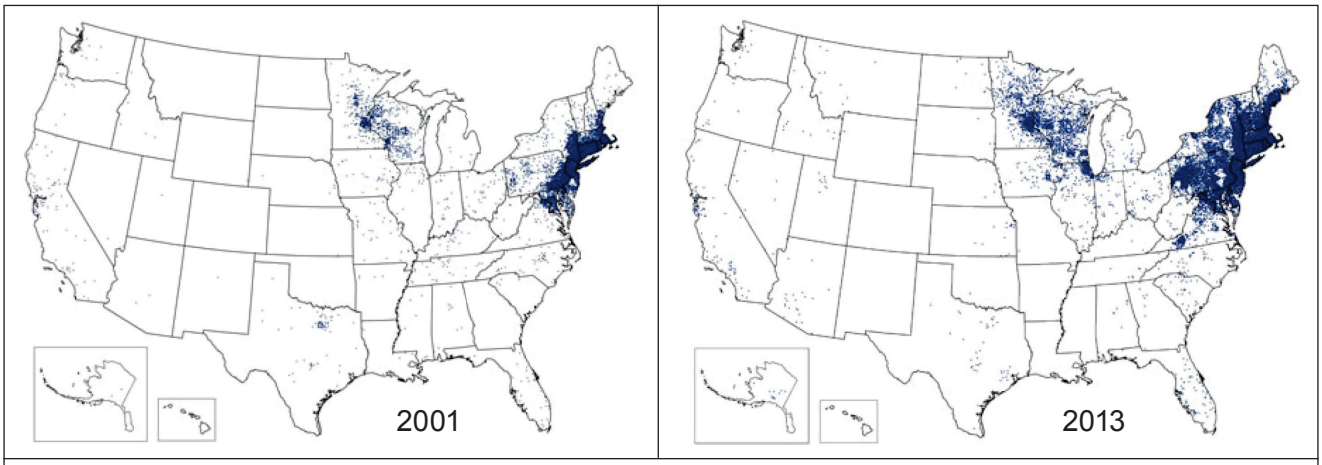
transmission, is most often responsible for the estimated 55,000 human rabies virus deaths worldwide each year.[2] By contrast, there were 5,000 rabid dogs reported in the United States in 1950. That number was down to 79 in 2006, when the canine rabies virus variant was declared eradicated in the United States.[3] Today, rabies is well controlled in the United States due to effective and readily available vaccines along with stray animal control. Consequently, when presented with a neurologic case in the United States, many clinicians may not initially consider rabies as a possible differential. However, recent events have served as reminder to the military importance of rabies. This disease is enzootic in the Middle East where many of our Soldiers deploy. Unfortunately, Soldiers may not understand why they are not allowed to keep stray dogs as pets; the stray dog may remind them of home, and they are often very resentful when these "pets" are removed. In fact, there are several organizations who are dedicated to bringing these stray dogs from the Middle East to the United States, and other countries, to be reunited with the Soldiers. This action has directly resulted in at least one case of a rabid dog being imported into the United States, and the exposure of numerous American citizens to the deadly rabies virus.[4] The act of keeping pets while deployed, although against policy, has also resulted in the unfortunate and unnecessary death of a Soldier from rabies and countless others receiving postexposure prophylaxis; a treatment which can be both painful and expensive.[5] It is so important for Veterinary Corps officers and other medical providers to understand the prevalence of rabies and other endemic diseases where our Soldiers deploy, when considering differential diagnoses. This is also a concern for civilian veterinarians as they are even less likely to include foreign diseases such as rabies on a differential list, but it is possible for them to see a dog adopted from an area where those diseases are endemic. Rabies is a real possibility, even in the United States, when you consider the mobility of our population and the possibility of international travel.

But there are also other "zebras" to consider which are far more likely within the United States, but are still often overlooked due to "localized" geographical location. Lyme disease, for example, is caused by *Borrelia burgdoferi*, a bacterium carried by the *Ixodes* tick, the most common in the United States being *I scapularis* and *I pacificus*. Previously, Lyme disease has had a few endemic areas of the United States, most commonly in the northeast (by far the most common location), while also being reported with some frequency in Wisconsin, Minnesota, California, and Oregon.[6] Recent surveillance data indicates that Lyme disease is increasing in terms of reported cases, as shown in the Table.[7] A review of Centers for Disease Control and Prevention data clearly shows an expansion (illustrated in the Figure) of Lyme from those previously endemic areas to many cases in previously unaffected states as it is now present in all of the lower 48 states. Over the last few decades, Lyme disease has spread for a variety of reasons including temperature, moisture, forest cover, and population density. All of these factors were used by the Companion Animal Parasite Council to predict the spread of Lyme disease occurrence within the United States.[8] Lyme disease can present with numerous signs including fever, lameness, anorexia, lethargy, and lymphadenopathy, and may or may not present with swollen joints.[1] These general signs can make the disease somewhat challenging to diagnose. But, there are risk factors to help clinicians determine likelihood of infection. One study evaluated the potential predictive value of canine seroprevalence as it relates to human cases of Lyme disease in a given county. The study found that there was correlation between canine seroprevalence and human incidence. Specifically, the presence of Lyme in more than 5% of dogs was associated with human Lyme incidences that were above average—the median number of human cases increased by more than 20 individuals (compared to a canine seroprevalence of 1.1% to 5%).[9] However, a much earlier study (1991)[10] was not able to prove the same association between canine and human cases. (It is important to note that the studies were performed 10 years apart and on different continents, so it is possible that the predictive value of canine Lyme cases is very location-dependent.) However, the earlier study still concluded that canines are good sentinels for human cases, given that they are much more likely to come in contact with the tick vector. They are, therefore, more likely to be infected early after the vector enters their geographic location.

Chagas' disease is another example of a diagnosis that can be missed due to geographical bias, and, according to the World Health Organization, its distribution is expanding due to the movement of people from Latin American to other locations around the world.[11] It is a parasitic disease caused by *Trypanosoma cruzi* that initially presents with fever, lymphadenopathy, and hepatosplenomegaly, along with other general symptoms.[7] The protozoa are spread by the *Reduviidae* or triatomine (kissing bug). Among humans, Chagas' disease is the most common cause of congestive heart failure in the world.[12] Within endemic areas, the disease has moved from the more rural areas into cities via human migration.[13] The infection has also been shown to spread into many southern states in the United States from Georgia to California because of the high population of animals involved in the protozoa's life cycle: raccoons, opossums and canines. It is also

Cases of Lyme disease reported in the United States for each of the years 2001 through 2013. Data from Centers for Disease Control and Prevention (http://www.cdc.gov/lyme/stats/index.html).

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total Reported Cases	17,029	23,763	21,273	19,804	23,305	19,931	27,444	28,921	29,959	22,561	24,364	22,014	27,203



Geographic distribution of cases of Lyme disease reported in the United States in 2001 and 2013 respectively. One dot is placed randomly within the county of residence for each confirmed case. Data from Centers for Disease Control and Prevention (http://www.cdc.gov/lyme/stats/maps/interactiveMaps.html).

important to remember that eleven different species of the triatomine bug are present in the United States. Bern et al. noted that "there are more than 130 triatomine species in the Americas, many of which can be infected by and transmit *T cruzi*."[14] This is particularly concerning given the risk of long-term carriers with Chagas' disease. Studies have proven that a chronic phase of infection is possible in humans and they can serve as reservoirs for subsequent *T cruzi* infections.[15] It is theorized that chronically infected canines may also serve as potential reservoirs for canine and human disease transmission.[16] The US Department of Defense trains all of its military working dogs (MWDs) at Lackland Air Force Base (AFB) in San Antonio, Texas, where the disease is endemic. These MWDs are potentially exposed to Chagas' disease during training, and could serve as potential reservoirs for disease transmission at their new duty site, particularly if the MWDs are asymptomatic prior to their permanent change of station move. Multiple dogs previously located at Lackland AFB have tested positive for Chagas' antibody, and at least one MWD has died of the myocardial effects of the disease (unpublished data, Department of Defense Military Working Dog Hospital, 2014). Thus, VCOs in all areas of the United States must consider Chagas' as a diagnosis.

New or emerging diseases in certain areas of the world are also concerning given human animal and human travel. Leishmaniasis is endemic in several regions throughout the world including locations where US military personnel and animals are stationed (eg, Middle East, southern Europe).[15] A case of canine leishmaniasis was recently diagnosed at the Joint Base Lewis-McChord Veterinary Center in Washington state. The patient was a 2-year-old male mixed-breed dog who initially presented to a civilian veterinarian for inability to gain weight, lethargy, and decreased appetite. A thorough history revealed that the dog was adopted from Afghanistan. Unfortunately, no records were available as to whether the dog received a health examination by an accredited veterinarian prior to travel or whether he was healthy and free of disease at that time, though the adoption agency stated that animals are free of clinical signs prior to entry into the United States. He was started on antibiotics, but because he showed no improvement, the clients brought him to the Joint Base Lewis-McChord clinic for a second opinion. At the second presentation, he had persistent weight loss in addition to 2 mm to 5 mm white nodules around his eyes and on his muzzle. These nodules were aspirated and contents examined under microscopy where it was revealed that they contained the protozoon that causes leishmaniasis, which is an obligate intracellular parasite. The patient was started on oral medications based on case reports using the medications available. Later, the client opted to move to a civilian clinic and at last follow-up was doing very well, gaining weight, increased energy, and owner-perceived less pain.

As previously mentioned, leishmaniasis is a disease of military importance; more than 600 soldiers have been diagnosed with the cutaneous form of the disease after deployments to Iraq, Kuwait, and Afghanistan.[17] Clearly, human and animal travel is playing a role in the expanding distribution of leishmaniasis cases at diagnosis. Leishmaniasis is a disease caused by the protozoa, *Leishmania* spp and it is spread by the sand fly.[1] Numerous different species of the protozoa have been known to cause infection including *L major* and *L tropica* which tend to cause the cutaneous form, and *L infantum* and *L donovani* which cause the visceral form.[15] This has typically only been found in areas where the sand fly is established. But there is the possibility of spread without the sand-fly vector. One meta-analysis explained that dogs can spread the disease sexually or transplacentally.[18] Additionally, while direct zoonotic transmission is believed to be a rare occurrence,[19] there are phlebotomine sand files (genus *Lutzomyia*) within the United States.[20] While a competent vector has not been identified, vector-borne transmission is nonetheless theoretically possible. All of these issues mean that leishmaniasis has potential to become an issue for both veterinary and human medicine in the United States, which could pose challenges for clinicians in diagnosis and successful treatment, especially considering that medications for treatment are not readily available in the United States. Late diagnosis could therefore be catastrophic for a patient in that treatment could be delayed and insufficient.

Management of Differential Lists

How does the clinician manage a differential diagnosis list when theoretical possibilities are almost endless? The most important management tool is a thorough history. It is crucial that the clinician determines any travel history, human or animal, since all diseases discussed here are a concern for both human and animal health, and most are zoonotic. Another possibility is to recommend preventive measures for disease even when not in an area considered endemic. For example, should military veterinarians recommend a Lyme disease vaccine to all patients, even in those areas where Lyme is not considered endemic? In addition, clinicians must consider diagnostics, such as the bloodwork, imaging, or cytology that may help to diagnose a disease that may not even be on their differential list. This means considering tests that give enough information to direct later diagnostics and remembering to use the problem-oriented approach. Even basic tests such as in-house cytology can be crucial in identifying certain infectious diseases, including parasites or fungus. Finally, VCOs as well as other clinicians must maintain an open line of communication, meaning that we need to discuss cases, write case-reports, and otherwise keep our colleagues informed of new diseases within a geographic location. This will help our colleagues keep these "zebras" in mind.

In Summary

Every day, providers must manage cases based on the most likely explanation for the information presented. But, it is the responsibility of the provider to ensure that all of the needed information is attained. We are constantly biased by various factors as clinicians, including geographic location (as the examples above illustrate). Providers must ensure that these "zebras," and others like them, are always kept on our differential diagnosis list. It is also crucial to ensure that the historical information is complete and the physical exam is thorough. In truth, rabies virus must also be on the differential for a dog with unknown vaccination history with neurologic symptoms, and SPD should be on the list for any dog that is vomiting. How far up we rank them on the list of differential diagnoses depends on how thoroughly we conduct our patient histories and account for potential geographic biases. Only by doing so can we endeavor to reach the correct diagnoses in time to implement appropriate treatment.

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Fielding the Remote Online Veterinary Record, a Veterinary Electronic Health Record to Improve Patient Care and Practice Management

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Department of Defense Directive 6400.04E[1] designates the Secretary of the Army as the Department of Defense (DoD) Executive Agent for DoD veterinary public and animal health services. This directive is accomplished through the Army Veterinary Services which operates military veterinary facilities throughout the United States (including Alaska, Guam, Hawaii, and Puerto Rico), as well as in countries in Europe and the Pacific. Although these facilities are maintained to provide veterinary care to the DoD military working dogs (MWDs), but they also provide veterinary care to pets of military service members and beneficiaries, such as retirees, as mission priorities permit. While the geographic dispersion of the veterinary facilities is necessary to ensure MWDs have timely access to veterinary care, it does present challenges, particularly regarding centralized practice management.

Although all US Army veterinary facilities were using a commercial veterinary practice management software program for their patient encounters, the clinics were still reliant on paper records for patient files prior to 2014. While the reliance on paper record systems is associated with notable limitations such as difficulty transferring radiographs and laboratory results, loss of files during moves, and time-consuming data mining, it was necessary due to DoD data network restrictions like prohibition of automatic third party software updates. Additional limitations of the previous system included impaired disease surveillance, network management, and standardization efforts due to the lack of centralized data reporting. In recognition of these restrictions and limitations, the US Army Veterinary Service began exploring options for a veterinary electronic health record (EHR) in 2003.

A primary prerequisite for the program was that it be 100% web-based with no end user software installation requirement. This was particularly important as the Veterinary Service provides veterinary support for all military services, not just the Army. By stipulating a no-end user software requirement, the Veterinary Service minimized potential issues with individual military service and installation specific information technology requirements. Although not a primary requirement, the program also had to support a geographically dispersed global practice, something not typically necessary for most veterinary EHRs.

The Veterinary Service received 7 competing proposals for the original request for proposals, however, only two of them met the primary requirements. Initially, a commercial, veterinary-specific product was identified as a potential solution. However, when the product failed initial testing, the Veterinary Service sought to modify another product which had been previously developed for the military, HEALTHeFORCES (HEALTHeSTATE, LLC, Fairfax, VA). HEALTHeFORCES was the EHR for the North Atlantic Regional Medical Command from 1999 until 2004, when it was replaced by AHLTA as the DoD Enterprise System. Following its replacement, HEALTHeFORCES was transitioned for use in 43 federal and community health centers within West Virginia as HEALTHeWV,[2] strictly as an EHR with no practice management components.

HEALTHeWV was modified to make it a veterinary EHR subsequent to its selection. Four new practice management components (scheduling, inventory management, invoicing, and reporting) were added as part of the modification. The modified product was designated the Remote Online Veterinary Record (ROVR). Veterinary personnel participated in all ROVR design meetings and the software qualification test was performed by personnel from 5 different military veterinary treatment facilities and by the Veterinary Services Central Fund staff (LTC K. Burkman, ROVR Program Officer, email, October 24, 2014). The application was beta tested at 4 locations for 3 to 6 months and independently tested by the Army Medical Department Board at the

Army Test and Evaluation Center to ensure it legally met all operational contract requirements prior to full operational fielding in 2014.

The vendor was responsible for the design, development, and delivery of the training required for implementing this program DoD-wide. Initially, a plan was developed to train all personnel at a central location within each US Army Public Health Command District. However, due to funding restrictions, participation was reduced to only key personnel (ie, clinic veterinarian, senior technician, and senior receptionist) from each location being trained in a geographically tiered method at 42 different sites in a train-the-trainer approach. The goal of these training sessions was to have no more than 15 personnel at each site attending the training to maximize student-trainer interaction. The vendor created a training environment for users to practice all of the functions without creating real charges or making false medical records within the active production environment. The key personnel subsequently trained individuals who did not attend the initial training. This training was facilitated by an extensive training module incorporated within the ROVR application to be used to provide such on-site training.

The key personnel training program encompassed 5 days of hands-on learning designed to provide a general working knowledge of the program's functional capabilities. Each day was dedicated to a different aspect of the program, allowing the new users to experience the entire program prior to implementing the application within their home veterinary facility. Key aspects of the training focused on the basic functionality of the application, including scheduling and patient administration, inventory management, invoicing and financial management, data warehousing and reporting, and the capture, storage, retrieval, and reporting of clinical episodes of care.

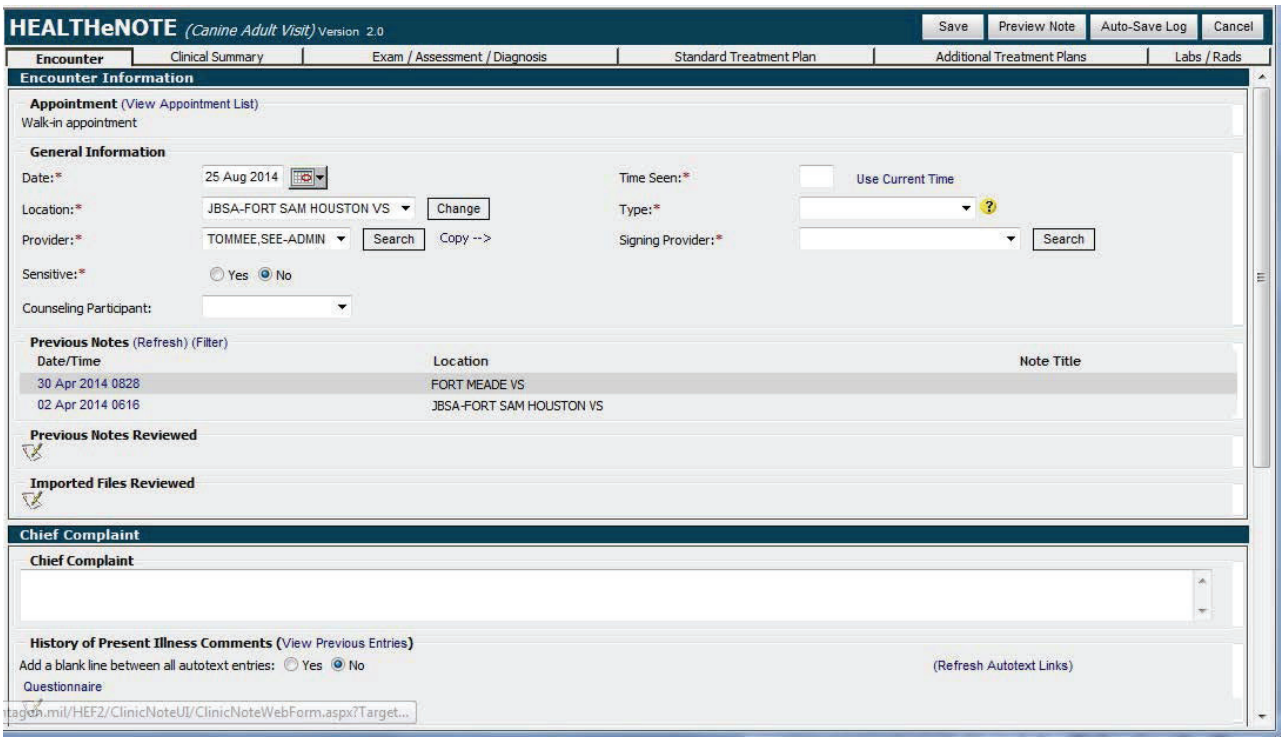
A large amount of time was dedicated to the use of the eNOTE, which is the actual medical documentation of the veterinary encounter. Within this portion of the EHR, illustrated in the Figure, the user can record all aspects of the encounter from the patient's medical history to the findings, diagnosis, and treatment. Significant time is also spent reviewing the patient registry functions in ROVR (diabetes, MWD, and screening registries) which allow users to quickly and easily monitor patient populations to ensure they are meeting specific health goals, such as food consumption, body condition, and body weight.

Veterinary facilities were required to use ROVR as their sole medical record and practice management program upon completion of the training course. Productivity goals were established to allow the clinics to initially start running at 25% of their normal capacity the first week using the program, 50% the next, 75% the third week, and be fully operational using the application by the fourth week.

Benefits of a Veterinary Electronic Health Record

Perhaps the most important, but as of yet unrealized, benefit of ROVR is enhanced disease surveillance. The Daniel E. Holland MWD Hospital at Lackland Air Force Base, Texas, serves as the DoD role 4 facility for veterinary care. It also serves as the storehouse for all MWD patient records after the animal has retired from military service into adoption, as well as the MWD serum repository. Veterinary epidemiologists have previously used these records and serum to examine morbidity and mortality trends in MWDs, including potentially zoonotic diseases.[3-5] However, the studies were often retrospective, which present limitations with regard to developing timely policies designed to limit future diseases. By contrast, veterinary EHRs have the potential to significantly improve the ability of public health personnel to identify and monitor disease trends.[6] In fact, veterinary EHRs have previously been used to examine whether companion animals can be used as sentinels for zoonotic diseases such as Lyme disease and leptospirosis.[7] With the implementation of ROVR, the Veterinary Service now has the ability to conduct similar surveillance among MWDs and also among privately-owned animals. The ROVR provides clinicians with drop-down selection menus for diagnosing their patients, as well as capturing the patient's signs and symptoms. Users can then query ROVR using keywords to compile a report. The information can be used to identify diseases affecting our pets and military working animals, as well as zoonotic diseases which may affect the service member. This allows preventive measures to be implemented in a timely manner to prevent future cases. Importantly, ROVR has the ability to not only conduct near-real time disease surveillance using case diagnoses, but can also be used to conduct syndromic surveillance as well. For MWDs specifically, the data from ROVR can be combined with the aforementioned MWD serum repository to conduct seroepidemiologic studies to not only identify cases of disease, but risk factors as well.

One of the important, realized benefits of the ROVR system is enhanced portability of patient records. All MWDs begin their military service at Lackland Air Force Base with the 341st Training Squadron where they receive care at the Holland MWD Hospital. Upon completion of their training, the MWDs are assigned to other military installations. While the majority of MWDs will spend their entire service permanently assigned



The eNOTE function within the Remote Online Veterinary Record allows providers to enter all veterinary healthcare information for a patient visit. Each data entry tab has drop-down menus to standardize entry for subsequent data queries. Providers can also create autotext scripts to facilitate routine data entry.

to their respective second installations, a small subset will be stationed at several locations during the course of their years of service. The implementation of ROVR simplified medical records transfer during MWD reassignments and should reduce accidental record losses. Additionally, ROVR will hopefully improve the timeliness and ease of MWD teleconsultations and the records review required for all MWDs to ensure they are suitable candidates for adoption. Users can also build report functions within ROVR for management and review of MWD records.

The ROVR has similarly improved record portability for privately-owned animals when their military owners are reassigned. Unlike MWDs, privately-owned animals frequently leave and re-enter the military veterinary system, increasing the likelihood for paper record loss. Now ROVR allows a more thorough and well documented medical record to be in place for each pet, potentially covering their entire lifespan instead of having just a few small snapshots of history, as was the case with the old system.

With the fielding of ROVR, the established Army Veterinary Services pharmacy and retail formulary was further standardized and uniform prices were created for all services to provide clients with consistent charges, regardless of their assignment location. Most significantly, ROVR improved practice management. It enables the electronic transmission of all financial reports directly to the Veterinary Services Central Fund (VSCF). Additionally, while each clinic still maintains individual autonomy for their appointments and inventory, the VSCF can now easily look at these items as well to help identify and correct issues in real time. For example, the Appointment Statistics Report, shown in the Table, enables the VSCF to identify not only issues related to missed or canceled appointments, but also examine whether examination rooms are maximized and if changes to staffing are needed to optimize access to patient care.

Unanticipated Issues

As with any new program, unanticipated issues appeared during the fielding. One of the most significant issues was poor connectivity between some of the outlying sites and the ROVR server. During the beta testing, a 3-ping test was conducted at each location to ensure that the network would be able to support the workload estimated for DoD-wide use of the program. Unfortunately, the predictions underestimated the actual volume of users that used the server during a typical clinic day. Another factor which further degraded connectivity was clogged bandwidth at individual sites. Several veterinary clinics shared bandwidth with the local military

Appointment statistics for US Army Public Health Command District Joint Base Lewis-McChord, June 1–30, 2014, as obtained from the Remote Online Veterinary Record.

Facility	Monthly Capacity[a]	Percentage of Capacity[b]	Kept	No Show	Cancelled by Facility	Cancelled by Owner	Clinical Encounters per Day: Mean Value
Beale Air Force Base	360	30%	109	4	5	13	5.32
Fairchild Air Force Base	24	233%	56	1	2	4	2.73
Fort Richardson	360	112%	402	28	13	78	19.61
Fort Wainwright	540	41%	219	10	8	36	10.68
Joint Base Lewis-McChord	1200	45%	542	45	1	86	26.44
Mountain Home Air Force Base	360	51%	185	7	3	17	9.02
Naval Air Station Lemoore	360	52%	186	9	1	12	9.07
Naval Air Station Whidbey Island	540	39%	212	24	9	24	10.34
Naval Base Kitsap-Bangor	540	41%	224	13	1	46	10.93
Presidio of Monterey	24	504%	121	7	0	10	5.90
Travis Air Force Base	360	79%	284	23	3	20	13.85

a. Monthly capacity is a function of the facility tier level, number of examination rooms, and expected number of days open per month.
b. Percentage of capacity = kept appointments/monthly capacity

medical treatment facilities that use AHLTA, which also requires considerable bandwidth for patient file transfers. In some locations, facilities were still using copper wire instead of fiberoptic cables. These limitations resulted in extremely long refresh times to toggle between the different aspects of the eNOTE, and occasionally resulted in application lockup at the point of entry.

In order to address this problem, the slower networks were identified and local information technology (IT) resources developed and incorporated upgrades. Fixes included upgrades to computer operating systems, better use of route and bridge space to support the clinics in the infrastructure, and installation of new fiberoptic cables. A continuous process is in place to work with all local IT departments to troubleshoot and provide better connectivity. Additional IT network solutions, discussed below, are also being examined to further improve connectivity.

Another issue that arose was the ROVRs incompatibility with Microsoft Internet Explorer (IE) 11. The ROVR was initially created to work with IE 8 and IE 9 which were the DoD standard at the time of its development. However, several installations have recently upgraded the operating systems to IE 11 which created an issue for facilities on those installations. Addressing this issue required an exemption so individual computers using ROVR would not be upgraded to IE 11 until ROVR is reprogrammed for compatibility.

Aside from network connectivity problems, some users found that the new eNOTE format required substantially more time for entry of all of the required information than did the previous record-keeping system. It is anticipated that this will improve as users gain familiarity with ROVR, especially the auto text and other time-saving features. Additionally, the program was initially designed to load smaller quantities of data in each tab of the eNOTE which required the user to toggle through several different tabs (Encounter, Clinical Summary, Exam/Assessment/Diagnosis, Standard Treatment Plan, Additional Treatment Plan, Laboratory Tests/Radiographs) to enter patient examination findings. Efforts are currently underway to develop and test a new eNOTE template in which all exam room findings will be available on a single tab. This should eliminate the data lag delays associated with switching tabs.

Issues also arose with the veterinary formulary in ROVR. Prior to ROVR's fielding, the Veterinary Medical Standardization Board had developed an approved formulary for all veterinary clinics. The most current version of the formulary was provided to the ROVR program developers, but changes were being incorporated into the formulary concurrent with ROVR development. This resulted in omission of new additions to the formulary when ROVR was initially fielded. Consequently, a clinic could not use a formulary-approved pharmaceutical which was not included in the ROVR inventory, even though it was in stock at the facility. It could only be used after it was added to the ROVR inventory in a future system update.

A ROVR help desk was created prior to launching the program to assist users with any issues that arose. Sites can submit requests to the help desk either electronically or telephonically. A configuration board subsequently reviews the request, and if approved, submits it to the vendor for implementation. The process has been fine-tuned and response tickets are now being addressed within 1 to 4 hours as opposed to the initial 8 to 12 hours. Rules

have also been created for "pass through" incidents, allowing tickets that meet certain rule to go straight to the ROVR support team for immediate resolution. Examples include tickets pertaining to creating new accounts, a user changing facilities, or inactivating accounts.

To date there have been several new builds to streamline the program and fix reported issues. As of October 2014, a majority of the missing formulary inventory items have been added for use by clinics. Another significant change is the eNOTE function now contains canine dental images to more clearly document oral issues. Additional template forms such as phone consultations are being added on a regular basis to meet user demand.

Future Directions

Although establishment of the ROVR help desk and similar efforts have helped to address many of the issues with ROVR, additional work is still necessary. For example, while the connectivity issues have been eased with upgrades to operating systems and changes to network routing, they are not yet fully resolved. In addition to the previously mentioned improvements to local network infrastructure, other potential solutions currently under consideration include development of regional servers to reduce demand on the main server and function as back-ups, and creating the ability to store patient data locally to be uploaded to the server later when a network connection would not be required.

Another improvement currently under development involves patient care in a deployed setting. The ROVR was launched for a 30-day trial in theater with the 72nd Medical Detachment Veterinary Service Support (VSS) unit beginning in mid-July 2014. During this trial period, only MWDs were tracked in the system since a method for tracking contracted dogs in ROVR had not yet been created. Over the course of the trial, users were directed to keep a log documenting what went well with the application and any issues they encountered. While the trial found several benefits to using ROVR such as record portability and enhanced access to full medical records, the evaluation ultimately concluded that ROVR was not ready for use in the deployed environment due to several limitations (LTC N. Chevalier, 72nd VSS Commander, email, October 31, 2014). Most of the limitations resulted because ROVR was created for garrison veterinary facilities, and many of the assumptions for garrison did not apply in the deployed environment. For example, ROVR has a standard inventory based on the Veterinary Medical Standardization Board (VMSB) formulary which is supported by the VSCF prime vendor program. However, in the deployed environment, medications are procured from Medical Logistics instead of directly from a civilian prime vendor. This means that most of the medications used in theater are human medications which are not approved in the VMSB formulary, and consequently not found in the ROVR inventory.

Another issue was related to the ROVR designation of the 72nd VSS as a single entity under the name "OEF 1 Vet Det." This was done partly to maintain operational security so MWDs could not be traced to specific forward operating bases or areas of operation. However, this designation caused the program to assume that all veterinary teams were collocated in the same facility, which was not the case. The ROVR inventory is designed to assume that all items are located within that one facility, not spread across several locations. This made it extremely difficult to track what actually was available and used. Solutions to these deployment-related issues are currently under investigation.

Conclusion

With the fielding of ROVR, the VSCF is better able to globally manage the military's veterinary practices and has access to more reporting capabilities. It is anticipated that as the application matures and evolves, a greater dataset for epidemiology and disease control will be available. Additional future developments to this program should include the capability of uploading radiographic images for real time consultation, as well as interface capabilities with external third parties such as laboratories allowing automatic entry of test results into the program, thus eliminating another manual entry function of the user.

The ultimate goals of creating the global program are to create a more cost efficient practice, allow for passive and active disease surveillance for MWDs and DoD beneficiary owned animals, and to determine the best practice management for different diagnoses. As the program continues to mature and the dataset grows larger, the possibilities for use of this program have only begun to emerge.

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Joint Base Lewis-McChord First Year Graduate Veterinary Education: Observations and Lessons Learned

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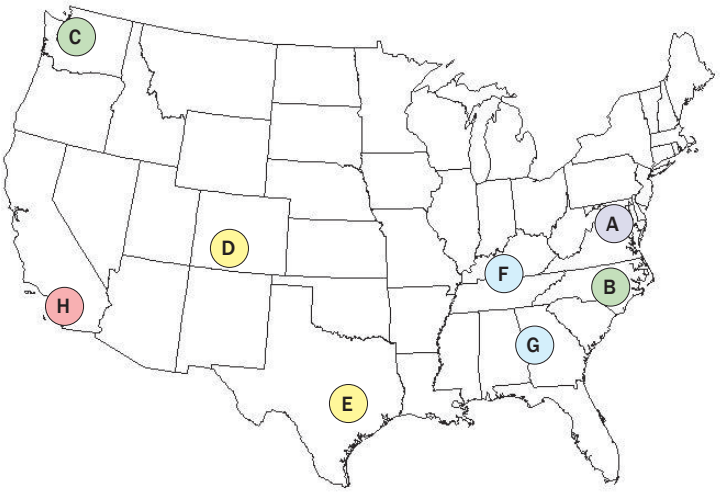
The First Year Graduate Veterinary Education (FYGVE) program was initiated in August of 2010. The year-long rotating internship is intended to provide exposure and reinforcement of those skills necessary for success in providing military veterinary medical services to the Department of Defense (DoD)[1] in accordance with *Army Regulation 40-905*.[2] First year internship programs exist in the Army Medical Corps and Army Dental Corps, but those are primarily clinically-focused. The FYGVE program includes public health and leadership tracks, in addition to clinical medicine. The duty requirements of a new Veterinary Corps officer (VCO) are diverse and challenging. Frequently, new officers are placed at isolated, single veterinarian duty sites, including Marine, Navy, and Air Force installations that may be located hundreds of miles from their peers or chain of command. These officers not only must be confident in their clinical abilities, but also must be prepared to manage Soldiers and civilians and oversee the procurement and protection of food for the installation. These diverse requirements are not adequately addressed in the typical veterinary school curriculum. The FYGVE program was conceived as a way to give a new VCO the best opportunity to succeed. This article is a retrospective review of the FYGVE program at Joint Base Lewis-McChord (JBLM) from October 2012 until June 2013, as experienced by three of the interns. It details how the program affected readiness and the ability to excel in the following areas of emphasis: animal medicine, food protection, public health, and leadership/management.

Background

Proper mentorship is critical to the development of new veterinarians as they transition from the role of student to doctor. New graduates often search for mentors as they enter the work force. A licensed veterinarian is legally able to treat any species of animal, but there are far more clinical situations than could ever be covered in a 4-year postbaccalaureate curriculum. This is especially true for the new VCO, whose responsibilities range from the full medical and surgical support of military working dogs (MWDs) and privately owned animals (POAs) of eligible beneficiaries, to advising hospital and installation commanders of matters of public health, to overseeing the procurement of safe food for all of the DoD (through the commercial sanitation audit program), to having responsibility for the financial success of the veterinary clinic. In addition, the young veterinarians are commissioned as captains in the US Army, thereby becoming not only a Soldier, but a leader as well. Attendance at the 3-month long Basic Officers Leadership Course, including a Veterinary Corps specific "vet track" component, is meant to provide new officers with a solid foundation of knowledge, However, it only paints a limited picture of the complete VCO. The day-to-day job functions are unveiled through the FYGVE program and then solidified throughout the officer's next assignment. The typical FYGVE program has 4 to 6 interns overseen by 2 FYGVE cadre, one boarded in veterinary preventive medicine and the other in a clinical medicine specialty (eg, surgery, internal medicine). While this article presents a review of the program at one site (JBLM), it is important to note that execution of FYGVE programs varies greatly between sites. The locations of all FYGVE programs are shown in the Figure. At JBLM, the interns split time between clinical medicine and public health rotations. Interns spent from 2 to 6 weeks in any rotation, but there was flexibility allowing for schedule changes for follow up on clinical cases or commercial sanitation audits, as needed. Interns could elect to schedule their own patient rechecks from 8 AM to 9 AM, with the official rotation starting at 9 AM. This flexibility allowed interns to follow up on their own clinical cases even when they had moved on to the public health rotation. While this was not a requirement, the continuity it provided was very useful from a learning perspective. The interns found the opportunity to conduct their own rechecks helpful for their professional development as clinicians.

Animal Medicine

The FYGVE program provides animal medicine mentorship by a board certified veterinary clinical instructor while practicing in a referral level veterinary hospital. The specialist is typically certified in small animal internal medicine, small animal surgery, radiology, or emergency/critical care. The JBLM site had an internal medicine instructor. The clinical instructor provided guidance during daily case round discussions, continuing education through monthly case presentations and journal rounds, as well as providing clinical credentialing in both medicine and surgery. Each FYGVE site has a Veterinary Center (VETCEN) as the animal medicine platforms. The VETCENs are the highest tier installation veterinary medical facility in the Army Public Health Command. The centers are equipped and staffed for routine to referral-level animal medical care and have an animal medical training capability. The JBLM VETCEN was fully staffed, including 2 full-time civilian animal care technicians who were hired specifically to support the FYGVE program. This staffing allowed the interns to see a busy clinic schedule consisting of six 30-minute sick call appointments scheduled from 9 AM to 12 noon, or ten 30-minute wellness appointments scheduled from 9 AM to 3 PM. The interns had the option of keeping any patients that required extensive workup or care for the afternoon. Equipment was up-to-date and readily available for use, providing hands-on experience with ultrasound, digital radiographs, in-house blood work, cytology, and endoscopy. This type of staffing and equipment is not typical of the average smaller military veterinary facilities, providing the interns the opportunity to learn as much as possible from a clinical perspective during their FYGVE year.



	Site	Start		Site	Start
A	Ft Belvoir	FY10	E	Ft Hood	FY12
B	Ft Bragg	FY11	F	Ft Campbell	FY13
C	Joint Base Lewis-McChord	FY11	G	Ft Benning	FY13
D	Ft Carson	FY12	H	Camp Pendleton (USMC)	FY16

Locations of current FYGVE sites and the year each program began. Camp Pendleton, California, will be implemented in FY16.

The confidence gained through mentorship by a clinical specialist has proven invaluable during the first assignment following FYGVE, typically as the officer-in-charge (OIC) of a veterinary treatment facility (VTF). Leaving the program clinically credentialed in medicine and surgery allows the new VTF section OIC to be fully functional upon arrival. In the US Army, a VCO must be "credentialed" prior to performing surgery and advanced workups without direct supervision on government-owned animals (GOAs) or POAs. The FYGVE program allows new officers to be credentialed prior to arriving at their first assignment, so they are able to start surgeries and advanced workups immediately. The key to gaining clinical proficiency and independence is continuous learning through repetition. The JBLM VETCEN maintains a heavy caseload, which allows interns to learn something new each day. That knowledge base was further solidified through case discussions with the clinical instructor and peers at the end of each day. Interns also had the opportunity to work up complicated POA cases, including providing a patient with 24-hour care. However, it was understood that interns, not enlisted veterinary technicians, provided overnight care for hospitalized POA patients that the intern elected to keep in-house. This experience was important because it conveyed to interns that Soldiers, whose primary responsibility is GOA care, should not be used for tasks that are not priority missions without due consideration of the task's impact on overall mission accomplishment. This lesson in mission priorities promotes an understanding of better Soldier care and utilization by their leaders.

The MWD population at JBLM offered each intern the opportunity to work with MWDs at least once monthly. These encounters typically involved completion of semiannual exams, vaccinations, and health certificates for travel. Occasionally, a FYGVE intern was called in for a MWD emergency, such as a splenic torsion or uncontrolled seizing. In these instances, all interns were given the opportunity to be involved through provision of overnight critical care case management and follow-on case discussion. Each intern also completed animal facility inspections, including the MWD kennel and Child Development Center classroom pet care.

At JBLM, interns did not complete deployment records for MWDs, nor execute any of the monthly record reviews, although a didactic session was performed. The preparation and maintenance of records is extremely important to a VCO, especially when assigned to a location without the assistance of an experienced enlisted veterinary technician. This would have been a very beneficial hands-on task to perform during FYGVE, especially since the implementation of the Remote Online Veterinary Record (ROVR), an online record keeping system that links all military veterinary facilities.* (Note: the hands-on component of record preparation and management is now a requirement in the current FYGVE curriculum.) Now that record reviews must be completed both on ROVR and in the Veterinary Service application portal, the FYGVE would also provide an excellent opportunity to create and teach a universal method to complete monthly record reviews.

One concern about the animal medicine component to the FYGVE program is the difference between what is available during the program compared to what will be available to VCOs at their next duty location. The fully equipped and staffed VETCEN imparted false expectations to some interns as to what would be waiting for them at their next assignment. The JBLM VETCEN has full surgical capability, radiology, ultrasound, and ophthalmic exam equipment. It is also fully staffed with civilian and military veterinary personnel to assist with the very large and demanding clinical mission. Interns found different levels of staffing and equipment at their next assignments. It is understood that different clinics have different capabilities, however, it would be useful if the FYGVE curriculum specifically addressed the continuum of care across veterinary facility tiers and levels of care. This information should include treatment alternatives under resource constraints and case-based discussions of referral/evacuation procedures that ensure VCOs are working within Army Veterinary Medicine Standardization Board guidelines. This area of training will be addressed in future years with required rotations to smaller VTFs, which will be more indicative of the resources interns will have at their next assignment. All follow-on assignment locations were also experiencing staffing shortfalls, resulting in clinical inefficiencies not encountered at the JBLM VETCEN. On the positive side, having completed the FYGVE experience, the interns felt they were better equipped than their peers who did not complete the program to deal with staffing shortfalls and other unexpected adversities during their first assignment. They also knew to reference Army regulations and how to obtain the resources that allow them to perform their animal health mission and prevent Soldier burnout in the process.

*See related article on page 61.

Public Health/Food Mission

The FYGVE program provided additional mentorship through a public health instructor. The instructor worked with the Public Health Command District and/or Region Food Safety Officer, a Veterinary Corps warrant officer highly specialized in the areas of food safety and defense, to ensure each intern quickly achieved phase 2 Commercial Sanitary Audit certification. Similar to animal medicine credentialing, this certification is required to complete food protection audits without supervision and is very important at the intern's next duty site. An Acceptable Commercial Sanitary Audit rating by a VCO is required before an off-installation food establishment can be listed in the *Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement*.[3] This listing is necessary to sell to the DoD. For continued listing as an approved source, these facilities must be audited by a VCO in accordance with *Military Standard 3006A*.[4] Compliance with this standard ensures that facilities are producing safe and wholesome food to minimize the risk of food-borne illness to service members and their families. Interns transitioned from staff auditors to lead auditors, becoming competent in performing food protection audits and correctly reporting commercial sanitation audit findings. This allowed a smooth transition to performing sanitary audits at their next assignment, as well as helping to prepare interns to volunteer for and complete Food and Water Risk Assessments (FWRA) outside the continental US in accordance with *Military Standard 3041*.[5] These FWRAs are conducted when there are insufficient DoD approved food sources to support short-term exercises. Veterinary Corps officers advise commanders of risks, as well as risk mitigation, regarding a particular food establishment.[6] A benefit of the JBLM site is a very large audit mission. Each intern completed numerous audits, an average of 15 different facilities each compared to an average of 9 audits per intern at other FYGVE sites during the 2013 FYGVE year. New VCOs outside of FYGVE may only perform 5 audits their first year. This increased audit load improves competency and more importantly confidence to better execute this mission at the next duty site where there is likely less opportunity for face to face mentorship.

Many public health topics were discussed during weekly FYGVE public health classes. Topics included zoonotic diseases, installation rabies board policy, bite reports, foreign animal diseases, response to refrigeration failures, the human-animal bond, and inspection of operational rations (eg, meals ready-to-eat). Though these

are broad topics, classes provided important resources that interns have frequently applied at current assignments. These classes directly led to the creation of rabies advisory boards at two sites, improved bite report standards, and improved communication on animal displays (such as petting zoos) on military bases. At JBLM, interns also completed the ServSafe program (National Restaurant Association, Washington, DC), which is accredited by the American National Standards Institute Conference for Food Protection. The ServSafe program is very useful for gaining knowledge of proper preparation and storage of food to reduce risk of foodborne illness. It gave the interns greater baseline knowledge of food safety, a topic that receives limited instruction in most veterinary school curricula. The interns recommended that this be added as a formal part of the FYGVE program.

Areas in public health for which interns felt less prepared upon reaching their first assignment included the Installation Food Vulnerability Assessment (IFVA) program, IFVA team development and its annual briefing to the installation commander in accordance with the *US Army Food and Water Vulnerability Assessment Guide*,* approved sources tracking for temporary vendors such as food trucks on the installation, the role of Veterinary Services in Moral, Welfare, and Recreation special events, and involvement of Veterinary Services in installation emergency support plans. Additionally, although interns were given a brief didactic introduction to the Installation Support Plan, (the program during which VCOs perform sanitary inspections of the commissary, post exchange (PX), and shoppettes), no sanitary inspections were performed as part of the FY13 FYGVE program at JBLM. However, as part of their responsibilities, the former interns are required to complete sanitary inspections regularly at their new duty sites. The FYGVE program now requires an IFVA component with a mock briefing to the installation commander and a requirement of performing 5 commissary and 5 PX/shoppette visits.

Leadership/Management

The development of leadership skills and management ability is a core aspect of the FYGVE curriculum. The leadership training that the interns received at JBLM provided the knowledge base and confidence to reach out to leaders in other commands and organizations on their respective installations. A number of the interns reached out to base commanders immediately upon reaching their follow-on assignment and now collaborate with a variety of commands and organizations on the installation. However, interns felt that the hands-on component of the leadership curriculum needed improvement. The leadership component of the program has changed greatly since the FY13 FYGVE year. Now, there is a leadership rotation and concrete benchmarks for interns to achieve. This rotation includes positions such as veterinary branch executive officer and intern class leader, as well as the completion of typical VCO organizational, leadership, and administrative tasks.

A unique aspect of the JBLM program was a leadership-focused book club. Interns read several books throughout the course of the year and then met for discussion. This was a very enjoyable and beneficial component of the program that has since been implemented at other FYGVE sites. Of interest is the fact that during the FY13 cycle for FYGVE at JBLM, all interns, cadre members, and the regional commander were female. That unique situation made discussions regarding women in leadership roles especially relevant and beneficial to participants of this FYGVE iteration.

An area of leadership training phase that the interns felt could be improved was counseling and development of subordinates. FYGVE interns were not afforded participation in integrated roles of leadership such as rating Soldiers, dealing with challenging situations, writing awards, etc. Though each intern was given the opportunity to issue a positive counseling statement to a Soldier of his or her choice, there was no opportunity to witness or contribute to developmental or disciplinary counseling. This would be difficult to implement since interns do not directly supervise any Soldiers and the privacy of the individual counseled must be respected. "Praise in public and correct in private" limited interns' experiences with these matters. Instead, group discussions of hypothetical scenarios and role playing were implemented to serve as an introduction to real world problems. Interns felt that this area should have received more emphasis during officer professional development, since Soldier development is one of the most important parts of a VCO's job as he or she assumes a clinic section OIC or branch chief position.

Similarly, management of civilian employees was covered in a couple of one-hour training sessions, but did not prepare interns for the administrative burden of rating, rewarding, reprimanding, and counseling civilian employees. Interns also did not receive a thorough introduction to the responsibilities and roles of employees within the Veterinary Services Central Fund (VSCF), the nonappropriated fund (NAF) entity that oversees the fiscal management of military veterinary facilities, separate from the operational chain of command. This group assists with reviewing income statements and general business management. The VSCF and the

NAF Civilian Personnel Advisory Center assists with civilian hiring/disciplinary matters as well as other human resources functions. The process for hiring civilian employees is an important topic that was not discussed during the FY13 iteration, which was unfortunate because all interns were faced with vacant positions upon arrival at their next duty site. It would have been beneficial to hold multiple teleconferences geared specifically towards FYGVE interns to better prepare interns for veterinary clinic manager level tasks. Teleconferences with VSCF did occur, however, they were of limited benefit to FYGVE interns as they were often focused on detailed topical instruction for specific employee positions, a discussion far too specific to be beneficial to the new VCO.

Perhaps the most significant advantage of the FYGVE year from a leadership/management perspective was the provision of resources for the future. Examples of counseling statements and annual evaluations were provided for future use. Regulations regarding specific circumstances were cited for interns to review. In addition, being stationed at a site where branch, district, and regional public health commands were located gave interns an excellent opportunity to be exposed to several types of leadership styles. Not only were the instructors 100% dedicated to preparing the interns for success in their future assignments, the chain of command also was fully engaged all the way through the regional command level. The authors strongly believe that identification and placement of the right people in the FYGVE instructor positions will continue to have a major positive effect on interns who participate in the program. Without cadre, district, and regional commanders who care about the program and the young officers in it, the goals of the program will not be realized.

Relationship Building

While the obvious benefits of the FYGVE program such as number of commercial audits, clinical credentialing, caseload, and inspections are quantifiable, all 3 interns felt that the most beneficial aspects involved building relationships with fellow interns, instructors, and noncommissioned officers. Working with peers enabled each intern to identify their strengths and weaknesses, and they were then able to work with each other to build on both. The bonds created during the FYGVE program have also translated into excellent working relationships with numerous Public Health Command personnel. Former interns now have contacts around the Veterinary Corps for questions, concerns, and advice, ranging from former instructors, intern-mates, food inspectors, warrant officers, etc. Though the FY13 JBLM interns have gone to their separate assignments, they continue to use their FYGVE colleagues as sources of perspective and knowledge as they encounter unique situations at their individual duty sites. The bond they now share after spending their first year in the Army together is perhaps the most unexpected advantage gained through participation in the program. A solid foundation of clinical competency allows the new VCO to focus more appropriately on veterinary treatment facility management, mission accomplishment, and leading Soldiers.

Summary

The FYGVE program provided a solid foundation to smooth the transition from veterinary student to Veterinary Corps officer. Not only did the program provide resources and exposure to vital areas of the mission, it also produced a network among interns and their instructors. This network was critical to their success as they assumed their next assignments. Interns left the experience with increased confidence and competency in clinical medicine, public health, and food safety. Improvements in the leadership/management track are already being added to the program. At the end of each internship year, an extensive after action report (AAR) is conducted. The AARs solicit feedback from interns and cadre alike. Many of the improvements added to the program have come directly from these retrospective reviews On the other hand, interns expressed concern about the direction for the future of the program and the effect of possible budget cuts.

This article presents the positive aspects and concerns expressed by 3 FYGVE interns about their internship experience during the FY13 iteration. Upon completion of the program at JBLM, all interns moved into the role as officer-in-charge of a veterinary treatment facility. Current duty sites for the intern authors are Kings Bay Submarine Base, Redstone Arsenal, and Fort Bliss. The intern assigned to Fort Bliss moved into the role of Chief of Veterinary Services for the Fort Bliss Branch a year after completion of the internship. This role includes oversight of 4 Veterinary Treatment Facilities that span 2 states. More than a year after completion, all interns agree that the FYGVE program provided a background that was integral to their success at their current duty stations.

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Associations Between Operationally Estimated Blast Exposures and Postdeployment Diagnoses of Postconcussion Syndrome and Posttraumatic Stress Disorder

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Abstract

Traumatic brain injuries and other blast-related injuries have been identified as the signature injury of the wars in Iraq and Afghanistan. Some operational units in Iraq, especially those responsible for clearing roadways, were exposed to hundreds of blast incidents and thousands of individual doses of concussive energy during their lengthy deployments. Using operational records maintained by a single command element, the researchers conducted a retrospective cohort study evaluating the association between estimated individual exposures to blasts and the risk for postconcussion syndrome (PCS) and posttraumatic stress disorder (PTSD). Tactical records documented all of the relevant details of the subjects' exposures to blasts during their missions. During the study period there were 313 blasts involving 418 service members resulting in 4,250 blast person events. Of that population, 12.9% were diagnosed with PCS, 8.6% with PTSD, and 5.3% with both. This study suggests that estimating the total individual dosage to concussive forces through physical evidence at the scene could be a useful predictor of future brain-disorder diagnoses. Those in vehicles sustaining heavy blast damage are at increased risk of being diagnosed with PTSD with a rate ratio of 2.79 (95% CI, 1.27-6.13) and PTSD in conjunction with PCS with a rate ratio of 4.10 (95% CI, 1.63-10.28). Standardization of the data collection method for blast incidents and additional follow-up studies could lead to the development of better ways of monitoring operational risk factors for negative health outcomes, plans to intervene in order to minimize health risks, and establish customized follow-up protocols based on specific dosage thresholds.

Traumatic brain injury (TBI) and other blast-related injuries are likely to be an enduring legacy of Operations Iraqi Freedom and Enduring Freedom.[1,2] Improvised explosive devices were the primary causes of exposure to blast energy and projectile material. The primary scientific and operational challenges to understanding and mitigating blast exposure risks have been the lack of data on the long-term sequelae from individual blast exposures, as well as lack of information regarding the relationship between relatively minor, cumulative exposures and brain injury symptoms. Several studies to date have shed light on these issues but with conflicting results.[3-8]

Primarily due to the wars in Iraq and Afghanistan, a great deal has been learned about mechanism of injury and pathophysiologic effects of blast-induced TBI.[5,6,9-12] There have been several animal and human studies documenting metabolic, molecular, cellular, and systemic effects from the primary blast injury along with several theories of injury mechanism.[3,5,7] Regardless of mechanism, these injuries are typically at the chemical and/or microscopic level which are impossible to appreciate with the diagnostic modalities available in a combat environment and therefore cannot definitively be determined in that setting.[5]

McCrea et al[13] argued that it is difficult at best to determine in the combat setting that confusion after a blast event is due to brain injury or psychological trauma. Thus, many Soldiers may meet the diagnostic criteria for mild TBI (MTBI) symptoms without having suffered any physiologic injury. Further, Walker et al[14] states that loss of consciousness at the time of injury is an important factor in determining risk for long-term sequelae, and that immediate evaluation by a provider is key to clarifying later diagnoses. There is typically a significant time gap in combat for these types of injuries between point of impact and a thorough medical evaluation. The lack of physical injuries that can be readily observed in the operational setting have made it necessary in many instances to diagnose MTBI on the basis of exposure history as recalled by the service member and subjective complaints. Many of these symptoms such as being dazed, loss of consciousness, memory deficits, fatigue, increased sensitivity to noise and light, insomnia, irritability, decreased concentration, and anxiety

are shared with acute stress reactions and PTSD.[15,16] Hoge et al[6] argues that there are many psychological phenomenon that may produce an apparent alteration in consciousness. These factors make it extremely difficult for providers in theatre to make informed prognostic decisions, which in turn can have a significant effect on a unit's mission readiness resulting from unfavorable Soldier health outcomes.

With these findings in mind, there has been an effort to study the relationship of MTBI, PCS, and PTSD. Hoge et al[6] found MTBI and PTSD to be strongly associated with 40% of Soldiers meeting criteria for PTSD who had a history of loss of consciousness. This finding is supported in further investigation by Wilk et al.[17] A study by Meares et al[18] further clarifies a strong role for psychological comorbidities in contributing to a symptom-complex that appears to be PCS. Bryant[15] addresses possible physiologic sources of PTSD in patients with MTBI, noting that the prefrontal cortex is often injured in MTBI patients. These findings makes differentiating the long-term effects of MTBI more difficult and may further confound the clinical course of PCS/PTSD, in that distinguishing one diagnosis from the other becomes more challenging.

Soldiers who self-reported exposure to blasts perceived themselves to have poorer health, missed more workdays, and were more symptomatic than Soldiers who were not exposed to blasts.[6] A study by Sim et al,[19] though specific to the nonblast injuries, supports the concept that, on average, concussions result in short-term injuries (impaired reaction time, attention deficits, memory dysfunctions, and cognitive processing delays) that resolve differentially over time. However, Vagnozzi et al[20] demonstrated lingering neurometabolic sequelae due to concussion among civilian athletes. Further, Trudeau et al[16] speculated that the physiologic sequelae produced specifically by blast-induced MTBI could be more permanent and result in prolonged PCS. This is supported by the finding by Terrio et al[2] that Soldiers who had a documented TBI were more likely to report post concussive symptoms upon redeployment (7.5%) than those who did not (2.3%).

With all of the challenges surrounding surveillance, diagnosis, and treatment of blast-related exposures and health outcomes, there is a rational need for better tools to collect information in operational settings. A tactical tool for measuring blast dosimetry with information readily available on the battlefield and transforming this data into predictive values for the development of long-term injury would be invaluable. This study is unique in that we compared individual operational exposure data to the development of PCS and PTSD in an effort to define cumulative exposure estimates that may lead to operational decisions aimed at reducing the likelihood of PCS/PTSD.

Method

This retrospective cohort study, approved through the Iraq Deployed Combat Clinical Research Team and the human subject review board at the Brooke Army Medical Center, Texas, included data for personnel assigned to 3 companies of combat engineers deployed to Iraq between (approximately) October 2006 and January 2008. Those 3 companies were chosen because of the similarity of their missions, geographic proximity in northern Iraq, and their shared command. Permission to use tactical records for the purposes of this study was provided by the brigade commander at that time.

Tactical records documented all of the relevant details of the subjects' exposures to blasts during their missions. A variable number of subjects were engaged in tactical route clearance missions nearly every day of the deployment, though blasts did not occur on every mission. Only missions during which a blast occurred received documentation and was therefore suitable for inclusion in the study. Subjects traveled only by military armored vehicle (not by foot) during missions. During a mission, vehicles moved in convoys in single-file formations, normally resulting in exposure of a single vehicle during an explosion, though occasionally 2 vehicles were affected. Missions during which a blast occurred were described in detail in narrative documents, spreadsheets, photos, and digital drawings that were provided to the research team on the classified network. Data needed for this study were manually abstracted by the primary author from those files in a format and level of detail that was considered unclassified.

Data included the vehicle order during the mission, the relationship of the vehicles to the blast, seat-assignment of each subject, and the level of damage to the vehicle as a result of the blast. The exact date of the blast event was considered classified, so the temporal relationships between blasts were transformed into the number of days from the beginning of data collection (the day of the first mission in which a blast occurred). Possible seat-assignments included the driver, front passenger, gunner (located in a turret protruding through the roof of the vehicle) or a rear passenger on either the same side or the opposite side of a documented blast. Not every vehicle had a gunner or rear passengers.

Vehicles directly in line with the explosion were considered "targeted," and thus the passengers of that vehicle were targeted as well. Precise proximity of a targeted

vehicle to a blast and the estimated size of the blast were not consistently available. Blast intensity was estimated by classifying the level of damage to each vehicle on a 4-point scale based on the information available in the tactical records. After "no damage," minor damage included paint or glass chips, blown-off external accessories or a flattened tire, but with no structural damage to the wheel or drive system. Moderate damage included visible cracks through one or more layers of glass, dents in the exterior armor, or damage to the wheel or drive system which sometimes left the vehicle inoperable. Heavy damage included penetration of the passenger cabin or damage to the engine block or chassis and meant that the vehicle was no longer drivable.

The blast intensity was used to estimate individual exposures in one of 3 models based on the blast damage assessment of the vehicle. In the simplest model, a blast dose was assigned to each individual present on a mission consistent with the level of damage to the vehicle in which they traveled on a scale of 0 to 3, 3 being the highest. Subjects in a vehicle that was not directly targeted (eg, all of the other vehicles in the convoy), as well as those in a targeted vehicle that suffered no damage, were assigned a blast intensity of zero.

Because gunners were partially external to the vehicle cabin, the "gunner model" postulated the he was exposed at a level above that of the other passengers. The gunner model classified exposures on a scale of 0 to 4 based on the amount of damage to the vehicle, but with the gunner receiving one point higher than any other passenger in the same vehicle. Finally, the "laterality model" took into account the position of each person in the vehicle in relationship to the blast. Those in a gunner position or ipsilateral with respect to source of the blast were considered to be more exposed (by a value of one) than those contralateral to the blast. The laterality model described blast exposures on a scale of 0 to 7. For each individual, the cumulative "blast intensity score" (BIS) for the entire deployment was the sum of all individual exposures under each of the models.

Diagnoses of PTSD and PCS were determined using data from the Defense Medical Surveillance System (Armed Forces Health Surveillance Center, www.afhsc.mil). A confirmed diagnosis was one or more healthcare encounters during which PTSD (ICD-9-CM code 309.81) or PCS (ICD-9-CM code 301.2), respectively, were documented as the primary diagnosis during the 365 days following deployment. Also included were subjects with 2 or more encounters with the diagnosis of PTSD or PCS in a secondary field. For PCS, diagnoses were excluded if, during the year following deployment, the healthcare record indicated that the subject suffered a concussion or other head injury requiring medical treatment, that is, a postdeployment incident.

Crude risk ratios and 95% confidence intervals were calculated using standard formulas. Bivariate and multivariate logistic regression models using SAS 9.0 (SAS Institute Inc, Cary, NC) were used to conduct sensitivity testing of our 3 observational models. We examined the relationships between the cumulative BIS, sex, age, the total number of times a subject was on a mission during which a blast occurred, and (independent of the BIS) the total number of times a subject was in a targeted vehicle.

Results

Over the study period, 477 service members were assigned to route clearance missions. The population was similar to other combat arms units with 99% male, 92% enlisted, and 72% aged 18 to 30 years. Other demographic and socioeconomic data were not available in this study, and the individuals themselves were never contacted by the study team.

During 366 days of observation, there were 313 blasts resulting in 4,625 individual potential exposure events (ie, the number of people in convoys multiplied by the number of blasts). In the final data set, 59 service members were excluded because their identification numbers were incorrectly transcribed during data collection and they could not be matched to health care record in the Defense Medical Surveillance System. Soldiers dropped from the study had a distribution of blast exposures that was consistent with those who were retained (data not shown). After the exclusions, the data included 418 service members with 313 blast events and 4,250 potential exposures. A total of 278 subjects were present in vehicles that appeared to have been directly targeted during a blast, resulting in 940 individual blast exposures.

Accumulation of blast incidents over the course of the study period on a relative time scale from the beginning of observations was well distributed. More blasts occurred during the first half of the deployment, but deployed personnel were at risk for blast exposures for most of the deployment. Further, blasts resulting in vehicle damage were also evenly distributed throughout the study period. Sixty blasts caused minimal vehicle damage and exposed 210 Soldiers; 50 blasts caused moderate vehicle damage and exposed 157 Soldiers; and 8 blasts caused heavy vehicle damage that affected 28 Soldiers.

Outcomes of PCS and PTSD were not evenly distributed among the population as shown in Table 1. Enlisted Soldiers had higher rates of PCS and PTSD at 13.8% and

Table 1. Crude Risk Ratios (CRR) for Diagnoses by Demographic Groups.

Age (years)	Any PCS		Any PTSD		Both	
	CRR	95% CI	CRR	95% CI	CRR	95% CI
<25	REF		REF		REF	
25-29	0.62	0.31-1.23	0.55	0.23-1.33	1.58	0.69-3.60
30-34	1.54	0.87-2.73	1.46	0.70-3.06	3.92	1.88-8.18
35-39	0.19	0.03-1.35	0.28	0.04-2.02	0.48	0.06-3.62
>39	0.19	0.03-1.35	0.28	0.04-2.02	0.48	0.06-3.62
Service Status						
Enlisted	4.54	0.65-31.8	3.00	0.42-21.2	1.80	0.25-13.0
Officer	REF		REF		REF	

Note: REF indicates reference population on which all calculations are based.

Table 2. Crude Risk Ratios (CRR) for Levels of Blast Exposure

Exposure	PCS CRR (95% CI)	PTSD CRR (95% CI)	Both CRR (95% CI)
>1 mission	2.69 (1.10-6.55)	1.70 (0.68-4.25)	2.74 (0.65-11.52)
Targeted at least once	2.90 (1.41-5.97)	1.76 (0.83-3.77)	3.19 (0.96-10.6)
>1 targeted blast	2.63 (1.49-4.61)	2.02 (1.04-3.93)	4.54 (1.56-13.2)
>2 targeted blasts	2.83 (1.69-4.73)	2.33 (1.24-4.38)	4.43 (1.77-11.09)
>3 targeted blasts	2.83 (1.74-4.61)	1.80 (0.96-3.40)	3.40 (1.51-7.65)
Any blast resulting in heavy BDA	1.74 (0.82-3.71)	2.79 (1.27-6.13)	4.10 (1.63-10.28)

9.1%, respectively, than did officers at 3% for both PCS and PTSD. Those aged 30-34 years had the highest rate of PCS and PTSD at 22.6% and 14.5%, respectively, as well as the highest rate of diagnoses with both (11.3%). The crude risk ratio (CRR) for developing PCS for those aged 30-34 years was 1.5 (95% confidence interval (CI), 0.87-2.37), for developing PTSD was 1.46 (95% CI, 0.70-3.06), and for developing both PCS and PTSD together was 3.92 (95% CI, 1.88-8.18). There were no other statistical significant risks for the other age groups in this study.

Soldiers on more than one mission during which a blast occurred (regardless of their individual or cumulative blast exposure) had a CRR for the diagnosis of PCS of 2.69 (95% CI, 1.10-6.55), as shown in Table 2. Being in a targeted vehicle at least once increased that risk to 2.9 (95% CI, 1.41-5.97). Being present during more than one targeted blast resulted in a slight lower, but still significant, risk of developing PCS. Being in any blast during which the vehicle experienced heavy battle damage did not predict a diagnosis of PCS in the postdeployment period.

Developing PTSD was not significantly associated with being on missions during which blasts occurred; nor was it associated with being in a targeted vehicle as a single event. However, PTSD was strongly associated with being in more than one targeted blast (CRR 4.54; 95% CI, 1.56-13.2), which became somewhat less pronounced with increasing numbers of exposures. Being in a vehicle that received heavy damage from a blast was also highly correlative with a diagnosis of PTSD during the 12 months following deployment (CRR 4.10; 95% CI, 1.63-10.28).

Sensitivity analysis of the blast models was crudely evaluated by establishing sequentially increasing cut-off values between "not exposed" and "exposed" based on the cumulative blast intensity score derived from the battle damage assessments. The crude rate ratios for diagnosis of PCS for the 3 blast intensity models (any targeted incident, simple, gunner, or complex) are consistent across various cutoff values for blast intensity scores, suggesting that no model was particularly better at predicting outcomes. The data for those models are presented in Tables 3, 4, and 5.

COMMENT

In our opinion, the best data is derived from the targeted exposures. Soldiers in vehicles targeted 2 to 3 times and those in vehicles sustaining heavy battle damage show a strong correlation to being diagnosed with PTSD, and an even stronger correlation to PCS together with PTSD. Furthermore, the confidence intervals overlap for the risk ratios in diagnosis of PCS, PTSD, and both PCS/PTSD together for each given level of exposure. Our data, therefore, suggests that there is no significant difference in the risk of diagnosis between PCS, PTSD, and both PCS/PTSD together per given exposure level after a Soldier has been targeted more than once. This may be indicative of the similarities between these 2 diagnoses, given the difficulties in distinguishing one from the other since there are no readily available objective markers for what may be their instigating injury (MTBI) as well as their similar clinical pictures. This data supports the Hoge et al research in that PCS and PTSD are strongly associated.[6]

Our study indicates Soldiers aged 30-34 years are more likely to be diagnosed with both PCS and PTSD. Soldiers in this age range are more likely to have been previously deployed but typically remain in positions with high exposure to blasts. These Soldiers may have some residual injuries/illnesses from their previous combat experiences that are reflected in this finding.

Table 3. Sensitivity Analysis of Simple Model.

Cumulative Intensity Score	PCS CRR (95% CI)	PTSD CRR (95% CI)	Both CRR (95% CI)
>0	2.36 (1.34-4.15)	1.61 (0.84-3.09)	2.42 (0.97-6.07)
>1	2.02 (1.22-3.32)	1.29 (0.69-2.42)	1.94 (0.86-4.37)
>2	2.24 (1.37-3.66)	1.33 (0.68-2.61)	2.09 (0.92-4.75)
>3	1.97 (1.13-3.44)	1.24 (0.54-2.85)	2.33 (0.95-5.70)
>4	2.19 (1.17-4.09)	1.37 (0.51-3.65)	2.43 (0.87-6.79)
>5	1.24 (0.42-3.60)	0.60 (0.09-4.15)	1.00 (0.14-7.05)

Table 4. Sensitivity Analysis of Gunner Model.

Cumulative Intensity Score	PCS CRR (95% CI)	PTSD CRR (95% CI)	Both CRR (95% CI)
>0	2.22 (1.25-3.96)	1.77 (0.89-3.50)	2.08 (0.83-5.20)
>1	1.71 (1.04-2.84)	1.14 (0.61-2.13)	0.97 (0.43-2.20)
>2	1.90 (1.16-3.12)	1.31 (0.69-2.47)	1.71 (0.76-3.86)
>3	1.82 (1.09-3.03)	1.68 (0.87-3.23)	2.32 (1.02-5.27)
>4	2.32 (1.39-3.88)	1.69 (0.83-3.43)	2.89 (1.26-6.62)
>5	2.63 (1.53-4.52)	1.34 (0.55-3.26)	2.44 (0.94-6.29)
>6	2.42 (1.27-4.62)	1.27 (0.41-3.87)	2.20 (0.69-6.99)

Table 5. Sensitivity Analysis of Complex Model.

Cumulative Intensity Score	PCS CRR (95% CI)	PTSD CRR (95% CI)	Both CRR (95% CI)
>0	2.90 (1.41-5.97)	1.76 (0.83-3.77)	3.19 (0.96-10.6)
>1	2.55 (1.35-4.80)	2.28 (1.07-4.89)	3.19 (0.96-10.6)
>2	2.30 (1.31-4.03)	1.77 (0.91-3.44)	3.00 (1.13-7.99)
>3	2.35 (1.37-4.40)	2.16 (1.11-4.20)	3.67 (1.38-9.77)
>4	2.29 (1.37-3.84)	1.69 (0.90-3.16)	2.36 (1.01-5.50)
>5	2.61 (1.57-4.35)	1.66 (0.89-3.10)	2.91 (1.25-6.76)
>6	2.12 (1.30-3.47)	1.35 (0.71-2.55)	2.12 (0.94-4.76)

There appears to be an association between blast exposure and the diagnosis of PCS and PTSD. This relationship appears to remain fairly constant despite not only an increasing number of exposures but also an increasing exposure intensity score. This denies us the ability to estimate a level of blast exposure with field expedient methods that may lead to operational decisions aimed at reducing the likelihood of PCS/PTSD. The investigators surmise this may be secondary to the fact that there are fewer subjects as blast intensity scores increase. There simply may have been too few subjects at the higher levels of exposure to clarify the subtle differences. It may also be due to our imprecise way of measuring blast dose. Perhaps a more scientific approach is required here by first incorporating blast pressure sensors, correlate vehicle damage to blast sensor readings, and use that data in a similar study. Our negative results could further be secondary to our method of collecting outcome data. We collected data only on those who met criteria for PCS and PTSD and did not imply diagnosis based on symptom complexes. Alternatively, we could have developed a case definition where subjects would meet criteria for our study if they were diagnosed with several of the symptoms of PCS or PTSD, such as headache, tinnitus, concentration deficit, and photophobia. This alternative may have eliminated some error resulting from the difficulty with which PCS and PTSD are diagnosed and distinguished. Finally, cumulative blast exposure simply may not result in injury in the same way as single, large exposures. This may have correlation to the findings that loss of consciousness is very important in determining long term sequelae.[12,14] Unfortunately, we did not include this vital piece of information as we did not have access to the deployment medical records. Our study would suggest that using readily available field exposure data may not be an accurate way to predict blast dose to the Soldier. Furthermore, the development of PCS and PTSD may not be as strongly related to blast dose as it is to other injuries or experiences.

These observations bring to light some limitations of this study, including the facts that the estimate of blast intensity was not validated independently with physical or biomechanical measurements; we were unable to evaluate other combat and noncombat exposures that contribute to PCS and PTSD; we did not have access to longitudinal health records during the deployment; and recorded health histories prior to deployment were not assessed.

Conclusion

Our study provides evidence that blast exposure and particularly being targeted in a blast are predictive of the development of PCS and further, for those targeted more than one time, PCS in conjunction with PTSD. Those in vehicles sustaining heavy battle damage are at an increased risk of being diagnosed with PTSD and PCS in conjunction with PTSD. Finally, Soldiers with previous deployments may be more likely to be

diagnosed with both PCS and PTSD. According to our data, the development of these diagnoses does not show a linear trend with increasing number of targeted exposures or increasing blast intensity estimates. We are, therefore, unable to delineate an exposure threshold that, if maintained, may decrease the incidence of PCS/PTSD, and above which commanders and providers may make informed, operational decisions regarding mission risk.

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Temperament Dimensions and Posttraumatic Stress Symptoms in a Previously Deployed Military Sample

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Abstract

This study examines the effects of temperament on self-reported posttraumatic stress disorder (PTSD) symptoms from a convenience sample of US military service members (N=559). Previously deployed active duty service members completed anonymous questionnaires that included demographics, temperament, and PTSD measures. This study also examines demographic variables such as age, gender, ethnicity, race, education, and marital status, and service-related variables such as branch, grade, and years of military service for moderating effects. Results suggest a relationship between the temperament dimensions and PTSD symptoms in that the temperament dimensions of low mood quality, high levels of activity generally and during sleep, and low flexibility were found to predict high levels of self-reported PTSD symptoms. This is the first study incorporating temperament as a predictor of PTSD within a military population and provides the basis for future research in this area.

Posttraumatic Stress Disorder

Although recently there has been much publicity about posttraumatic stress disorder (PTSD) in the national media, PTSD is not a new phenomenon. In the last century, PTSD was called war neurosis, soldier's heart, shell shock,[1] combat fatigue and battle fatigue.[2] According to the *Diagnostic and Statistical Manual of Mental Disorders IV* (DSM-IV) the diagnostic criteria for PTSD includes experiencing or witnessing events that involved actual or perceived death or injury to self or others in which the exposed individual responded with intense fear, horror, or helplessness.[3] Symptoms of PTSD include: initial stressor (exposure to a violent event); persistent re-experiencing of the event while awake or in the form of nightmares; avoidance of stimuli associated with the event; alterations in affect and emotional detachment; and alterations in arousal and reactivity such as sleep disturbances and hyper-vigilance. The diagnosis of PTSD requires the symptoms remain for a month or longer and the "disturbance must cause clinically significant distress or impairment in social, occupational, or other important areas of functioning."[3]

Posttraumatic stress disorder is a continuous concern for the Departments of Defense (DoD) and Veterans Affairs (VA), especially for service members associated with combat operations, including their families. However, determining the overall prevalence rate of PTSD is not an easy task. In a critical review of the combat-related PTSD prevalence estimates, the authors reported a range of 2% to 17% point prevalence rate of US military veterans since the Vietnam War.[4] In a study on service members serving in theater for Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF), it was reported that 14% of the 1,965 survey responders met the criterion for PTSD.[5] If the survey responders are representative of the currently over 2.5 million troops who have been deployed in support of OIF and OEF,[6] this would indicate that approximately 350,000 will have PTSD.

All military personnel do not develop PTSD, and many studies have focused on the risk and protective factors to determine methods of protecting those at greatest risk. Factors that have a possible role in the risk of developing PTSD include "age and education at the time of deployment, gender, race, early conduct problems, intelligence, childhood adversity, family history of psychiatric disorder, pre-deployment psychological and physical health, poor social support after trauma, and personality pathology."[4(pp9-10)] To our knowledge, this article is the first descriptive study on temperament and PTSD in a military sample.

Temperament

In the 20th century, child psychologists Thomas and Chess studied infant and child development. They stated that, "Temperament can be equated to the term behavioral style. Each refers to the "how" rather than the "what" (abilities and content) or the "why" (motivations) of behavior. In this definition, temperament is a phenomenological term and has no implications as to etiology or

immutability. On the contrary, like other characteristics of the organism—whether it be height, weight, intellectual competence, or perceptual skills—temperament is influenced by environmental factors in its expression and even in the nature as development proceeds."[7(p9)]

Based on the classic infant temperament styles established by Thomas, Chess, and colleagues, temperament may be viewed as a continuum from "very easy" to "very difficult." They identified 9 trait-dimensions of infant temperament which include: (1) activity level; (2) rhythmicity; (3) approach-withdrawal; (4) adaptability; (5) threshold of responsiveness; (6) intensity of reaction; (7) quality of mood; (8) distractibility; and (9) attention span and persistence. These results came from their 1950s New York Longitudinal Study[8] (NYLS). The temperament dimensions are used to categorize infant temperament as "easy," "difficult," or "slow-to-warm up."[7-9]

"Easy" babies are defined by "regularity, positive approach responses to new stimuli, high adaptability to change, and mild or moderately intense mood that is preponderantly positive." "Slow-to-warm up" babies are characterized "by a combination of negative responses of mild intensity to new stimuli with slow adaptability after repeated contact...mild intensity of reactions, whether positive or negative, and by less tendency to show irregularity of biological functions."[7] "Difficult" infants are defined by "irregularity in biological functions, negative withdrawal responses to new stimuli, nonadaptability or slow adaptability to change, and intense mood expressions which are frequently negative."[7]

Results of the NYLS reported 40% of the infants in the study were classified as "easy," 15% "slow-to-warm up" and 10% "difficult." With 65% of the infants accounted for, the remaining 35% did not neatly fit into one of the categories and were classified as mixed.[7,9] Temperament is generally considered relatively stable from infancy throughout maturation and adult life.[11-16] "Most current temperament researchers would agree with Buss and Plomin's (1984) notion that early onto genetic appearance, moderate stability, and distinctive biological manifestations are key ingredients of a definition of temperament."[17(p14)] In essence, temperament can be considered "as one's general style of behavior."[15]

The theoretical relative stability of temperament establishes the connection between the child and adult temperament literature. Windle and Lerner[15] developed 10 adult temperament dimensions: (1) activity level-general; (2) activity level-sleep; (3) approach-withdrawal; (4) flexibility-rigidity; (5) mood quality; (6) rhythmicity-sleep; (7) rhythmicity-eating; (8) rhythmicity-daily habits; (9) distractibility; and (10) persistence. The principle here is that measuring a person's temperament in adulthood would result in very similar styles to their childhood temperament. As with Thomas and Chess's temperament dimensions, these adult temperament dimensions do not measure performance ability or motivations for behavior but places the emphasis on how people behave. For example, activity level-general refers to an overall measure of how much a person moves, whereas activity level-sleep refers to the amount of movement a person has while asleep or in bed. Approach-withdrawal indicates the initial response a person has when being presented with new people, items, or circumstances. The flexibility-rigidity indicates how long it takes for a person to accommodate to changes in their environment. Mood quality is the degree to which a person overtly displays their mood such as smiling or laughing. The 3 rhythmicity dimensions for sleeping, eating and daily habits indicate how regular a person is in maintaining their daily schedules in order to function. The distractibility dimension indicates the degree to which a person can be distracted from a task at hand. The final dimension, persistence, refers to the amount of time a person will continue with a given task or activity.[18]

PTSD and Temperament

A limited but growing number of studies have investigated the role of temperament in the development of PTSD and anxiety disorders in children and adult populations. Using the terrorist attacks of September 11, 2001, (9/11) as a pivotal event, Lengua and colleagues found preattack anxiety levels, as a measure of temperament, were associated with children reporting a higher level of postattack posttraumatic stress (PTS) symptoms.[19] It was not that children were directly exposed to the 9/11 attacks but that they witnessed the events and heard the commentary on television. Otto and colleagues found that "on the day of the attacks adults watched a mean of 8.1 hours of television coverage, and their children watched a mean of 3.0 hours."[20] Results such as these were used to support the belief that children may develop PTSD through media exposure of a traumatic event. A distinction is made for adults and children; the exposure to a traumatic event via any visual media is not applicable for adults "unless work related" such as combat medics or civilian first responders.[19]

Additional studies of traumatic events support the idea that indirect exposure is sufficient to induce PTSD, at least in vulnerable populations such as children.[21] Temperament is considered to be relatively stable and this stability helps to predict how children will manage and react to their environments.[22] For example, children exposed to traumatic domestic violence were found to be more resilient when characterized with an easy temperament.[23]

The Current Study

Data from a cross-sectional study was analyzed to examine the relationship between temperament and PTSD.

Methods

Procedure

Data were collected from a convenience sample of service members using anonymous self-reporting questionnaires. Demographics information and measures for PTSD and temperament were included. Subjects were recruited from gathering places such as the post or base exchanges and classrooms from Joint Base San Antonio (JBSA), which includes Fort Sam Houston and Lackland Air Force Base in San Antonio, Texas. The subjects completed the voluntary 15 to 20 minute questionnaire and returned it to the study personnel who had provided the questionnaire. The data were collected from summer 2010 to summer 2011. As PTSD rates have been steadily increasing since deployments to Iraq and Afghanistan began, we included only previously deployed service members in our subject pool to examine the relationship of temperament dimensions to the development of self-reported PTSD symptoms in this population. Criteria for participation included a deployment of at least 30 days, aged 18 years or older, and on active duty at the time the questionnaire was completed. Due to the lack of collecting personally identifiable data and the anonymous nature of the questionnaire, this study received an exempt determination from the Brooke Army Medical Center Institutional Review Board.

Participants

The participants included 559 service members recruited from JBSA. The demographics and service-related characteristics are described in Tables 1 and 2. Demographics include age, gender, ethnicity, race, education, and marital status. Service-related characteristics include branch of service, grade, and years of military service.

Measures

Two measurement tools included in the questionnaire package were the PTSD Checklist-Military (PCL-M)[24] and Dimensions of Temperament Survey–Revised (DOTS-R).[15]

PCL-M

The PCL-M[24] is a 17-item self-report inventory that is widely used in DoD and VA with excellent reliability and validity. The PCL-M assesses the severity of each DSM-IV[3] defined PTSD symptom. Each item corresponds to DSM-IV diagnostic criteria for PTSD and is scored on a 1-5 scale (1-not at all; 5-extremely). Previous research on the PCL-M indicated mean scores of 64.2 (SD=9.1) for PTSD subjects and 29.4 (SD=11.5) for non-PTSD subjects.

Table 1. Demographics of Study Participants.

	Number (N=559)	%N
Age Group (years)		
25 or less	45	8.0%
26-30	126	22.5%
31-40	271	48.5%
41 or over	117	20.9%
Gender		
Male	401	71.7%
Female	157	28.1%
Ethnicity		
Hispanic	69	12.3%
Non-Hispanic	484	86.6%
Race		
Caucasian/White	358	64.8%
African American	107	19.5%
Asian/Pacific Islander	33	5.9%
Other	48	8.8%
Civilian Education*		
Some HS, GED, HS Diploma	20	3.6%
Some College, AAS, BA/BS	407	72.8%
MA/MS, Professional, PhD	125	22.5%
Marital Status		
Never married	81	14.5%
Currently married or living with a partner	378	67.6%
Currently separated or divorced	93	16.6%

*HS-High School; GED-General Educational Development; AAS-Associate's Degree; BA/BS-Bachelors Degree; MA/MS-Master's Degree; PhD-Doctorate Degree

Table 2. Service Related Characteristics of Study Participants.

	Number (N=559)	%N
Branch of Service		
US Army	345	61.7%
US Air Force	206	36.9%
US Navy	6	1.1%
US Coast Guard	2	0.4%
Grade (combined services)		
E1-E4	29	5.2%
E5-E7	305	54.6%
E8-E9	20	3.6%
WO1-WO4	9	1.6%
O1-O3	129	23.1%
O4-O5	40	7.2%
O6-above	8	1.4%
Years of Military Service		
2 or less	8	1.5%
3 to 4	43	7.8%
5 to 7	72	13.1%
8 to 10	113	20.5%
11 to 14	120	21.8%
15 to 20	138	25.0%
21 or more	57	10.3%

DOTS-R

The DOTS-R[15] is a revision of the initial Dimensions of Temperament Survey developed by Lerner and colleagues[25] to assess temperament factors. The DOTS-R, a 54-item questionnaire, measures 10 adult temperament dimensions: (1) activity level-general; (2) activity level-sleep; (3) approach-withdrawal; (4) flexibility-rigidity; (5) mood quality; (6) rhythmicity-sleep; (7) rhythmicity-eating; (8) rhythmicity-daily habits; (9) distractibility; and (10) persistence. The internal consistency coefficients (Cronbach's alpha) reported by Windle and Lerner were .84, .89, .85, .78, .89, .78, .80, .62, .81, and .74, respectively, for the 10 listed factors demonstrating acceptable reliability of this instrument.[15,26]

Data Analysis

Data analysis was conducted using SPSS Version 19 (IBM Corp, 2010). Pairwise deletion was used to control for missing data so that the respondent was dropped from the analyses that involved only the variables that have missing values. Linear regressions were used for data analyses using the "enter" method which enters all variables at the same time. The first linear regression analysis was used to determine which temperamental factors would be associated with PTSD scores. All 10 temperament dimensions were entered into the model and regressed on the total PTSD score. The second linear regression was conducted in which the temperament factors plus demographics and service-related characteristics were used to predict PTSD score.

Results

In the first regression analysis (Model 1), all 10 temperament factors were entered into a linear regression as independent variables; 4 of the 10 temperament dimensions were found to be significant predictors of the PTSD score: mood quality, activity level-sleep, flexibility-rigidity, and activity level-general. This regression analysis determined that temperament dimensions predict 36% of the variance for a PTSD score. Mood quality was found to be the strongest predictor, responsible for 26% of variance in PTSD scores. The remaining significant variables (activity level-sleep, flexibility-rigidity, and activity level-general) only accounted an additional 10% of the variance in the PTSD score. Therefore, mood quality is the best predictor of self-reported PTSD symptoms. Table 3 presents the descriptive statistics for the temperament dimensions and the PTSD measure.

The second regression analysis (Model 2) was conducted to determine if the effects found in the first regression equation remained after adding the demographic and service-related variables. Mood quality, activity level-sleep, flexibility-rigidity and activity level-general remained significant predictors after adding the demographic variables and service-related variables. Rhythmicity-sleep and rhythmicity-daily habits of the temperament dimensions, age and race of the demographic variables, and branch of the service related variables were also found to be significant in this second model. However, the addition of all these variables into the model only increased the variance accounted for by 3%. The regression models are shown in Table 4.

Comment

Using self-report measures, the temperament dimensions appear to be related to PTSD symptomology. The mood quality temperament dimension was found to be the strongest predictor of self-reported PTSD score followed by activity level-sleep, flexibility-rigidity and activity level-general. The inverse relationship indicates that individuals reporting higher mood quality reported lower PTSD symptom scores. This result is similar to that reported by Miller[27] in that the personality construct of positive and negative emotionality was related to PTSD. Personality constructs like positive and negative emotionality have been found to be closely related to dimensions of temperament identified in early childhood and infancy, and that these constructs remain stable throughout adulthood.[27] Changes in sleep and restlessness are consistently listed symptoms for PTSD within the DSM-IV. Gellis et al[28] studied sleep disturbances in service members with a positive PCL-C screen for PTSD and found a "positive relationship between depression and nightmares" with disturbed sleep. Measures of the mood quality dimension, including other temperament factors, have been demonstrated to be relatively stable over a lifespan. This is a reflection of the individuals' temperaments and not affective symptoms associated with PTSD. The contrary is plausible however, and further investigations with a within-subjects design of

Table 3. Descriptive Statistics for Temperament Dimensions and Posttraumatic Stress Disorder Measure.

	N	Minimum	Maximum	Mean	SD
Activity Level General	559	7	28	18.12	4.47
Activity Level Sleep	551	3	16	10.83	3.41
Approach-Withdrawal	559	8	28	18.74	3.47
Flexibility-Rigidity	559	5	20	14.39	3.00
Mood Quality	559	5	28	22.30	4.91
Rhythmicity-Sleep	559	2	24	14.76	4.00
Rhythmicity-Eating	559	3	20	13.14	3.70
Rhythmicity-Daily Habits	559	2	20	11.77	2.95
Distractibility	559	5	20	12.23	2.79
Persistence	559	2	12	8.57	1.65
PTSD Score	547	17	76	30.21	14.33
Valid N listwise	543				

pre- and postdeployment measures of temperament may elaborate the relationship quantitatively.

Research suggests that PTSD disposition in the military may be based on predisposing factors including gender, age at trauma, race, education, previous trauma, general childhood adversity, psychiatric history, reported childhood abuse, and family psychiatric history.[29,30] Some of these factors, such as race, were only significant in certain populations. Others such as general childhood adversity had more uniform predictive effects and predicted PTSD more consistently.

One limitation of our study is the relatively small sample size and limited military occupational specialties. Our modest sample size yielded some significant findings, but the ideal population sample would include a larger number of personnel with a variety of occupations to represent the entire spectrum of military members to include but not be limited to combat ready infantry, mechanized cavalry, medical personnel, logisticians, and ordinance personnel, among others. Our sample was derived from installations within Joint Base San Antonio, Texas, where the primary missions are basic training, medical education and training, and health care delivery.

A second limitation could result from the use of a self-report instrument. The use of self-reporting surveys/screening tools are commonly thought to be biased, however, social science depends on these tools. Brener and colleagues reviewed over 100 studies of self-reported questionnaires for validity and determined that they are "accurate when individuals understand the questions and when there is a strong sense of anonymity and little fear of reprisal."[31] Any bias in self-reporting may result from participants completing the questionnaires in non-controlled environments, such as at a food court, at home or workspace, either alone or in the presence of others, which may cause reluctance in providing honest answers.[32]

It is important to note that the DSM-IV has been updated to a newer version (DSM-V[33]), however, the PTSD measure used in this study is based upon the DSM-IV criteria and for consistency we used the DSM-IV criteria for this study. In our opinion, this does not reflect on the results being presented.

Conclusion

Our results indicate the need to increase research in the area of temperament/PTSD to determine if people with certain temperaments may be more vulnerable to PTSD. If this is the case, efforts to develop and provide protective/preventative measures before exposure to traumatic situations may be considered. In addition, perhaps the most vulnerable could be assigned to a military occupation that is supportive of "goodness of fit" between temperament and occupation, and even minimize exposure to traumatic situations.[7,9] This information is important for the well-being of our military service members and should continue to be studied.

Future Directions

Both findings and limitations to this study provide insight into future directions for research into the relationship between temperament and PTSD. To the authors' knowledge, this was the first study of temperament and PTSD within a military sample. Its replication would strengthen the initial findings. Additional cross-sectional designs may benefit from a more inclusive model of the variation in PTSD symptoms to control for known moderators and risk factors not measured in the study, such as trauma intensity, peritrauma fear, and combat exposure.[30,32] These findings may help clinicians take into account a patient's unique temperament when treating personnel affected by PTSD.

Table 4. Regression Models Predicting Posttraumatic Stress Disorder Score.

	Model 1			Model 2		
Variable	B	SE	β	B	SE	β
(Constant)	58.14	5.57		50.94	7.43	
Activity Level General	0.43	0.13	0.13, *P*<.001	0.44	0.13	0.14, *P*<.001
Activity Level Sleep	0.79	0.16	0.19, *P*<.001	0.81	0.16	0.19, *P*<.001
Approach-Withdrawal	-0.05	0.18	-0.01	-0.08	0.18	-0.02
Flexibility-Rigidity	-0.78	0.19	-0.16, *P*<.001	-0.71	0.20	-0.14, *P*<.001
Mood Quality	-0.89	0.12	-0.30, *P*<.001	-0.84	0.12	-0.28, *P*<.001
Rhythmicity-Sleep	-0.35	0.18	-0.09	-0.44	0.18	-0.12, *P*<.05
Rhythmicity-Eating	-0.17	0.19	-0.04	-0.06	0.19	-0.01
Rhythmicity-Daily Habits	-0.45	0.23	-0.09	-0.49	0.23	-0.10, *P*<.05
Distractibility	-0.08	0.21	-0.02	-0.12	0.21	-0.02
Persistence	0.19	0.35	0.02	0.34	0.35	0.04
Age				1.46	0.66	0.09, *P*<.05
Gender				1.21	1.16	0.04
Race				1.13	0.55	0.07, *P*<.05
Ethnicity				-1.31	1.60	-0.03
Branch of Service				-1.79	0.50	-0.13, *P*<.001
Marital Status				0.91	0.70	0.05
Education				-0.18	0.57	-0.02
Rank Combined				-0.06	0.34	-0.01
Adjusted R^2	0.357			0.385		
F for model (*df*)	31.15(10,532), *P*<.001			19.37 (18,511), *P*<.001		

B indicates the unstandardized coefficient.
β indicates standardized coefficient.

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Predicting Willingness to Report Behavioral Health Problems and Seek Treatment Among US Male Soldiers Deployed to Afghanistan: A Retrospective Evaluation

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Abstract

This retrospective evaluation explores anonymous survey data to identify predictors of Soldier willingness to report and seek treatment for behavioral health problems during screening mandated by the Department of Defense (DoD). After controlling for stigma and barriers to care concerns, Soldiers with high (+1SD) combat exposure and high (+1SD) levels of posttraumatic stress symptoms were significantly more willing to report these symptoms during DoD-mandated screening. Furthermore, Soldiers who perceived that their unit leaders took action on anonymous Unit Behavioral Health Needs Assessment survey findings were significantly more likely to report a willingness to disclose behavioral health problems and seek treatment for the same. Performance improvement considerations are discussed.

Anonymous estimates indicate that up to 30% of veterans returning from combat operations in Iraq and Afghanistan meet screening criteria for various psychological problems.[1,2] Fewer than half of Soldiers who meet anonymous screening criteria for a behavioral health problem report these problems during Post-Deployment Health Assessment (PDHA) screening.[3] Furthermore, Soldiers who met anonymous screening criteria for a behavioral health problem were significantly less willing to honestly report these problems during PDHA screening.

Rates of Soldiers identified as having behavioral health problems during non-anonymous screening mandated by the Department of Defense (DoD) are less than half the anonymous estimate.[3] Furthermore, among Soldiers identified during DoD-mandated screening as having a behavioral health problem, less than 10% received treatment for these problems within the first year following their return from combat operations.[1]

Stigma and barriers to care are 2 factors with empirical support that help explain why Soldiers with behavioral health problems are reluctant to report these problems during DoD-mandated screening.[1,2,4] Stigma concerns Soldier beliefs that others (eg, leaders and/or fellow unit members) might think less of them for seeking treatment. Barriers to care include Soldier perceptions that certain obstacles make accessing available treatment services difficult (eg, getting time off work, scheduling an appointment).

This retrospective evaluation explores anonymous Unit Behavioral Health Needs Assessment (UBHNA) data in order to identify predictors of Soldier willingness to honestly report problems and seek treatment during PDHA screening.* Special emphasis was given to identifying organizational factors that unit leaders and behavioral health officers might be able to influence in order to encourage honest reporting of mental health problems during an upcoming PDHA screening and subsequent treatment seeking when indicated.

Method

Periodic use of anonymous surveys to evaluate rates of behavioral health problems is common among deployed units.[5] The UBHNA survey is an anonymous survey used by behavioral health officers to assist unit commanders with combat stress control planning.[6,7] Consisting of 6 pages that query 7 content areas (ie, demographics, deployment experiences, work environment, training, behavioral health, family, and survey satisfaction), the UBHNA survey is a compilation of free, open-source scales previously validated on a military population (eg, the 17-item Posttraumatic Stress Disorder Checklist, the 9-item Patient Health Questionnaire for depression).[2,8-10] Key capabilities of the UBHNA include estimates of Soldiers meeting screening criteria for behavioral health problems (ie, depression, posttraumatic stress disorder (PTSD), and suicidal ideation), stigma and barriers to care concerns, and a variety of unit climate characteristics (eg, leadership, cohesion, mission readiness).

Large-sample norms established at 3 different time points (pre-, during-, and postdeployment) for nearly every item on the UBHNA are used as a rough gauge of

*Restricted access: https://www.rto.wrair.army.mil/bhr.html

unit behavioral health at each phase in the deployment cycle. Behavioral health officers are trained to use the UBHNA to provide anonymous estimates of behavioral health problems within a particular unit, provide feedback in relation to established norms, and make recommendations on ways to improve unit behavioral health.

Like the Mental Health Advisory Team reports that informed the creation of the UBHNA,[5,6] this study uses a conceptual framework that is based on the Soldier Adaptation Model (SAM).[11] The SAM consists of 3 domains: stressors, moderators, and strains.

Stressors include workplace conditions that tax the physical or psychological fitness of Soldiers (eg, combat exposure, austere living conditions). Moderators "are attitudes and circumstances that increase or decrease the impact of stressors (eg, leadership climate)."[12] Finally, strains are potential outcomes (eg, depression, PTSD) following exposure to stressors and moderators.

While there is a strong dose-response relationship between combat exposure and psychological problems like PTSD, unit leaders have limited ability to moderate levels of combat exposure. The UBHNA, however, can help unit leaders identify behavioral health interventions which are designed to help Soldiers cope with known risk factors (eg, seeking evidenced-based treatment for PTSD).

In late June 2011, the task force commander responsible for approximately 750 Soldiers assigned to an infantry battalion requested a UBHNA survey which was conducted in July 2011. The unit deployed to Afghanistan in January of 2011 and conducted counterinsurgency operations in the eastern province from January 2011 until December 2011. This was the second year-long deployment to Afghanistan for this unit in 3 years. In November of 2011, approximately one month prior to PDHA screening, a second iteration of the UBHNA survey was conducted on this same task force by the same 2-man combat stress control team collocated within the unit's battalion aid station.

The study sample consisted of Soldiers assigned to an infantry battalion performing combat operations in Afghanistan. There were 6 subordinate (company) commands within the battalion, four of which were infantry companies consisting of approximately 100 Soldiers, a headquarters company with a scout platoon, and a support company responsible for meeting the logistic needs of the battalion. Three of 4 infantry companies occupied their own combat outposts within the battalion's area of operations, while the battalion staff/headquarters company, logistic support company, and an infantry company all shared a common forward operating base in the eastern region of Afghanistan. Female Soldiers were excluded from this analysis given known gender differences in healthcare utilization rates,[13-16] and too few female participants (n=4).[17] Analysis of the UBHNA survey data was authorized under a protocol approved by the Joint Combat Casualty Research Team, Bagram, Afghanistan.

Measures

Willingness to Honestly Report Behavioral Health Problems and Seek Treatment. Two items were added to the standard UBHNA survey that explored Soldier willingness to honestly report symptoms on an upcoming PDHA, as well as willingness to seek treatment if screening indicated (or Soldiers believed) they had a behavioral health issue.[3] Using a scale ranging from 1 (strongly disagree) to 5 (strongly agree), Soldiers were asked to indicate how much they agreed with the following statements: "I feel comfortable honestly reporting any behavioral health problems during the postdeployment screening," and "If screening results indicate or I believe I have an ongoing behavioral health issue, I will seek treatment."

Combat Exposure. Five items on the UBHNA survey query combat exposure levels. Two of the 5 items ("How often were you in serious danger of being injured or killed?" and "How many times did you engage the enemy in a firefight?") used a scale ranging from 0 (never) to 3 (many times). The remaining 3 items were dichotomous (eg, "Were you responsible for the death of an enemy combatant?"). A dichotomous sum score was created from all 5 items (α=.34).

Posttraumatic Stress Disorder Checklist (PCL): Anonymous rates of posttraumatic stress disorder (PTSD) were estimated using a cut-off score of 50 or higher on the PCL.* The PTSD Checklist (PCL) was first developed by researchers within the Veterans Administration.[18] Overall Cronbach's alpha for the PCL have ranged from 0.87 to 0.97 in research conducted across a broad spectrum of trauma-related research.[19] A continuous scale of PCL symptom levels was used for this retrospective evaluation (α=.93).

Patient Health Questionnaire-8 (PHQ-8): The PHQ-8 used for this retrospective study constitutes a modification to the PHQ-9, a validated screen for depression widely used throughout the DoD for both research and clinical purposes.[20-22] Because one item from the PHQ-9

*Restricted access: https://www.rto.wrair.army.mil/bhr.html

is used to estimate both depression and suicidal ideation, the item measuring suicidal ideation was removed from the scale and used as an independent predictor of willingness to report behavioral health problems and/or seek treatment (see Suicidal Ideation below).

Soldier responses were measured using a scale ranging from 0 (not at all) to 3 (nearly every day). Sum scores were produced using the 8 remaining items of the PHQ-9 (α=.87).

Suicidal Ideation (SI): Estimates of SI were taken from a single item on the PHQ-9 (ie, "Over the LAST 4 WEEKS, how often have you been bothered by…thoughts that you would be better off dead, or of hurting yourself in some way"). A scale ranging from 0 (not at all) to 3 (nearly every day) was used to measure Soldier responses. Scores on this item were treated as a continuous variable.

Table 1. Demographic Characteristics of Sample.

Variable	UBHNA No. (%N) (N=150)*
Age (years)	
18-24	81 (54.0)
25-29	40 (27.0)
≥30	29 (19.0)
No. of prior deployments	
0	102 (69.0)
1	41 (28.0)
≥2	5 (3.4)
Rank	
Enlisted	95 (64.0)
Noncommissioned officers	42 (28.0)
Officers	11 (7.0)
Psychological disorders	
Posttraumatic stress disorder	26 (17.3)
Depression	4 (2.7)
Suicidal ideation	22 (14.8)
Any problem	39 (26.0)
Source of mental health services received in the past year	
Mental health professional at a military facility	21 (14.0)
General medical doctor at a military facility	11 (7.3)
Military chaplain	16 (10.7)
Medic in unit	16 (10.7)
Soldier in unit (excluding medic)	22 (14.8)

*Exact numbers vary due to missing data.

Stigma: Six items on the UBHNA survey query Soldier perceptions of stigma concerning behavioral healthcare. All stigma items were preceded by the following stem: "Rate each of the possible concerns that might affect your decision to receive behavioral health counseling or services." Soldiers evaluated all 6 items using a scale ranging from 1 (strongly disagree) to 5 (strongly agree). Sample stigma items include: "Members of my unit might have less confidence in me," and "It would harm my career." A sum score was created using all 6 items (α=.93).

Barriers to Care: Four items on the UBHNA survey query Soldier perceptions of barriers to care. All items were preceded by the following stem: "Rate each of the possible concerns that might affect your decision to receive behavioral health counseling or services." Soldiers evaluated all 4 items using a scale ranging from 1 (strongly disagree) to 5 (strongly agree). A composite variable was created by summing all 4 items (α=.76).

UBHNA Survey Follow-up: Five items were added to the standard UBHNA survey to evaluate Soldier perceptions of unit leader use of the July 2011 UBHNA survey findings.[23,24] All 5 items employed a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Three items queried perceptions of survey-based actions (ie, feedback, problem identification, and visible action) taken by unit leaders following the July UBHNA survey to improve the psychological wellbeing of their Soldiers (eg, "In the PAST 3 MONTHS: I believe my unit used the July 2011 survey results to identify issues for improvement"). A sum score was generated across all 3 survey-based actions (α=.84).

Linear regression was used to evaluate predictors of Soldier willingness to honestly report behavioral health problems during PDHA screening. A series of 3 statistical models were used to predict Soldier willingness to honestly report problems during an upcoming PDHA. Model 1 included strain indices for mental health problems (adjusted for rank and combat exposure levels) which would logically predict the perceived need to report problems and/or seek treatment. Model 2 included established moderators of Soldier willingness to report problems and/or seek treatment (eg, stigma), as well as an exploration of routine unit climate variables found on the UBHNA (eg, leadership, cohesion, morale) and items added as part of a UBHNA survey follow-up. Finally, Model 3 examined the interaction between combat exposure and PTSD symptoms when predicting Soldier willingness to report problems and/or seek treatment in the event that either differed as a function of this interaction. Soldiers who arrived after July (n=7) or failed to provide an arrival date (n=9) were removed from analysis. All analyses were performed using IBM SPSS (Ver 21).

Results

Table 1 describes the demographic characteristics of this sample. The majority of Soldiers were young males (≤24 yrs), enlisted (64%), and serving their first deployment (69%). Seventeen percent of Soldiers met criteria for PTSD, 15% reported some level suicidal ideation in the past month, while only 3% met criteria for depression—rates comparable to during- and postdeployment norms reported elsewhere.[2,3] Among sources of mental health services received during the past year, 14%

of Soldiers sought services from a mental health professional. While representative of US Army infantry battalions, the demographic characteristics of this sample differs in important ways from the sample used to create UBHNA during deployment norms; namely, this was an all-male sample of younger, more junior ranking Soldiers relative to the UBHNA sample.*

Table 2 presents χ^2 findings related to the 6 stigma items, 4 barriers to care items, and willingness to report mental health problems and seek treatment during mandated PDHA screening. Replicating findings reported elsewhere,[4,20] Soldiers with any behavioral health problem were significantly more likely to endorse all stigma items and 3 of 4 barriers to care items than Soldiers who screened negative. Unlike previously reported findings, however, Soldiers with a current behavioral health problem did not differ in their willingness to honestly report behavioral health problems on the PDHA.[3]

Table 2. Stigma, Willingness to Honestly Report Behavioral Health Problems and Seek Treatment (N=130).*

Survey Item	Any Problem†	χ^2	*P*
I don't know where to get help.	Negative (n=94)	8.54	.074
	Positive (n=36)		
I don't have adequate transportation.	Negative (n=94)	15.16	.004
	Positive (n=36)		
It is difficult to schedule an appointment.	Negative (n=94)	12.85	.012
	Positive (n=36)		
There would be difficulty getting time off work for treatment.	Negative (n=94)	16.46	.002
	Positive (n=36)		
It would harm my career.	Negative (n=94)	34.14	.000
	Positive (n=36)		
Members of my unit might have less confidence in me.	Negative (n=94)	20.93	.000
	Positive (n=36)		
My unit leadership might treat me differently.	Negative (n=94)	19.67	.000
	Positive (n=36)		
I would be seen as weak.	Negative (n=94)	30.17	.000
	Positive (n=36)		
My visit would not remain confidential.	Negative (n=94)	23.24	.000
	Positive (n=36)		
My leaders discourage the use of behavioral health services.	Negative (n=94)	24.58	.000
	Positive (n=36)		
I feel comfortable honestly reporting any behavioral health problems during the postdeployment screening.	Negative (n=94)	5.32	.256
	Positive (n=36)		
If screening results indicate or I believe I have an ongoing behavioral health issue, I will seek treatment.	Negative (n=94)	6.58	.160
	Positive (n=36)		

*Data exclude missing values, because not all respondents answered every question.
†Any problem includes posttraumatic stress disorder, depression or suicidal ideation.

Table 3 presents bivariate correlations between outcome and predictor variables. There was a strong (positive) bivariate correlation between willingness to seek treatment and willingness to report behavioral health problems (r=0.75, P<.001). Weak (positive) correlations exist between perceptions of survey-based action and willingness to report problems (r=0.30, P<.01) and seek treatment (r=0.23, P<.05). There was no correlation between combat exposure levels and willingness to report problems or seek treatment. Depression symptoms (PHQ-8) were weakly (negatively) correlated with willingness to seek treatment (r=-0.15, P<.01). Neither PTSD symptoms nor SI symptoms were correlated with either outcome.

Table 4 presents fully standardized multivariate findings for a series of 3 models predicting willingness to honestly report behavioral health problems during PDHA screening. Model 1 is the baseline model that accounts for rank; combat exposure; and PTSD (PCL), depression (PHQ-8), and SI symptoms, none of which predicted willingness to honestly report behavioral health problems. Model 2 introduces individual-level perceptions of stigma, barriers to care, leader actions with respect to the July UBHNA survey findings, as well as prior treatment from a behavioral health professional in the past year. Results from this model indicate that when controlling for all other variables, officers (β=.92, P<.05) were significantly more willing to honestly report behavioral health problems relative to enlisted Soldiers. Furthermore, Soldiers who perceived that their unit leaders took any action on the July UBHNA survey findings were significantly more willing to report behavioral health problems (β=.12, P<.01). Finally, Model 3 includes a positive interaction between combat exposure and PTSD symptoms (PCL) when predicting willingness to honestly report behavioral health problems (β=.01, P<.05). Figure 1 is a plot of the interaction between combat exposure and PCL scores when predicting willingness to report problems. Soldiers with high PCL scores did not differ in their willingness to report mental health problems as a function of combat exposure. However, Soldiers with high (+1 SD) combat exposure and low (-1 SD) PCL scores were significantly less willingness to report behavioral health problems.

*Restricted access: https://www.rto.wrair.army.mil/bhr.html

Table 3. Correlation Matrix for all Outcome and Predictor Variables (N=134).[a]

	Range	M	SD	RPT	WTX	CBT	PCL	PHQ8	SI	STG	BTC	ACT	MHP
RPT – Willing to Report Problems	1-5	3.58	1.10	1.00									
WTX – Willing to Seek Treatment	1-5	3.69	0.99	0.75[b]	1.00								
CBT –Combat Exposure	0-5	2.93	0.95	-0.11	-0.18	1.00							
PCL – PTSD Symptoms	17-85	35.06	14.64	0.02	-0.04	0.46	1.00						
PHQ8 – Depression Symptoms	0-24	7.76	5.49	-0.09	-0.15[c]	0.51	0.71[b]	1.00					
SI – Suicidal Ideation	0-4	0.24	0.64	0.06	-0.00	0.41	0.35[c]	0.46[b]	1.00				
STG – Stigma	6-30	14.81	6.65	-0.09	-0.16	0.41	0.44[b]	0.51[c]	0.39[b]	1.00			
BTC – Barriers to Care	4-20	7.75	3.26	-0.03[d]	-0.10	-0.13	0.29[c]	0.41[d]	0.25	0.64[b]	1.00		
ACT – Visible Action	0-12	4.66	2.81	0.30[c]	0.23[d]	-0.13[b]	-0.14	-0.13	-0.03	-0.21	-0.01	1.00	
MPH – Mental Health Professional[e]	0-1	NA	NA	0.02	0.10	0.16	0.31[c]	0.16	0.12	0.09	-0.04	-0.20	1.00

[a]Data exclude missing values, because not all respondents answered every item.
[b]$P<.001$
[c]$P<.01$
[d]$P<.05$
[e]Dichotomous variable: 1=Yes (n=21) indicates received services from a mental health professional at a military facility in the *Past Year*; 0=No (n=113).

Table 4. Standardized Linear Regression Findings for Willingness to Report Behavioral Health Problems (N=120).

	Willingness to Honestly Report Behavioral Health Problems											
Variable	**Est**	**SE**	***t***	***P***	**Est**	**SE**	***t***	***P***	**Est**	**SE**	***t***	***P***
Model 1 (R^2=0.07, $F_{6,113}$=1.42, P=.21)												
Intercept	-0.08	0.13	-0.64	.521	-0.15	0.13	-1.13	.263	-0.21	0.13	-1.61	.110
Noncommissioned officer	0.13	0.22	0.58	.565	0.16	0.22	0.73	.469	0.17	0.21	0.82	.416
Officer	0.71	0.44	1.62	.108	0.92	0.43	2.14	.035	1.01	0.42	2.37	.019
Combat exposure	-0.20	0.11	-1.77	.080	-0.18	0.12	-1.61	.111	-0.19	0.11	-1.69	.094
Posttraumatic stress symptoms (PCL)	0.02	0.01	1.63	.106	0.02	0.01	1.69	.093	0.01	0.01	1.42	.160
Depression symptoms (PHQ-8)	-0.05	0.03	-1.72	.088	-0.04	0.03	-1.32	.190	-0.03	0.03	-1.19	.236
Suicidal ideation	0.17	0.19	0.90	.372	0.21	0.19	1.11	.268	0.24	0.19	1.26	.210
Model 2 (ΔR^2=0.10, $F_{4,109}$=2.16, P=.05)												
Stigma					-0.01	0.02	-0.52	.603	-0.01	0.02	-0.57	.569
Barriers to care					0.02	0.04	0.58	.566	0.01	0.04	0.33	.743
Any survey-based action					0.12	0.04	3.33	.001	0.12	0.04	3.34	.001
Mental health treatment (Past Year)					0.28	0.29	0.98	.329	0.27	0.28	0.97	.335
Model 3 (ΔR^2=0.04, $F_{1,120}$=6.30, P=.05)												
Combat Exposure X PCL									0.01	0.01	2.11	.037

PHQ-8 indicates Patient Health Questionnaire-8. PCL indicates postraumatic stress disorder checklist

Table 5 presents fully standardized multivariate findings for willingness to seek treatment if PDHA screening indicates (or Soldiers believed) they had a behavioral health problem. Beginning with Model 1, only combat exposure (β=-.23, $P<.05$) was negatively correlated with willingness to seek treatment. After including stigma, barriers to care, prior treatment from a behavioral health professional, and perceptions of any leader actions to address the July UBHNA survey findings (Model 2), we see that officers (β=.90, $P<.05$) were significantly more willing to seek treatment relative to enlisted Soldiers. Conversely, Soldier perceptions that unit leaders took any survey-based action was positively correlated with willingness to seek treatment (β=.09, $P<.01$). Finally, the interaction between combat exposure and PCL scores (Model 3) was not significant.

Comment

Collectively, these findings continue to highlight the dose-response relationship between combat exposure and behavioral health problems like PTSD. When evaluating the interaction between combat exposure and

PTSD symptoms, we see that Soldiers' willingness to report behavioral health problems increases as both combat exposure and PTSD symptoms increase.

However, Soldier willingness to seek treatment for a behavioral health problem identified during PDHA screening varied only as a function of combat exposure—as exposure levels increased, willingness to seek treatment decreased.

Clearly, Soldiers weighted other factors as more important than behavioral health symptoms levels when contemplating their willingness to seek treatment. The Soldier Adaption Model continues to have conceptual relevance here, in that it allows researchers to explore possible moderators of combat exposure—willingness to seek treatment relationship. Soldiers who perceived that their unit leaders took visible action on prior UBHNA survey findings were significantly more willing to report behavioral health problems during PDHA screening; so too for willingness to seek treatment if PDHA screening indicated (or Soldiers believed) they had a behavioral health problem. These exploratory findings suggest multiple benefits stemming from leader actions to improve the (psychological) command climate of their unit in response to UBHNA survey findings. Not only do perceptions of survey-based actions predict Soldier willingness to participate in future UBHNA surveys,[24] survey-based actions by unit leaders appears to encourage both honest reporting and treatment seeking among their subordinates.

Given the nonrandom (convenience) sampling methods used in this retrospective study, findings reported here may not generalize beyond this unit. Furthermore, no attempt was made to verify whether unit leaders actually had taken survey-based action in response to the July UBHNA survey. Finally, these data did not allow for assessment of actual reporting during PDHA relative to Soldier intentions to report captured by the November UBHNA.

These findings merit replication. Future studies should examine the relative contribution of various forms of UBHNA survey follow-up (eg, feedback, problem identification, visible action) when predicting Soldier willingness to report problems and/or seek treatment. Finally, the ability to track actual treatment-seeking would add an important element missing in this retrospective study.

Acknowledgement

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Table 5. Standardized Linear Regression Findings for Willingness to Report Behavioral Health Problems (N=120).

	Willingness to Seek Treatment for a Behavioral Health Problem											
Variable	Est	SE	*t*	*P*	Est	SE	*t*	*P*	Est	SE	*t*	*P*
Model 1 (R^2=0.10, $F_{6,113}$=2.04, *P*=.07)												
Intercept	-0.11	0.11	-0.98	.331	-0.20	0.11	-1.72	.088	-0.24	0.12	-2.08	.040
Noncommissioned officer	0.21	0.19	1.06	.292	0.22	0.19	1.13	.260	0.23	0.19	1.21	.231
Officer	0.75	0.38	1.97	.052	0.90	0.38	2.40	.018	0.97	0.38	2.57	.011
Combat exposure	-0.23	0.10	-2.31	.023	-0.20	0.10	-1.95	.054	-0.20	0.10	-2.01	.047
Posttraumatic stress symptoms (PCL)	0.01	0.01	1.42	.159	0.01	0.01	1.12	.265	0.01	0.01	0.89	.377
Depression symptoms (PHQ-8)	-0.04	0.02	-1.53	.130	-0.02	0.03	-0.80	.426	-0.02	0.03	-0.69	.493
Suicidal ideation	0.01	0.17	0.05	.964	0.02	0.17	0.15	.885	0.04	0.17	0.25	.802
Model 2 (ΔR^2=0.08, $F_{4,109}$=2.37, *P*<.05)												
Stigma					-0.01	0.02	-0.46	.648	-0.01	0.02	-0.50	.622
Barriers to care					-0.00	0.03	-0.10	.918	-0.01	0.03	-0.31	.760
Any survey-based action					0.09	0.03	2.76	.007	0.09	0.03	2.75	.007
Mental health treatment (Past Year)					0.49	0.25	1.95	.054	0.48	0.25	1.94	.055
Model 3 (ΔR^2=0.03, $F_{1,120}$=4.12, *P*<.05)												
Combat Exposure X PCL									0.01	0.01	1.69	.095

PHQ-8 indicates Patient Health Questionnaire-8. PCL indicates postraumatic stress disorder checklist

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A Heart Gripping Case: Carcinoid Heart Disease

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A 63-year-old female with stage I poorly differentiated ductal carcinoma of the left breast, tumor tissue positive for both estrogen and progesterone receptors, was treated with lumpectomy followed by 4 cycles of adriamycin and cyclophosphamide. Following a course of adjuvant radiation, she was started on hormonal therapy with an aromatase inhibitor, anastrozole. After 18 months of hormonal therapy, the patient developed recurrent hot-flashes and facial flushing. These symptoms were only partially relieved with venlafaxine. She also developed recurrent atypical chest pain and mid-epigastric pain, occurring intermittently during her treatment, several times per week for 4 to 5 five years. At the initial time of this complaint, she underwent a thorough cardiac workup, including a gated exercise treadmill test with thallium based nuclear medicine imaging showing a normal electrocardiogram, normal ejection fraction, but with imaging concerning for anterolateral ischemia. A follow-up left heart catheterization was consistent with moderate one-vessel coronary artery disease involving the first diagonal branch of the left circumflex coronary artery. Cardiology felt this was not contributing to her chest pain and no intervention was undertaken. As the initial episode of chest pain occurred shortly after starting alendronate for osteopenia, her treating physicians believed they may be related and changed this medication to intravenous zoledronic acid. Despite resolution of her symptoms for a few weeks, her symptoms returned. She was then evaluated by gastroenterology and a thorough workup including liver specific enzymes, lipase, esophageal and gastric biopsies, abdominal imaging including ultrasound, computed tomography, and upper endoscopy were all normal. She was treated empirically with dicyclomine and omeprazole.

Her symptoms worsened with new complaints of dysphagia along with continued vasomotor symptoms. She underwent a barium swallow showing a delay at the aortic arch and distal esophagus; repeat upper endoscopy and abdominal CT were both normal. Esophageal dilatation was performed and she was started on empiric medical treatment for esophageal spasms with a calcium channel blocker and as needed sublingual nitroglycerin. Her symptoms improved significantly with this medication regimen, but never totally resolved. Approximately one year later, she had a syncopal episode with a repeat unremarkable cardiac workup including electrocardiogram, transthoracic echocardiogram, and holter monitor, and the event was attributed to vasovagal syncope. Her hot-flashes, chest pain, and mid-epigastric pain continued intermittently with further workup unremarkable including a negative HIDA scan and negative repeat upper endoscopy. A gastric emptying scan did reveal significant delayed gastric emptying, but pro-motility agents failed to improve her symptoms.

Four years after her initial complaints of intermittent atypical chest pain, abdominal pain, and vasomotor symptoms, a repeat abdominal CT revealed an enlarging 2.3cm by 2.3 cm soft tissue mass noted within the mesentery adjacent to the duodenum with internal calcifications. Given the location of the tumor and concomitant vasomotor symptoms, the diagnosis of carcinoid syndrome was entertained. A subsequent serum chromogranin A was elevated at 52 ng/ml (reference normal <34 ng/ml) and a 24-hour urine 5-HIAA was elevated at 15 mg/24 hrs (reference range 0-6 mg/24 hrs). A PET-CT showed uptake in the lesion of concern, as well as focal hypermetabolic activity at the cecum without a clear anatomic correlate. An octreoscan confirmed radiotracer uptake in the soft tissue mass adjacent to the duodenum, a new liver lesion with uptake, and a single focus of uptake within the mediastinum without a clear anatomic correlate. She underwent a right hemicolectomy with liver wedge resection. Pathology confirmed metastatic carcinoid tumor in the distal ileum, mesoappendix, and liver.

Within one month after resection, she developed recurrent chest pain, diarrhea, and hot-flashes. Repeat chromogranin A levels were 159.2 ng/ml. Further workup with a postoperative octreoscan showed a new liver

lesion with radiotracer uptake and continued mediastinal uptake without a clear anatomic correlate. A gated cardiac CT showed a 1.5 cm soft tissue mass splaying the left anterior descending and the first diagonal branch coronary arteries, shown in Figures 1 and 2, with no discernible tissue plane between the mass and the ventricle. Cardiac MRI confirmed the mass at the bifurcation of these coronary arteries as well, with apparent continuity with the myocardium. She was evaluated by cardiothoracic surgery at our institution and this lesion was felt to be unresectable. She sought a second opinion at an outside institution and surgical resection of the tumor was performed. The patient noted immediate relief of her chest pain, flushing and diarrhea after the surgery and her chromogranin levels declined. She has been followed for one year since with serial PET scans and chromogranin levels without signs of definitive recurrence.

Carcinoid tumors are a heterogeneous group of neuroendocrine tumors whose clinical characteristics and behavior vary based on the primary site of origin, as each is derived from different precursor cells. Based on SEER data, most carcinoid tumors originate from the small bowel or appendix, and 80% of small bowel primary carcinoids are found in the ileum, as in our patient.[1] Given their location, small bowel carcinoid tumors commonly present with vague abdominal complaints as they must grow quite large to cause obstructive symptoms, and diagnosis is often delayed for years. Hence, the majority of patients present with metastases at diagnosis, most commonly to the liver and regional lymph nodes. Our patient presented in a similar fashion, with epigastric abdominal pain for several years prior to being diagnosed with metastatic disease.

Carcinoid syndrome, characterized by intermittent flushing, diarrhea and wheezing, is present in 5% to 7% of carcinoid tumors originating in the small bowel.[2] Carcinoid heart disease, occurring in more than 50% of patients with carcinoid syndrome,[3,4] usually manifests as right heart failure and valvular regurgitation secondary to valve and endocardial fibrosis. However, it is important to note cardiac metastases are included in the spectrum of carcinoid heart disease. Cardiac metastases are rare, though when they occur, carcinoid syndrome or metastatic disease to the liver is present a majority

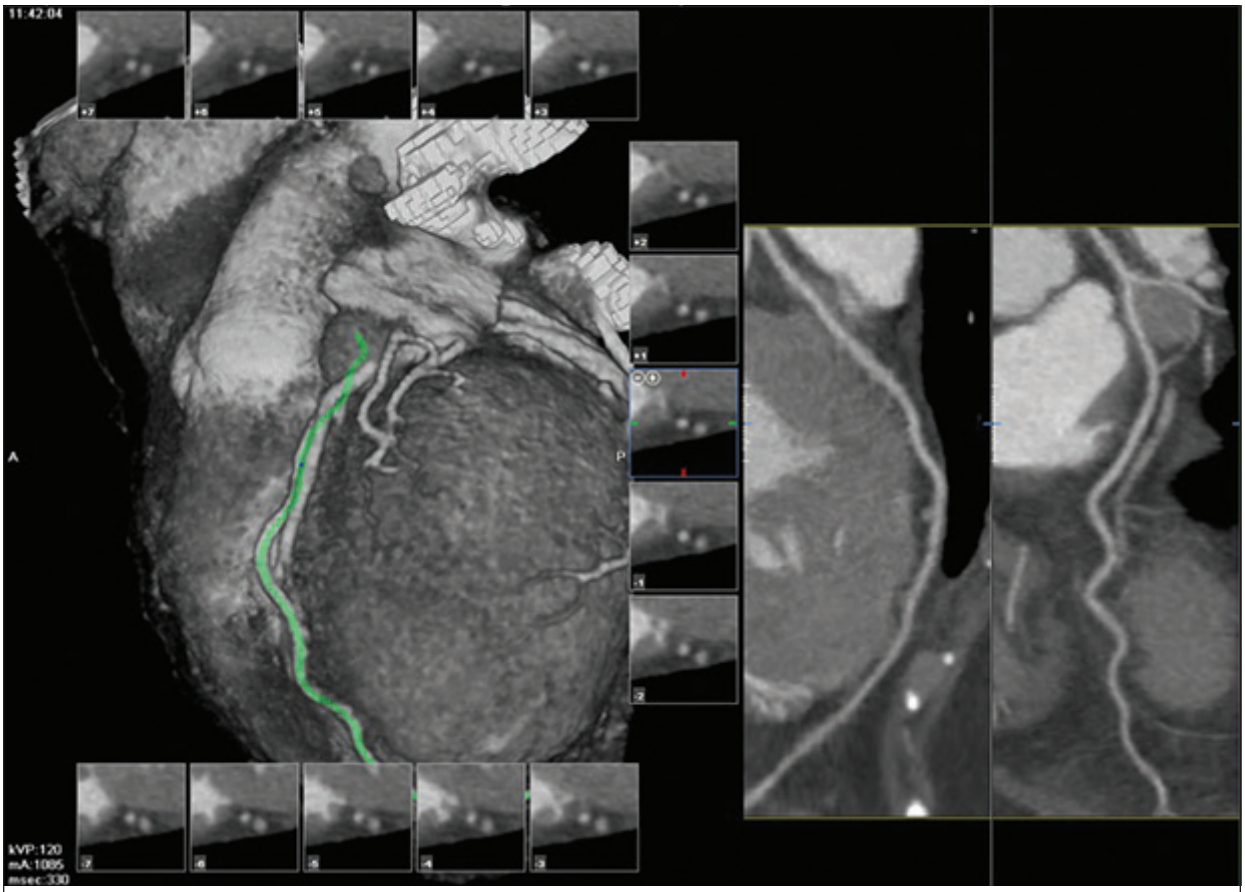

Figure 1. CT Coronary showing a 1.5 cm soft tissue mass splaying the left anterior descending and the first diagonal branch coronary arteries.

of the time. In our review of the literature, only slightly more than 20 cases of cardiac metastases were reported since 1980, the majority originating from the ileum. A case series of 74 patients with carcinoid by Pellika et al. found 3 (4%) patients had metastases to the heart, all of which originated from the ileum and were associated with carcinoid syndrome.[5] In another case series by Pandya et al, of 11 patients with myocardial metastases, 9 (82%) had ileal primary tumors, and all 11 had hepatic metastases and carcinoid syndrome.[6] Two other cases of cardiac metastases were found, both presenting as carcinoid syndrome and found to have small bowel primary tumors in the presence of extensive metastasis, including the heart.[7,8] Several cases of carcinoid heart disease without valvular involvement have been documented. Overall, these cases are similar to our case with respect to the extensive metastases and ileal primary, though this is one of only 2 cases presenting with angina.

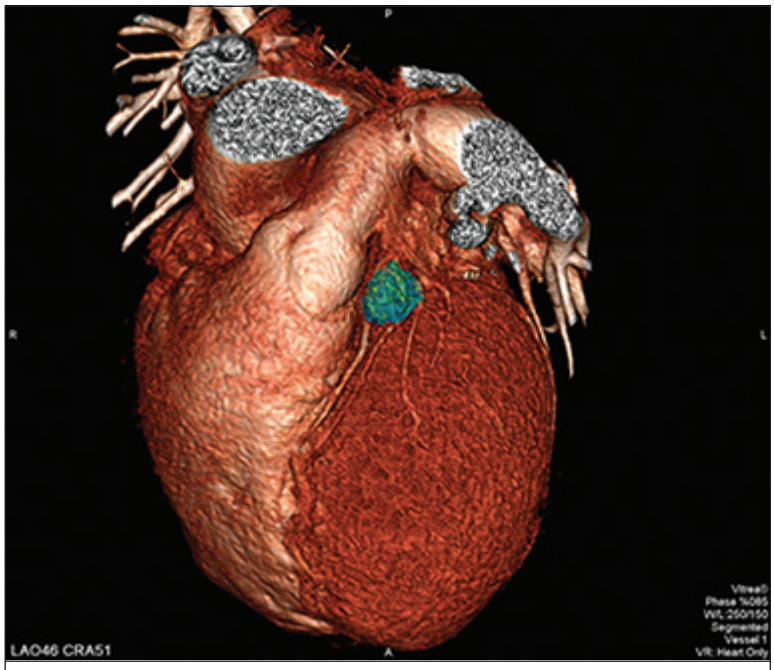

Figure 2. 3D CT Coronary showing a 1.5 cm soft tissue mass splaying the left anterior descending and the first diagonal branch coronary arteries.

Cardiac metastases can also occur in the absence of hepatic metastases as noted in 4 case reports, though only one originated from the small bowel. In one case, a carcinoid tumor of the heart was discovered incidentally on a CT scan for suspected pancreatitis and was subsequently found to have a pancreatic mass 6 months later, which was thought most likely to be the primary.[9] There were no manifestations of carcinoid syndrome or evidence of liver metastases. Another presented with symptoms of carcinoid syndrome and was found to have cardiac metastases along with a mass in the pancreatic head.[10] No hepatic involvement was discovered based on imaging and laparotomy findings. A third case involved a patient with known bronchial carcinoid, status post resection, who presented with symptoms of heart failure and was found to have diffuse infiltration of the myocardium with carcinoid tumor in the absence of valvular disease or hepatic metastases.[11] Another case is one of a patient with appendiceal carcinoid who developed cardiac arrest and at autopsy was found to have carcinoid infiltration of the a patient with myocardium.[12] One case describes carcinoid heart disease involving the interventricular septum, presenting with palpitations and paroxysmal atrial fibrillation.[13] Finally, one case describes a patient with metastatic carcinoid inducing coronary vasospasm with associated inferior ST-segment elevations.[14]

Based on the results of our literature review, cardiac metastases are most common in the presence of small bowel carcinoid tumors and hepatic metastases, though cardiac metastases without hepatic involvement have been demonstrated, and they may be more common than what is reported. It is also important to recognize cardiac metastases can occur in the absence of carcinoid syndrome, and as the sole manifestation of carcinoid heart disease. Furthermore, these metastases can cause symptoms of heart failure in the absence of valvular disease, cardiac arrest, arrhythmias, or angina by mass effect, as noted in our case. Hence, while cardiac metastases are rare in patients with carcinoid tumor, they should be considered in the differential for any patient presenting with cardiac-related complaints and a history of carcinoid tumor.

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Abstracts of Podium Presentations from the 4th Annual Academy of Health Sciences Graduate School Research Day

The following research abstracts were presented on December 10, 2014, as part of the 4th Annual US Army Academy of Health Sciences Graduate School Research Day at Joint Base San Antonio Fort Sam Houston, Texas.

Evaluation of the Anxiolytic Effects of Asiatic Acid, a Compound from Gotu kola or Centella asiatica, in the Male Sprague-Dawley Rat

Valdivieso DA, Kenner C, Lathrop K, Lucia A, Stailey O, Bailey H, Padrón G, Johnson AD, Ceremuga TE
US Army Graduate Program in Anesthesia Nursing

Purpose: Commonly used herbal remedies may have significant interactions on the administration of anesthesia. The purpose of this study was to investigate the anxiolytic and antidepressant effects of Asiatic acid and its potential modulation of the γ-aminobutyric acid (GABAA) receptor.

Participants: Fifty-four male Sprague Dawley rats were divided into 5 groups.

Methods: Fifty-four male Sprague Dawley rats were divided into 5 groups: vehicle (DMSO), Asiatic acid (AA), midazolam, or a combination of flumazenil with AA or midazolam with AA, and injected intraperitoneally 30 minutes prior to testing. All animals received equivalent intraperitoneal volumes consisting of 2 separate 1 ml injections, for a total volume of 2 ml. The rats were tested on the Elevated Plus Maze (EPM) for 5 minutes. All testing occurred between 3 PM and 9 PM over 4 consecutive days to control for the circadian rhythm of the animals. Data was analyzed using a 2-tailed multivariate analysis of variance (MANOVA) and a LSD post hoc test.

Results: Analysis of the ratio of open-arm time to total time in the EPM showed significant increases in time spent in the open arms by the rodents in the midazolam with AA group compared to the vehicle group, AA group, midazolam group, and flumazenil with AA group. Analysis of mobility in the EPM showed significant decreases in the mobility of rodents in the AA, midazolam, and the midazolam with AA group compared to the vehicle group. In addition, significant differences in levels of mobility were found between the flumazenil with AA group and the midazolam with AA group. Differences between the AA group and the midazolam with AA group were not statistically significant. Analysis of mean maximum speed in the EPM showed significant decreases in the speed of rodents in the AA and midazolam with AA group compared to the vehicle group.

Conclusion: There is possible synergistic or additive effect between AA and Midazolam, with AA action at unidentified receptor sites such as the central motor centers and peripheral neuromuscular junctions. Further studies are recommended to determine the efficacy of prolonged treatment for anxiety and depression as well as using additional anxiety tests such as light-dark exploration and open field test in the rat model.

Value/Relevance: The findings from this research are significant and relevant to nursing for several important reasons. It is imperative for healthcare providers to be knowledgeable about both traditional and alternative medicines to effectively anticipate possible interactions and administer safe anesthesia care perioperatively. Understanding psychological and physiologic effects of commonly used herbal medications such as Asiatic acid is important to explore their potentially therapeutic effects by reducing the untoward effects and morbidity associated with anxiety and also to avert any potential interactions.

Presentation of this abstract was selected as the best of the podium presentations at the 4th Annual Academy of Health Sciences Graduate School Research Day.

Prospective Musculoskeletal Injury Rates Among Different Categories of Soldiers

Shaffer SW, Teyhen DS, Butler RJ, Williams AM, Prye J, Goffar SL, Kiesel KB, Rhon DI, Plisky PJ
US Army-Baylor University Doctoral Program in Physical Therapy

This abstract was published in the *Journal of Sports and Orthopaedic Physical Therapy* (January 2015; Volume 45, No. 1, pages A37-A38).

Presentation of the above cited abstract was selected for second place among the podium presentations at the 4th Annual Academy of Health Sciences Graduate School Research Day.

Patient-Centered Medical Home Models and the Impact on Primary Care Practice within the Veterans Health Administration

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US Army-Baylor University Graduate Program in Health and Business Administration

Purpose/Hypothesis: Patient-centered medical home (PCMH) models have been touted as a way to enhance primary care provider efficiency, improve access to care, and significantly affect quality of care. Multiple pilot studies have been performed with variable results. The Veterans Health Administration has invested over $700 million to date transitioning all of their primary care clinics to this model, making it the largest integrated health system in the United States to do so. However, since they are still in the transitional process, the return on investment has yet to be fully determined. The aims of this literature review are to examine the changes the PCMH model has had on care for veterans in the United States and to determine if the transition to the PCMH model has proven beneficial to date.

Participants/Data Description: A literature review was performed per the methods detailed below.

Design/Methods/Materials: In order to perform a complete literature review on this topic, 4 separate search engines were utilized through the Baylor University library online: OneSearch Beta 2.0, CINAHL with Full Text, Wiley Online Library, and MEDLINE via EBSCO host. Articles included in the original searches included those that used the phrases "medical home model" and "primary care," as well as "veterans." Articles without original data, such as historical or review articles, were excluded. After application of exclusion criterion, a total of 23 articles were accepted for review.

Findings/Results: Five overarching themes emerged from the literature regarding outcomes from PCMH model implementation in the primary care clinics of the VHA: mental and behavioral health implications; homelessness, emergency care usage, and avoidable hospitalization; effect on and opportunities for patients with chronic illnesses; staff adjustments to structural changes and continuity of care; and financial impact.

Conclusions: The aims of this literature review were to examine the outcomes the PCMH model has had on care for veterans in the United States, and to determine if the transition to the PCMH model has proven beneficial to date. Based on the literature reviewed, the implementation of the PCMH model within the Veterans Health Administration has experienced positive and negative outcomes to the organization and staff, however, patient outcomes seem to be solely positive. The overarching goals of the PCMH model may not be met to date, but results since the onset of the transition are trending towards increasing access to primary care providers, decreasing improper utilization of emergency department care, improving utilization among veterans in special population groups, and increasing profitability.

Value/Relevance: The Veterans Administration's investment has not achieved its desired goals to date; however, the trends over time are promising and should continue to be monitored for long-term outcomes of PCMH transition. Lessons learned from studies involving structural changes and staff or cultural attitudes throughout this transition may be useful for other healthcare organizations considering transitioning to a PCMH model.

Presentation of this abstract was selected for third place among the podium presentations at the 4th Annual Academy of Health Sciences Graduate School Research Day.

Long-term Outcomes Among Patients Enrolled in Pre-diabetes Management With Registered Dietitians at a Large Academic Military Teaching Hospital

Henry C, Stankorb SM, Salgueiro M
Brooke Army Medical Center

Purpose/Hypothesis: If left unmanaged, pre-diabetes may progress to diabetes. Diabetes increases overall medical costs with a host of diabetes-related complications. Therefore, efforts to prevent progression of pre-diabetes may result in substantial health savings. The purpose of this review was to examine the conversion rate from pre-diabetes to diabetes for 3 years following initial enrollment in a pre-diabetes education and management program.

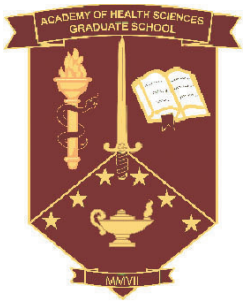
Participants/Data Description: Records included in this retrospective review were those of patients with an International Classification Coding (ICD-9) indicating diagnosis of pre-diabetes during calendar years 2008 through 2010. Records were included from individuals aged 17 or more years who attended the pre-diabetes group education program.

Design/Methods/Materials: Retrospective chart review using the M2 datamart to query medical records of patients meeting the above criteria. The following data was extracted for all identified individuals: gender, height, weight, age, body mass index (BMI), and A1C at the time point closest to the scheduled baseline appointment (±90 days). Patient's medical records were queried for BMI and A1C for 3 consecutive years after the initial visit anniversary (±90 days). Lastly, a query of the records for each patient was conducted to determine if they received an ICD-9 which indicated conversion from pre-diabetes to diabetes within the 3-year time frame.

Findings/Results: A total of 332 records was used in this retrospective performance improvement study. A slightly higher proportion of subjects were male (54.2%) and the average participant was aged 57.1±12.5 years at baseline. The mean BMI following the initial pre-diabetes education from year one through year three ranged between 30.0-31.5 kg/m^2 and the A1C mean was 6.0% to 6.1%. Of the patients with pre-diabetes who attended the pre-diabetes education, 24% were documented as converting to diabetes. The rate of conversion from pre-diabetes to diabetes was greatest during the first year with 9.3% converting. Each following year the rate of conversion decreased with only 6.3% converting during year three. There were no statistically significant differences in baseline characteristics and A1C between those who converted and those who did not.

Conclusions: The 3-year 24% conversion rate observed in this project was higher than the 14% rate observed at a similar time frame in the lifestyle intervention arm of the Diabetes Prevention Program (DPP). Given that nearly a quarter of patients converted from pre-diabetes to diabetes over 3 years, the overall pre-diabetes management program may not be optimized to achieve the desired result of delaying progression to diabetes over longer periods of time.

Value/Relevance: With the current scrutiny surrounding military budgets, optimizing programs that can reduce costs and resources, such as shared medical appointments, are essential. Cost effectiveness data from the DPP show that although a lifestyle intervention requires more initial resources, the cost per case of diabetes delayed or prevented offers a net cost savings over the long term.



Implications of Early and Guideline Adherent Physical Therapy for Low Back Pain on Utilization and Costs

Childs JD, Fritz JM, Wu SS, Flynn TW, Wainner RS, Kim FS, Robertson E, George SZ
US Army-Baylor University Doctoral Program in Physical Therapy

Purpose/Hypothesis: Initial management decisions following a new episode of low back pain (LBP) are thought to have profound implications for healthcare utilization and costs. The purpose of this study was to evaluate the impact of a patient's status on both timing and adherence to clinical practice guidelines. We also sought to determine if the precedent seen in civilian payer environments favoring early physical therapy referral regardless of guideline adherence would be observed in the Military Health System (MHS).

Participants/Data Description: Patients with a new consultation to a primary care provider for standard diagnosis of LBP from January 1, 2007, to December 31, 2009, were identified from the MHS Management Analysis and Reporting Tool (M2).

Design/Methods/Materials: Descriptive statistics, utilization, and costs were examined on the basis of timing of referral and adherence to practice guidelines (early + adherent, delayed + nonadherent, etc) over a 2-year period. Utilization outcomes were compared using adjusted odds ratios with 99% confidence intervals.

Findings/Results: 821,723 continuously-eligible patients with a primary care visit for LBP who were aged between 18 and 60 years at the index visit were considered, with 753,450 unique patients eventually included in the analysis. Mean age was 36.9 years (SD=12.5), with 42.2% being female. Physical therapy was used by 14.9% (n=122,723) of patients, with 24.0% (n=17,175) receiving early physical therapy that was also adherent to recommendations for active treatment. Early referral to guideline adherent physical therapy was associated with significantly lower utilization of advanced imaging, lumbar spinal injections, lumbar spine surgery, use of opioids, and 60% lower total LBP-related costs during the 2-year follow-up period.

Conclusions: Cost savings from early guideline adherent physical therapy may have important implications for designing optimal care process models.

Value/Relevance: Future research is necessary to examine which patients with LBP benefit most from early access to physical therapy and determine strategies for routinely providing early guideline adherent care.

Social Media: How Hospitals Use it and Opportunities for Future Use

Richter JP, Muehlstein D, Wilks C
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The paper for which this abstract was prepared was published in the *Journal of Healthcare Management* (November-December 2014; Volume 59, No. 6, pages 447-461).

Influence of Pain and Prior Injury on Musculoskeletal Injury Occurrence: A Prospective Review of a Large Military Cohort

Teyhen DS, Shaffer SW, Butler RJ, Goffar SL, Kiesel KB, Rhon DI, Plisky PJ
Office of The Surgeon General of the Army

This abstract was published in the *Journal of Sports and Orthopaedic Physical Therapy* (January 2014; Volume 44, No. 1, pages A39-A40).

A Novel Return to Duty Screening Tool for Military Clinicians

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INTRODUCTION:

- Musculoskeletal injuries represent the most costly threat to military medical readiness.[1]
- Previous injury has been cited on numerous occasions as the greatest predictor of future injury.[2]
- It is difficult to assess clinically when an injured service member has fully recovered, and there is no standardized procedure being utilized to assist military clinicians in making this determination.
- Although there are several systems aimed at predicting musculoskeletal injuries, they are equipment and time intensive and not specific to the military.[3,4]

PURPOSE:

- Assess the inter-rater and test-retest reliability of a newly proposed Return to Duty (RTD) screening tool that requires minimal training, equipment, time, is gender-neutral and can be used by any military clinician in any environment.

METHODS:

- Subjects
  - N = 34 (male = 22; female = 12)
  - Mean Age = 28.5 ± 5.9 years
- Procedures
  - Subjects were screened to ensure no sign of musculoskeletal injury or pain within the last two weeks
  - Subjects completed the RTD Screening tool consisting of (Figure):
    - Modified Overhead Deep Squat (3)
    - Modified Anterior Reach (3)
    - Modified Feagin Hop (2)
    - Modified Trunk Stability Push-Up (2)
    - Forward Step Down in Low Light (2)[5]
    - Modified Hip Abduction (2)[6]
    - Subjective Risk for Injury (2)[7]
- Data Analysis
  - Intraclass correlation coefficients
  - Kappa coefficients
  - Cronbach's alpha

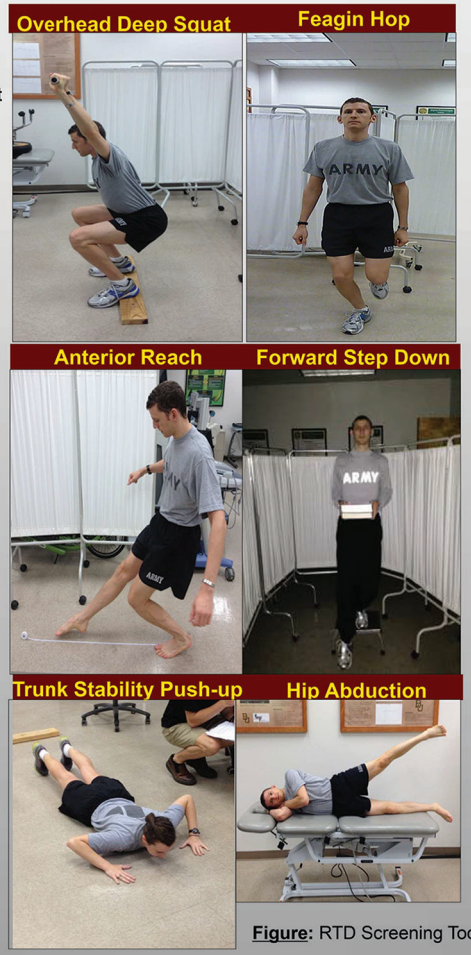

Figure: RTD Screening Tool

RESULTS:

- Mean Composite Scores (Maximum Score = 16)
  - Rater 1, Day 1: 11.26 ± 2.35
  - Rater 1, Day 2: 12.43 ± 1.47
  - Rater 2, Day 1: 11.38 ± 2.51
  - Rater 2, Day 2: 12.61 ± 1.73
  - Males: 11.3 ± 2.3, Females: 11.6 ± 3.0
- Reliability
  - The mean ICC (2,1) for inter-rater reliability was 0.88 (95% CI: 0.78,0.94).
  - All individual events demonstrated moderate to excellent chance-corrected agreement between raters (range: k = 0.52-1.0) with the exception of the modified hip abduction event which was rated fair (k = 0.26).
  - Test-retest reliability for the composite score was 0.57 (95% CI: 0.21, 0.79).
  - Cronbach's Alpha analysis was done to look at the internal consistency of all 7 items (α = 0.33-0.52)

DISCUSSION & CONCLUSIONS:

- This novel RTD screening tool showed good overall inter-rater reliability, suggesting that entry level clinicians trained on the grading requirements are able to reliably administer the tool.
- In addition, the screen showed gender-neutrality with no significant difference observed between males and females.
- However, the RTD screening tool had only moderate test re-test reliability, suggesting the presence of a learning effect.
- Future research should consider including a longer practice session to ameliorate any possible learning effect, as well as to evaluate validity for predicting musculoskeletal injury risk.

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- This study was approved by the Brooke Army Medical Center Institutional Review Board

U.S. ARMY MEDICAL DEPARTMENT
AMEDD CENTER & SCHOOL

The poster was selected as best of the presentations as part of the 4th Annual Research Day held December 10, 2014, at the Graduate School, Academy of Health Sciences, AMEDD Center & School, Joint Base San Antonio Fort Sam Houston, Texas.

Ultrasound imaging of the ankle syndesmosis: Evidence of tibiofibular widening during clinical examination

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Purpose/Hypothesis

- To establish the reliability of ultrasound imaging of the ankle syndesmosis during the clinical external rotation test and examine the magnitude of tibiofibular widening.
- Syndesmosis injuries, known as high ankle sprains, lead to long-term disability. Clinicians need safe, reliable and accurate syndesmosis tests to guide clinical decisions.
- Ultrasound imaging is used to identify ligament injury and to measure tibiofibular widening during tibial external rotation, but the reliability of these measurements has not been established.

Participants

- 37 participants (19 males; 18 females) with a history of chronic ankle instability based upon self-report using the Ankle Instability Instrument and Foot and Ankle Ability Measure (FAAM) activity of daily living (ADL) and Sports scales.
- Subject demographics were 30.7 ± 6.9 years, height 173.8 ± 10.0 cm, weight 77.3 ± 19.7 kg, FAAM 88.8 ± 11.3%, FAAM Sports 77.8 ± 14.7%.

Design/Methods

- Ultrasound imaging of the distal tibiofibular joint was performed first in a neutral, resting ankle condition, and next with combined ankle dorsiflexion and tibial external rotation stress applied by another clinician.
- The distal tibia and fibula were visualized, images captured, and saved for later measurement.

Data Analysis

- Two blinded examiners measured the mediolateral tibiofibular distance (mm) with digital calipers on imaging software.
- Intrarater and interrater reliability of these measurements were determined with ICCs.
- A paired t-test was performed upon the tibiofibular distance variable (mm) with independent variable of condition (no stress, stress) on the ankles of subjects with chronic ankle instability.

Figure 1: Subject position with stress applied.

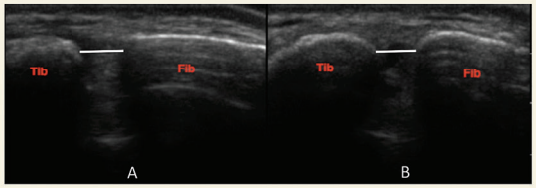

Figure 2: USI of tibiofibular distance (mm) under no stress(A) and stress conditions (B).

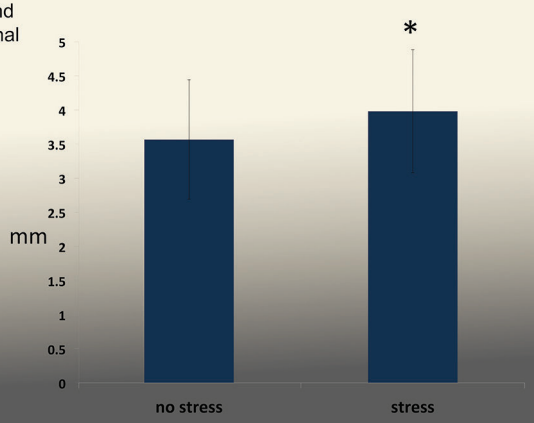

Figure 3: Tibiofibular distance between conditions. *p<.05 vs no stress

Results

- Intrarater reliability was 0.74 (0.62, 0.82). Interrater reliability was 0.86 (0.78, 0.91).
- The tibiofibular distance in the stress condition (3.98 ± 0.91mm) exceeded that in the no stress, neutral position (3.57 ± 0.87mm, P = 0.006) which corresponds to a 12% increase in the mediolateral width of the joint during the stress condition.

Conclusion

- Ultrasonography of the ankle syndesmosis is a reliable method of quantifying tibiofibular distance and can be performed safely in a dynamic examination with and without ankle joint stress.
- Significant increases in tibiofibular widening were identified in individuals who have chronic ankle instability, but who were not suspected of having chronic syndesmosis injuries.
- The syndesmosis should not demonstrate excessive widening with joint stress because it could compromise the integrity of the talocrural joint.
- Further studies should investigate this dynamic ultrasound imaging technique in suspected syndesmosis injuries.

Military Relevance

- Establishing reliable tibiofibular measurement methods adds value to military health care by augmenting the standard ankle examination using provocative special tests with quantifiable methods of ultrasound imaging to improve clinical decision making.

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3. Milz P, et al (1998). *Acta Orthopaedica Scandinavica*, no. 1: 51–55.
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5. Williams G, et al (2007). *Am J Sports Med 35*, no. 7: 1197 – 1207

•This study was approved by the Brooke Army Medical Center Institutional Review Board

The poster selected for second place among the presentations as part of the 4th Annual Research Day held December 10, 2014, at the Graduate School, Academy of Health Sciences, AMEDD Center & School, Joint Base San Antonio Fort Sam Houston, Texas.

COMPARISON BETWEEN RANGERS, COMBAT, COMBAT SERVICE, AND COMBAT SERVICE SUPPORT SOLDIERS ON MULTIPLE PERFORMANCE MEASURES PREDICTIVE OF INJURY RISK

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INTRODUCTION:

- Previous research supports that physical performance can vary by sport and occupation
- Musculoskeletal injuries affect more than 900,000 service members annually, resulting in more than 25 million limited-duty days and over $500 million in direct healthcare-related costs
- Emerging evidence suggests that performance on a variety of movement tests can identify athletes at risk for injury; providing an opportunity for injury risk mitigation strategies

PURPOSE:

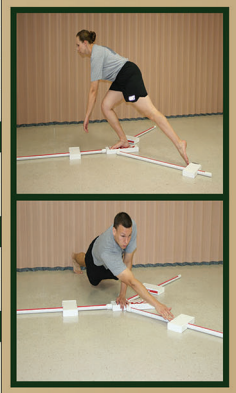
- To compare performance across different groups of Soldiers
- Hypothesis: Rangers and soldiers in combat units would perform better than soldiers in combat service or combat service support units

METHODS:

- Subjects:
  - 1,466 active and healthy duty Soldiers (1.8 ± 0.1 m, 82.4 ± 12.4 kg, 26.7 ± 3.4 kg/m^2, 24.7 ± 5.0 years)
  - 211 (14.4%) Rangers, 636 (43.4%) combat, 301 (20.5%) combat service, and 318 (21.7%) combat service support
- Movement Tests:
  - *Movement Competency:* Functional Movement Screen (FMS)
  - *Trunk Stability:* Upper quarter Y-Balance Test (UQYBT)
  - *Balance:* Lower quarter Y-Balance Test (LQYBT)
  - *Power:* Triple Hop
  - *Annual Physical Fitness Test Score (APFT):*
    - 2-mile run time
    - Number of sit-ups and push-ups in 2 minutes
- Data Analysis:
  - ANOVA and post-hoc analyses with a Bonferroni correction

RESULTS:

- Rangers performed better on all tests compared to the other 3 groups ($p < 0.05$)
- Soldiers in combat units only performed better than soldiers in combat service and combat service support units on FMS, YBT-LQ, and APFT ($p < 0.05$)
- Combat service and combat service support soldiers had equivalent performance on DF, FMS, YBT-LQ, and APFT ($p < 0.05$)



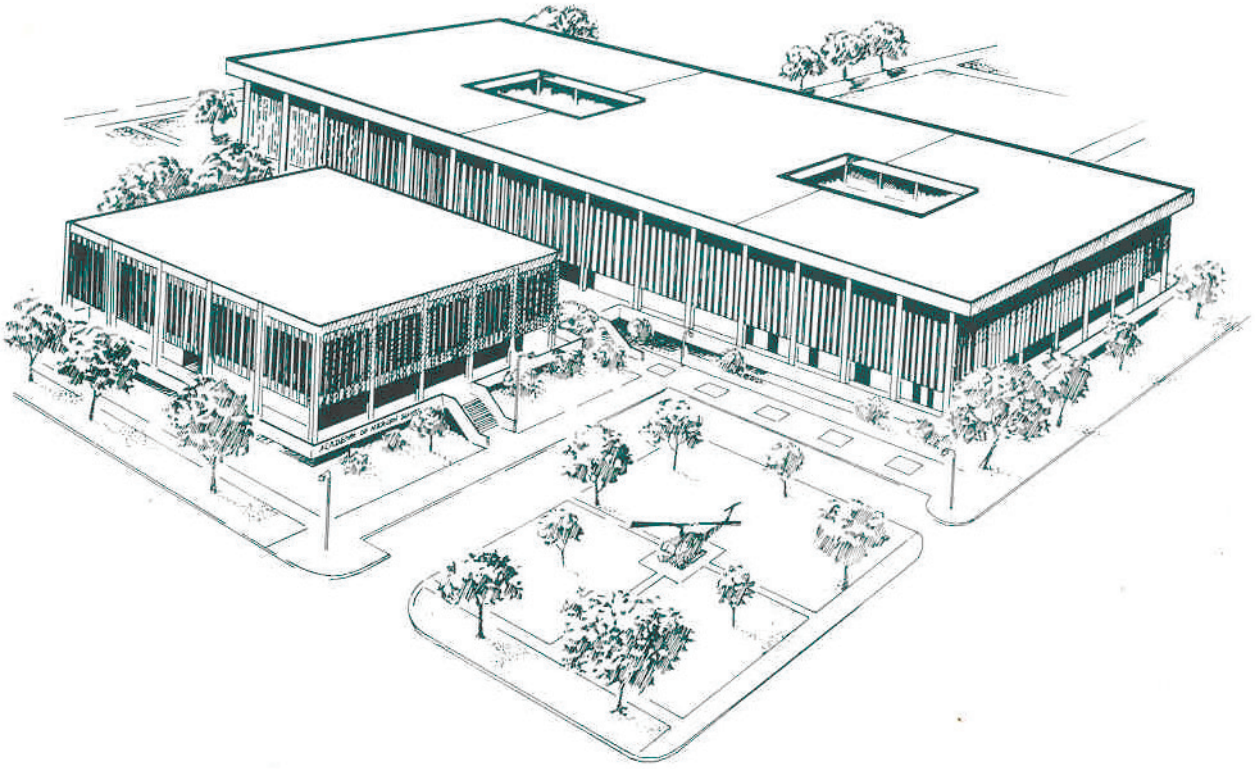
FMS (0-21 points)	
Rangers	16.2 ± 2.4
Combat Soldiers	14.4 ± 2.5
Combat Service	13.9 ± 2.8
Combat Service Support	13.8 ± 2.5
LQYBT (% limb length)	
Rangers	102.2 ± 7.3
Combat Soldiers	95.0 ± 8.5
UQYBT (% limb length)	
Rangers	96.7 ± 7.8
Combat Soldiers	86.2 ± 8.4
Triple Hop (cm)	
Rangers	462.5
Combat Soldiers	453.9
Combat Service	434.4
Combat Service Support	422.1

DISCUSSION/CONCLUSION:

- As hypothesized, soldiers in Ranger units performed better than those in other units
- The baseline differences in performance may indicate that unique injury risk algorithms may need to be developed based on classification of military occupation
- A better understanding of unit-specific normative data for tests associated with physical performance and injury risk provides a foundation for future injury prediction and prevention strategies

The opinions and assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Departments of the Army or Defense.

The poster selected for third place among the presentations as part of the 4th Annual Research Day held December 10, 2014, at the Graduate School, Academy of Health Sciences, AMEDD Center & School, Joint Base San Antonio Fort Sam Houston, Texas.



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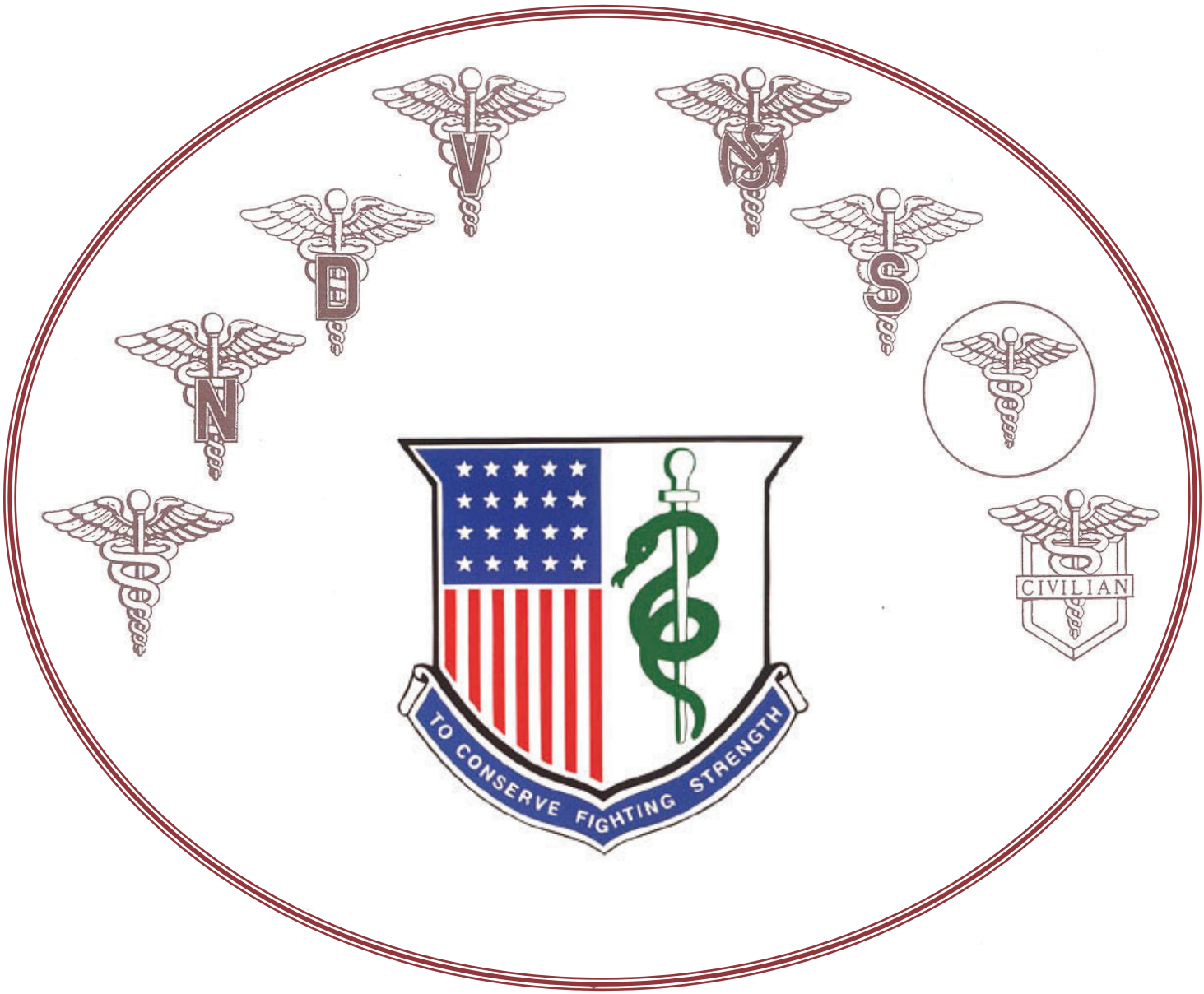

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