

JOURNAL

THE UNITED STATES ARMY MEDICAL DEPARTMENT

THE UNITED STATES ARMY VETERINARY CORPS

January - March 2009

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THE UNITED STATES ARMY
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Perspective

Major General Russell J. Czerw

The focus of this issue of the *AMEDD Journal* is the US Army Veterinary Corps, a small component of the Army Medical Department, but one that plays an indispensable role in safeguarding the health and well-being of Soldiers, Marines, Sailors, and Airmen throughout the world. Moreover, in this increasingly dangerous environment of potential threats from many sources, large and small, the Veterinary Corps has become a vital resource of homeland defense capabilities, lending their expertise in epidemiology, biohazard control, and especially in the protection of the food and water supply. Articles in this issue reflect the broad range of responsibilities and activities of Army veterinary professionals, from directed energy injury research to the care and rehabilitation of severely injured military working dogs. Army veterinary professionals do it all, and I am happy for this opportunity to showcase their expertise and capabilities.

The *AMEDD Journal* welcomes BG Timothy Adams, the Chief of the Army Veterinary Corps, to this issue with an excellent overview of the evolving responsibilities and challenges of the Corps, and the philosophical and organizational approaches which are necessary to deal with them. His observations articulate the sense of dedication, responsibility, and loyalty that is the hallmark of today's Army, and reflected every day in the performance and achievements of our Army healthcare professionals.

*Department of Defense Directive 6400.4*¹ dictates the missions for the Army Veterinary Corps. The first policy of the DoD Veterinary Service Program is "Ensure food ingredients and food products are safe, wholesome, and meet quality standards."^{1(p2)} This responsibility is featured in 3 articles. First, CW3 Chris Heryford describes a valuable capability offered by the Veterinary Command to assist commanders of units scheduled for short-term deployments into foreign countries, whether for infrastructure rebuilding, humanitarian assistance, or military training. Quite often these deployments are into areas with little or no regulation or standards of food handling, storage, preparation, or delivery, and limited knowledge of available potable water sources. The commander can



request a food and water risk assessment prior to deployment. Veterinary or preventive medicine specialists will go to the area and evaluate the potential sources of food and water as to the level of risk each poses, and make recommendations towards mitigation of those risks. This information provides the deployment commander with the knowledge needed to make crucial decisions regarding providing food and water to the troops. CW3 Heryford provides a detailed, clearly articulated description of what is involved in such assessments, and how the information should be used by those responsible for the health of deploying troops. Next, LTC Roger Parker, the Director of the DoD Veterinary Food Analysis and Diagnostic Laboratory here at Fort Sam Houston, has contributed a very informative article describing the roles and responsibilities of the laboratory, and the detailed control measures to ensure quality assurance. Additionally, he describes the extensive systems of collaboration among testing laboratories nationwide, including military and other federal agencies, as well as local, state, and university resources. Finally, COL Marc Mattix presents an excellent article which is a primer on existing threats to the food and water supplies of developed countries, and how such threats are addressed and countered. The Army Veterinary

Corps is front and center in this effort, and COL Mattix makes the importance of that role very clear.

Veterinary units have been deploying in support of Operations Iraqi Freedom and Enduring Freedom since the beginning of the Global War on Terror. The next 2 articles focus on such deployments to the respective theaters, presenting different perspectives on the mission requirements and the challenges faced in accomplishing them. CPT Marla Brunell's article details the various categories of support provided during the 64th Medical Detachment (VS) deployment to southwest Asia and northeast Africa. The veterinary personnel were organized into small squads at various locations, each of which was responsible for the entire spectrum of veterinary support: food inspections, both receipt and storage; medical support for the assigned military working dogs; stray animal control; and examination of local animals brought into the base compound. This article provides a clear look at the extent of the important work that small numbers of our veterinary professionals perform on a daily basis to ensure the health of all of our deployed Soldiers. MAJ Jessica McCoy's article presents a different aspect of the missions of veterinary Soldiers, the veterinary civil action program (VETCAP). While the VETCAP has been a part of military operational deployments for many years, their use in Afghanistan came into question because of the alleged detrimental effect on the domestic veterinary infrastructure. Therefore, a detailed study was designed and conducted to evaluate the local impact against the military value, and attempt to quantify the tradeoffs. This is an excellent depiction of the "big picture" roles that Army veterinary personnel play in support of the military mission in a theater of operations.

Dogs have long been an important component of the military. Moreover, our understanding of their capabilities and our ability to train and use them continues to expand. Today, military working dogs are more vital than ever in the counterinsurgency environment of both combat theaters. However, the very nature of that environment has resulted in a much larger incidence of serious trauma injuries among those dogs than seen in earlier conflicts. MAJ Janice Baker and her coauthors have contributed a well written, informative article describing how Army veterinary professionals have adapted to the situation, both in staffing adjustments and, more importantly, in

how such trauma is handled in the field. As is usually the case in the Army where doctrine and standing procedures do not fit the situation at hand, time and again our skilled and dedicated medical and veterinary professionals have adapted, cooperated, and found ways to save the lives of these valuable resources. MAJ Baker et al also present carefully developed recommendations as to doctrine, training, and organization based on real world experience and success. In that the current environments are probably the template for future conflicts, this article is a must read for those planning for the future employment and care of military working dogs.

MAJ Kelley Evans' article discusses another aspect of care which must be considered for military working animals. The dangers to Soldiers represented by the chemical, biological, radiological, and nuclear threats are understood and addressed by doctrine, training, and equipment. However, those same threats apply to the animals that accompany us into harm's way. MAJ Evans presents a historical background of the military veterinarians' efforts to address the various unconventional threats, the first of which was the use of poison gas in World War I. He describes the various measures developed and used, including a variety of gas masks for both draft animals and dogs, and special containers for the smaller animals. He also discusses the current efforts to provide both protection and treatment capability for the military dog which reflect the current threat environment. This is an interesting read which provides insight into an aspect of US military history that is not well known.

Rabies is a zoonotic viral disease which has plagued humans throughout history. It is present on every populated continent except Australia, and continues to kill thousands of people every year. Rabies has always been a threat to US military personnel as they deploy around the world, and military health providers are often not able to obtain data on the prevalence of rabies in a given area of operations. As LTC Greg Saturday and his coauthors point out in their informative article about rabies in Iraq and Afghanistan, the first indication to US medical personnel of the actual presence of rabies is usually the result of an incident involving a military member. An animal bite sets off a chain of events in which the animal is captured, a sample of brain tissue is sent to the Veterinary Laboratory Europe (VLE) at Landstuhl, Germany, and

the Soldier begins treatment. Test results are obtained within hours once the sample arrives at the laboratory. However, these individual tests following bite incidents have been the only data available about the presence of rabies in the area. Obviously, this limited sample is of marginal value in understanding the extent of rabies infections. In their article, LTC Saturday et al discuss use of a test procedure developed by the Centers for Disease Control and Prevention that allows in-theater testing of animals by deployed veterinary personnel, as well as local civilian veterinarian resources. The test is relatively simple and cost effective, requiring minimal resources and no special facilities to perform. The test was deployed by the VLE into both theaters in the summer of 2008, and data collection began almost immediately. This is another example of the initiative and professionalism of our skilled professionals to identify a problem, and then implement a solution. In this situation, as is so often the case, the solution benefits not only our Soldiers, but the local civilian populace as well.

As we have pointed out in this and previous issues of the *AMEDD Journal*, US Army veterinary professionals are working in many areas of medical science outside of those defined as missions of the Veterinary Corps. The article by LTC Deborah Whitmer and Dr Bruce Stuck is an excellent example of another one of those critically important areas of research. Directed energy, predominately in the form of lasers, is a growing threat to unprotected eyes, especially on the modern battlefield. Laser beams are now almost ubiquitous, whether as range finders, target designators, aiming devices, or used intentionally as blinding or burning weapons. Often the injury is sustained without the Soldier's knowledge of the cause. LTC Whitmer and Dr Stuck present a very informative, well-illustrated, clinical description of the potential threat, the mechanism of damages inflicted on the eyes, and current research on methods of examination and treatment. This article should be a must-read for all medical personnel involved in patient examination and evaluation, as it provides a basis for inquiry about eye injury and follow-on examination and treatment.

Rabies is the best known zoonotic disease in that it is, unfortunately, a common threat to (and from) the animals that live among us. However, there are others that our troops encounter as they deploy around the world. LTC Christopher Keller presents a well-researched, informative analysis of a viral disease that is endemic

among a specific genus of monkey, commonly called macaques, that are indigenous throughout Asia and Africa. The B virus, a form of herpesvirus, has a high fatality rate in documented human infections. Although most of those cases involve biomedical research personnel working with the animals, they serve as a warning as to the serious nature of the disease which can, of course, be contracted through encounters in the wild. LTC Keller's thorough presentation of the clinical aspects of the disease, its diagnosis, and treatment should be considered an important resource for both medical planners and those conducting predeployment training for those areas within which macaques are found.

CPT Kristina McElroy has provided information about an important postgraduate educational and practical application opportunity for medical and veterinary professionals interested in epidemiology. The Epidemic Intelligence Service is a 2-year, postdoctoral-level fellowship program of the CDC that conducts epidemiologic investigations, research, and public health surveillance nationally and internationally for all types of epidemics, including chronic disease and injuries. Selectees get first hand experience in detection, identification, analysis, and response for actual and potential large-scale health threats. The training and experience they receive is unique and increasingly important, especially in this era of the increasing threat of bioterrorism. CPT McElroy's article is an excellent introduction to this opportunity, and she has provided complete information for anyone who may be interested. Anyone who has any interest in the practice of epidemiology should investigate this program.

Army veterinarians usually work in the background, providing continuous support while performing vital functions that are not known to the majority of people. Occasionally, a veterinarian steps to the front and becomes the "point" in events that are not only very important at the time, but also may have historical significance. In fairness, this applies not only to US Army veterinarians, but also those of other militaries, even our adversaries. MAJ Boris Brglez's fascinating article presents one of those unique situations from late in World War II, when US and German Army veterinarians joined together to ensure that the legendary line of Lipizzaner horses would be preserved for future generations. The successful operation to seize and move the herds of horses intact has been saved from

obscurity by its association with General George Patton, because it was units of his 3rd Army that accomplished it, with his approval. However, as MAJ Brglez makes clear, it was the recognition of the significance of the horses by the leaders on the front lines, many of whom were actually veterans of horse cavalry units, that inspired the bold, almost flawlessly planned and executed operation. Unfortunately, lost in most depictions of this operation is the fact that it almost assuredly would not have occurred without the initiative and cooperation of 2 military veterinarians from opposing sides of the battlefield. This article clearly provides that important perspective.

I am pleased that we have the opportunity to include 3 additional articles in this issue dealing with aspects of combat medicine. Each of these articles, albeit brief, contain information which is timely and important to Army medicine's most important mission—saving the lives of our wounded Warriors. First, LTC Clayton Simon and his coauthors have contributed an overview of fresh frozen plasma (FFP) and its use in damage control surgery. They examine the properties of FFP and provide information about its storage and use. Also, they present clinical data from its use in combat damage control at a combat support hospital. This article is packed with well-documented, clearly presented information which should be considered as we review and revise our doctrines for combat medical care for future conflicts.

Next, LTC Paul Barras and his coauthors present a proposal for a different approach to administering anesthesia in the battlefield environment. In their clearly presented, extensively documented article, they make a solid case for total intravenous anesthesia (TIVA) as the standard method of anesthesia at every level of combat damage control, beginning with the forward surgical team. LTC Barras et al explain that TIVA is safer for the patient, requires much less equipment than inhalant anesthetics, is easier to control, and can be administered continuously throughout the intensive care period if necessary. Their article is another example of the initiative and high levels of medical skill and knowledge that are common characteristics of Army medical professionals.

MAJs Robert Mabry and Peter Cuenca have the final article in this issue. They present a proposal to change

the current combat lifesaver (CLS) training for all Soldiers that is mandated by the Army Training and Doctrine Command. They advocate elimination of the requirement to train Soldiers in the placement of intravenous (IV) lines and the administration of IV fluids. Their article is a logical, well-considered presentation of the factors that argue against using already limited training time to train a skill that, in application, may be detrimental to both the injured Soldier and that Soldier attempting to provide first aid. First, they discuss the extreme difficulty of training an individual to correctly and safely administer an IV, even in the most benign environments. More importantly, they present the current clinical evidence that IV fluid administration early in the trauma care cycle is rarely helpful to the injured, and is often counterproductive. Rather, the authors contend that hemorrhage control should be the primary concern for the initial caregivers, and detailed training in application of tourniquets would be of much greater value in saving the lives of severely wounded Warriors. The information in this article should be carefully considered by those charged with defining our Soldiers' necessary skills, syllabus design, and planning to meet the training requirements.

Finally, I am proud to present a collection of research abstracts prepared by the 2009 class of doctoral students of the US Army-Baylor University Doctoral Program in Physical Therapy. The 5 abstracts report the results of the students' research projects which were conducted as part of their curriculum and in support of the Neuromusculoskeletal Injury Prevention and Rehabilitation Research Program. The projects were collaborations of the military students and physical therapy experts from the TRUE Foundation and universities. These abstracts are another clear indication of the high levels of professional knowledge and skills found in the Army Medical Department, as well as the outstanding opportunities available for our dedicated medical professionals.

REFERENCE

1. *Department of Defense Instruction 6400.4: DoD Veterinary Services Program*. Washington, DC: US Dept of Defense; August 22, 2003.

A Corps Challenged, Capable, and Committed

Brigadier General Timothy K. Adams

The United States Army Veterinary Corps existed for the better part of the last century, and continues to be an integral part of the Army Medical Department and the Department of Defense, as well as serving interagency responsibilities across the federal government. The Army Veterinary Corps is essential and contributes to a comprehensive approach to both animal and human health. However, never have we been as challenged as we are today. As we look for answers and ways to achieve our constantly expanding mission, we must continue to be flexible and adaptive. Operating in two combat areas of responsibility and around the world on other fronts, we are covering missions from care of military working dogs, to class I food safety and quality assurance, support of provincial reconstruction teams, research and development, and much more.

We are a small Corps with a huge mission that is expanding, and we are being spread thinner and thinner. As Corps Chief, I look for signals of change and avenues and connections to effectively and efficiently enhance and contribute to health and global security—one health, combining both human and animal medicine and preventive medicine as they relate to the health of our warriors, national public, and international partners. As a Corps, we must continue the exceptional service and support provided and look for efficiencies and ways to optimize our resources. The Active Army and our Reserves are performing with amazing tenacity and professionalism, however, this cannot be sustained without adjustments and a rebalancing of our entire force. This rebalancing effort is underway and we are a part of it.

Though many challenges lie ahead, the Corps will adjust to assist in the rebalancing of the force. Stability operations, humanitarian assistance, food defense, and civil support are areas of new, heightened focus. We are currently on track in the Total Army Analysis for approval of four new veterinary service medical detachments (two active and two reserve) in this effort to rebalance and cover down on current and



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anticipated missions. Retention and leadership development are high priority initiatives, and significant progress has been made with pay incentives and continuing education. Our Corps must look within to muster the determination and motivation to serve in a capacity commensurate with sacrifices already made. Personal benefit can only be defined and measured by the individual, however, Corps mission success will be measured by the overall success and security of the nation. Never have times required more sustained selfless service and sacrifice, and never has there been more potential for these attributes to impact on our future. In his inaugural address, the Commander-in-Chief said:

[The] values upon which our success depends—hard work and honesty, courage and fair play, tolerance and curiosity, loyalty, and patriotism—these things are... true... What is demanded then is a return to these truths. What is required of us now is a new era of responsibility—a recognition...that we have duties to

A Corps Challenged, Capable, and Committed

ourselves, our nation, and the world, duties that we do not grudgingly accept but rather seize gladly, firm in the knowledge that there is nothing so satisfying...than giving our all to a difficult task.

These are relevant words for the challenges confronting us, and the United States Army Veterinary Corps gets it!

Veterinarians and veterinary personnel—enlisted, commissioned, or civilian—have a unique ability to relate, translate, and adapt to a variety of situations and challenges. We know this, and I am confident that we will continue to rise to the challenges that lie ahead while leading on all fronts. As we undergo the impending transformation of our military, and as the

operational climate and global landscape change, we must not only be adaptive, but resilient to its impact on our responsibilities.

As part of the Army Medical Department team, the Veterinary Corps will continue to lead, and the Corps will respond effectively. We all have an opportunity and obligation to be a part of this which transcends individual achievement and interests.

Never have we been so globally challenged, but never have we been so capable to meet these challenges. I am confident, I am proud and I remain ever committed to the success of the world's finest military veterinary organization and its future successes.



Food and Water Risk Assessment: A Decision Tool for the Tactical Commander

CW3 Chris Heryford, VC, USA

SCENARIO

A unit consisting of 200 US Navy Construction Battalion personnel are tasked to execute a 30-day nation building initiative in a country with little to no infrastructure. The mission encompasses design and construction of a local school in cooperative efforts with the local government. Food sources approved by the US Department of Defense (DoD) are not available in the country, and transportation of government-owned food or military rations into theater is not an option. Where do the troops eat? The only viable option remaining is for troops to subsist on the local economy for the duration of the exercise. During advance party and reconnaissance operations, exercise planners identified and generated a list of potential food caterers and/or food suppliers in the local area. US Army Veterinary personnel, who are responsible for food safety, were contacted and traveled to the area of the exercise, months in advance. They conducted food and water risk assessments (FWRA) of all local food producers and suppliers identified by the exercise planners. Risk levels and recommendations were determined for each food establishment and presented to the combatant commander who then decided on the safest actions regarding the troop feeding plan. Decreasing the possibility of food and waterborne diseases during the exercise was obviously the ultimate goal.

BACKGROUND

Scenarios such as that described above are occurring more frequently. Globalization, due to many factors including the end of the Cold War and the inception of the Global War on Terrorism, stimulated avenues and opened doors into many countries. The joint concept initiated by DoD increased the opportunities for various exercises with foreign militaries, not to mention the vast array of humanitarian missions and infrastructure rebuilding around the world. Additionally, the National Guard Security and State Partnership Program* links US states with partner countries with goals for evolving international affairs missions for the National Guard using the unique civil-military nature of the Guard to interact with both active and reserve forces of foreign countries. Currently, US military exercises occur on a regular basis in diverse areas throughout the world with no end in sight.

What does this mean from a food safety perspective? Commanders on the ground, particularly in developing countries, must find a way to safely feed their troops without government approved sources. Depending on the country, eating local food in an exotic foreign land can be exciting yet unsafe due to insufficient sanitation

standards and environmental public health issues. In the past, food establishments/suppliers chosen in a local area for an exercise were either “passed” or “failed.” This approach left no options for a commander if every food establishment failed, which, historically, was the case most of the time. In contrast, a food and water risk assessment is the process of assessing all identified hazards and risks involved in a commander’s troop feeding plan and providing sound recommendations that will reduce the overall risk to the Soldier. The assessment, initial risk levels, and potential mitigation steps to achieve reduced risks are provided as a recommendation to the supported unit’s commander as a decision tool for possible actions and/or changes to the projected troop feeding plan. After an assessment is conducted, selection of food sources becomes the discretion of the commander based on accepted risks.

US Army Veterinary Command (VETCOM) food safety programs historically provided minimal support to short-term exercises due to a lack of knowledge concerning their existence and capabilities. The food safety support for smaller exercises was inconsistent and sporadic, as field commanders simply did not know the support existed. Marketing the availability of FWRA service to all branches of the US military increases the awareness and decreases risk of food and

*<http://www.ngb.army.mil/ia/Tab2.aspx>

water-borne disease outbreaks (diarrhea and vomiting) during exercises. The VETCOM maintains an aggressive stance for supporting the Warfighter during exercises throughout the world using FWRA. In recognition of the value of providing options to the commander, exercise support is at the top of the list for mission priorities. FWRA, provides diverse options, consultation, and recommendations which offer command flexibility to future troop feeding plans.

RECEIVING THE MISSION

A Veterinary Corps officer (VCO) is the most likely candidate to be an assessor for conducting a FWRA. However, Preventive Medicine officers could be selected in the absence of a VCO. Whichever the case, once a support mission is received, procrastination is not an option. The process of supporting certain exercises can be extremely fluid at times, so proactive execution promotes success. A majority of the support is provided prior to the actual exercise, preferably occurring during the initial planning phase for a unit's deployment. Preparation and coordination inevitably consume more time than actual time on the ground in the country. General exercise intelligence should be gathered about the number of troops involved, duration of the exercise, and location. Modifying a feeding plan late in the process, just before or during an exercise, is nearly impossible. Exercise planners must have a general idea of where they want to procure their food well in advance. A list of food preparation facilities, caterers, hotel restaurants, and/or other facilities must be provided to the appropriate VETCOM headquarters in theater by the unit conducting the exercise. The list of possible food sources by location is absolutely crucial in order to initiate an assessment.

There are a number of additional potential impediments that cannot be overlooked, to include: country clearances, visas, travel coordination, immunizations, and points of contact. Proper preparation greatly reduces the possibility of being halted at an airport and ultimately forced to return home before ever getting started. If assigned to a mission, never assume that someone else is taking care of the aforementioned requirements. Establishing contact with key players for an exercise is rather challenging and frustrating at times, especially for joint exercises. People change positions, go on leave, or are transferred. Telephone numbers and email addresses might be incorrect or not work at all, so attempting to speak

to the right person could result in the classic, endless cycle of telephone pursuit. Perseverance builds character. An initial point of contact list should contain several individuals, and not be limited to the exercise planner(s), operations staff or commander of the unit conducting the exercise, the military coordinator and/or the Bilateral Affairs Officer in the country's US embassy, the local Ministry of Public Health or equivalent position, and the food establishment managers. Usually, support missions comprise of one or 2 assessors, and do not coincide with the supported unit's movement. Thus, those with whom you gain contact become imperative elements in successful support.

Become aware of the country's public health stance. Begin by surfing the world-wide web. The final risk determination is dependent upon the collection of significant environmental health information prior to entering a country. Knowledge of prevalent zoonotic diseases, local sanitation standards, and public water conditions should be the background for recommendations the assessor will provide the supported unit. Particular health risks from an animal and food standpoint mirror a country's unique infrastructure development. A quick history lesson on the social and political paths of a country leading to the present situation provides insight into what may be expected concerning potential risks from the food defense and security standpoint. The World Health Organization, Centers for Disease Control and Prevention, and the Armed Forces Medical Intelligence Center are worthy sources of information on the internet. An internet search for a country's history seems too simple, yet it is an effective tool for developing general expectations. A well-rounded picture of the country is the goal.

Anyone assigned to an FWRA should prepare a packing list of equipment and references. As a minimum, the most recent versions of *Army Military Standard 3006*¹ and *Army Technical Bulletin MED 530*² should be readily accessible. Surface swabbing becomes a valuable means for the identification of improper cleaning and sanitation procedures, so bring a Novalum[®] (Charm Sciences, Inc, Lawrence, MA 01843) with an adequate number of shelf-stable surface swabs. Acidity/alkalinity and chlorine test strips are small, light, easy to pack, and effective for determining adequate sanitation concentrations during

production and cleaning. A quick-reading digital thermometer with alcohol swabs for temperature verifications and an ultraviolet “black” light to reveal possible rodent activity should be on the list as well. The suggested equipment, shown in the Figure, is not all-inclusive and should be altered to meet the assessor’s needs to obtain the best objective evidence within the limits of the available assets. The tools and references shape the mission for meaningful data collection and ensuring the assessor is able to adequately evaluate the situation.



Recommended minimum test kit equipment for member of FWRA team.

EXECUTE THE MISSION

The VCO should arrive in the exercise area months before the unit to allow the exercise commander to adjust plans if needed. There are 3 main actions that should occur:

1. Conduct FWRAs of all caterers, restaurants, and/or food preparation facilities involved in the troop feeding plan.
2. Conduct interviews with local public health officials to determine common zoonotic and food/waterborne disease statistics and data in the country.
3. Draw bottle and source (tap) water samples for laboratory testing. All objective evidence gathered throughout the process influences the initial risk assessment of each food establishment.

The assessment is similar to an initial commercial sanitary audit outlined in *Military Standard 3006*¹ without the availability of any prearranged production details. Consequently, facts and details are discovered while an assessor is in the food establishment, so the assessor should remain flexible, observant, and receptive. While assessing a food establishment, a number of concerns should be verified, to include origin of raw ingredients, water potability, sanitation and cleaning programs, sanitation training program, pest control program, food processing operations, storage, cooking, and holding times and temperatures (HACCP Plan), general infrastructure conditions and equipment, and food defense. An accurate record of significant food safety and security deficiencies, as well as plotting product flow should be recorded. It is extremely important to take good notes.

Laboratory testing of the source water for each establishment serves as additional data for influencing the risk assessment. Onsite preventive medicine (PM) water testing assets provide the perfect solution; however, PM resources are not always available. If PM is not in theater, the VCO creates alternate avenues for testing by bringing Colilert vessels or sterile urine specimen cups. As a last resort, purchase the most predominantly consumed brand name bottled water in the area, and use the bottles for sample collection. Pour out the bottled water, rinse the bottle 5-6 times with the source water in question, and collect the sample. In most situations, samples will have to be brought back in your check-in luggage due to limited or questionable shipping providers, therefore taping the caps and triple bagging with zip lock bags is recommended. Samples should then be submitted to the nearest DoD Veterinary Laboratory after the VCO returns. At a minimum, all water samples will be tested for routine microbiological parameters, with further chemical and radiological testing if adequate sample volumes are available. Final test results influence the initial risk level.

Interviews with local public health officials provide additional data for supporting initial risk decisions. Coordinating and executing interviews often reveal exclusive data not discoverable through internet resources or text references. Ask simple questions:

- What diseases are endemic to this area?
- What is the overall water quality in the area?

Food and Water Risk Assessment: A Decision Tool for the Tactical Commander

- What are some of the government controls in place for sanitation standards?
 - Are there laboratories in the area?
 - What are the public health capabilities?
 - Even better, obtain any available statistical data. It is amazing how a few questions will gain information of tangible value. A list of questions should be prepared and answered, yet allow a free flowing conversation supported by good listening skills.
- Sanitation and hazard analysis and critical control point* training for personnel preparing food
 - Additional laboratory testing
 - Use single service disposable plates and utensils

REPORTING

There are 2 documents submitted at the end of the evaluation, the FWRA report for the exercise commander and the after-action report, both prepared in general memorandum format. Once the tap water laboratory results are complete, each food service establishment will have a separate risk level assigned, to include the detailed deficiencies discovered during each visit. When feasible, the VCO will personally brief the tactical commander. Normally, the tactical commander will not be in the country during the FWRA, so email and telephone may be the only means of communication. Attempt to remove any misconception about the assessments by emphasizing that food establishments are neither approved nor disapproved. Keep the information and guidance concise and to the point. At a minimum, the recommendations and residual risk levels should be discussed. The after-action report is filtered through the chain of command and the Defense Occupational and Environmental Health Readiness System.[†]

CONCLUSION

The FWRA program is actually an old concept with a new approach and a new name. The Army Veterinary Command provided similar services in the past with less standardization and visibility. On June 1, 2008, the Veterinary Command released a supplement to *Technical Guide 248*³ entitled “Food and Water Risk Assessment.” It is the first comprehensive standard for conducting FWRA. The goal of the program is to provide improved customer service to the tactical commanders and their Soldiers. Approaching food safety concerns with FWRA broadens the perspective of the commander’s decision process, and removes the “go/no go” mentality for designation of food sources. Commanders are educated about their troop feeding plan and are therefore able to formulate decisions based on solid information and risk analysis.

Although determination of the overall initial risk is subjective, it is supported by observations of food handling practices (both unsafe and satisfactory), potential hazards based on food science knowledge and tests, and VCO experience. Focus on critical food safety issues, the absence or presence of critical control points, data from laboratory results of source water tests, and answers obtained during public health interviews.

The combination of discoveries assist the determination of the probability and severity of each identified hazard, and ultimately an initial risk level, as shown in the Table, which is comparable to the concepts in *Army Technical Guide 248*.³ Initial risk levels are categorized as extremely high, high, moderate, or low.

The initial risk level is the amount of risk of possible health hazards in a feeding plan to which Soldiers are exposed before recommended food safety controls are identified and applied. Once that initial risk level is established, appropriate recommendations and control measures are compiled. The assessor generates recommendations that will reduce critical microbiological, chemical, and physical hazards found during the assessment. Some general examples are:

- Avoid particular food products
- Do not drink from any available tap water sources
- Verify temperature prior to consumption
- Immediate consumption upon receipt

*A management system, also known as HACCP, by which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement, and handling, to manufacturing, distribution, and consumption of the finished product, namely the “farm-to-table-continuum.” Source: <http://www.afdo.org/afdo/HACCP/>

[†]<https://doehsportal.apgea.army.mil/doehrs-oehs/>

Hazard Severity	Hazard Probability				
	Frequent (A)	Likely (B)	Occasional (C)	Seldom (D)	Unlikely (E)
	[Corresponding Risk Estimate]				
Catastrophic (I)	Extremely High	Extremely High	High	High	Moderate
Critical (II)	Extremely High	High	High	Moderate	Low
Marginal (III)	High	Moderate	Moderate	Low	Low
Negligible (IV)	Moderate	Low	Low	Low	Low
The determined probability of a given hazard mapped against that hazard's severity defines the corresponding risk estimate for that combination of factors.					

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Quality Assurance, Networking, and Collaboration Actions by the DoD Veterinary Food Analysis and Diagnostic Laboratory

LTC Roger W. Parker, VC, USA

INTRODUCTION

The Department of Defense (DoD) Veterinary Food Analysis and Diagnostic Laboratory (FADL) at Fort Sam Houston, Texas, is the definitive DoD veterinary laboratory resource providing force health protection in support of US Armed Forces around the globe. A priority mission of this 50-person agency is food safety, defense, and quality assurance supporting food supplies purchased and distributed for consumption by all of the US military services. Another priority mission is diagnostic testing for prevention and control of zoonotic and animal diseases concerning government-owned animals and privately-owned animals of authorized personnel within military communities. Finally, the FADL provides technical consultation on the integration of laboratory testing into science-based food audit and inspection systems of the US Army Veterinary Service.

Food microbiology capabilities include verification testing of food vendor quality assurance programs, operational ration pathogen screening, foodborne illness sample testing, food/water surveillance testing, and pathogen/toxin identification. Microbiology methods incorporate conventional microbiology using agar plates and advanced, rapid techniques, such as real-time polymerase chain reaction. Food chemistry capabilities include quantifying pesticides, antimicrobials, and toxic residues; identifying heavy metals; confirming quality packaging indices; and performing routine chemistry testing for moisture, protein, fat, and solids. Chemistry methods range from simple extractions for percent fat, single-analyte instrumental analysis such as mercury and cyanide, and very complex tests such as gas chromatographic mass spectrometry (GC-MS) for pesticides or inductively coupled mass spectrometry (ICP-MS) for heavy metals. Techniques such as infrared spectrometry and microscopy are used to identify foreign object contamination of foods. Diagnostics capabilities

include serology (eg, equine infectious anemia, brucellosis, toxoplasmosis, Lyme disease, Rocky Mountain spotted fever, ehrlichiosis, and babesiosis); rabies testing (suspect animals involved with human exposure, rabies serology of animals destined for international movement); and infectious disease surveys (eg, leptospirosis). Diagnostic methods include immunoassays, rapid screening tests, and virus neutralization or propagation using cell culture.

QUALITY ASSURANCE

Most testing is performed according to approved official methods as promulgated by the following recognized methods standardization bodies: AOAC* International, US Department of Agriculture, US Food and Drug Administration, American Public Health Association, US Centers for Disease Control and Prevention, US Environmental Protection Agency (EPA), and World Health Organization.

Quality control of procedures is a priority responsibility of all FADL personnel with formal oversight by a section of quality assurance scientists and specialists. FADL has been accredited by the American Association for Laboratory Accreditation (A2LA) since 2001. Independent auditors from A2LA conduct on-site, 3-day comprehensive systems audits of the FADL on a biennial basis. During intervening years, A2LA conducts formal off-site reviews of FADL quality systems documents. Laboratory accreditation from A2LA is based on *ISO/IEC 17025:2005*,¹ the internationally accepted criteria for competence. The FADL complies with the *ISO/IEC 17025* requirement to have “quality control procedures for monitoring the validity of tests and calibrations undertaken.”^{1(p20)} Quality control procedures include the regular use of certified reference materials and/or internal quality control using secondary reference

*Association of Analytical Communities. Information available at: <http://www.aoac.org/>. Accessed Jan 23, 2009.

materials, and replication of tests or calibrations using the same or different methods. The FADL conducts its own internal audits, method reviews, and quality control checks on a continuous basis to maintain the highest level of quality. In addition to internal performance-based quality control, the FADL participates in proficiency testing, usually by contracting with an external provider who assesses laboratory performance by interlaboratory comparison.

LABORATORY NETWORKING AND COLLABORATIONS

The FADL participates in the following laboratory networks and collaborations:

- The Directory of DoD Public Health Laboratory Services² is a central database compilation of information which allows medical personnel to determine the locations of appropriate laboratories where specimens of public health concern can be tested, to obtain contact information and information related to sampling and sample handling, to improve reporting and surveillance of emerging pathogens, and to help protect force readiness. In the event of a large or suspected outbreak, the Directory's list of points-of-contact should help ensure notification of proper personnel, and efficient use of DoD's extensive laboratory resources.
- The DoD Joint Occupational and Environmental Surveillance Laboratory Compendium³ is a database of environmental testing laboratories. The database was created to assist DoD, EPA, and other personnel who respond to emergency situations in the identification of qualified and appropriate laboratory capabilities and capacities to analyze chemical and biological analytes, as well as chemical warfare, bioterrorism, and radiochemical agents.
- The FADL actively collaborates with the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) and USACHPPM-South (Fort Sam Houston, Texas) in some overlapping environmental surveillance missions (eg, vector-borne diseases and operational water safety).
- As part of the Global War on Terrorism, the FADL's mission now incorporates the need for rapid detection of biowarfare/bioterrorism agents in food and water. To further develop this capability, the FADL has established a memorandum of understanding with the US Army Medical Research Institute of Infectious Diseases* (USAMRIID). There are critical support requirements in the area of food defense which can most readily be filled using the expertise and experience at USAMRIID.

The Food Emergency Response Network[†] (FERN) integrates the nation's food-testing laboratories at the local, state, and federal levels into a network that is able to respond to emergencies involving biological, chemical, or radiological contamination of food. The FERN plays a number of critical roles related to food safety and defense, including:

- Provides a national surveillance program that offers an early means for the detection of threat agents in the American food supply.
- Prepares the nation's laboratories to respond to food-related emergencies.
- Provides significant surge capacity to strengthen the nation's response towards widespread complex emergencies (intentional or inadvertent) related to agents in food.
- Enhances the ability of the nation to restore confidence in the food supply following a threat or an actual emergency targeting that food supply.

The FADL gains additional benefit by sending laboratory scientists to FERN-provided training workshops involving advanced methods. As part of FERN's food surveillance program, the FADL uploads food pathogen testing results into eLEXNET[‡], a secure, internet-based system that centralizes food safety laboratory data to allow multiple government agencies to compare, communicate, and coordinate analytical findings.

For highly pathogenic avian influenza diagnostics, the FADL participates in the National Animal Health Laboratory Network[§] (NAHLN). The network is part

*Information available at: <http://www.usamriid.army.mil/>

†Information available at: <http://www.fernlab.org/>

‡Electronic Laboratory Exchange Network (US Dept of Agriculture and the Food and Drug Administration). Information available at: http://www.boozallen.com/consulting/industries_article/658975. Accessed January 23, 2009.

§US Dept of Agriculture, Animal and Plant Health Inspection Service. Information available at: http://www.aphis.usda.gov/animal_health/nahln/. Accessed January 23, 2009.

Quality Assurance, Networking, and Collaboration Actions by the DoD Veterinary Food Analysis and Diagnostic Laboratory

of a national strategy to coordinate and link the diagnostic testing capacities of the federal veterinary diagnostic laboratories with the extensive infrastructure of state and university veterinary diagnostic laboratories. The NAHLN enhances the nation's early detection of, response to, and recovery from animal health emergencies, including bioterrorist events, newly emerging diseases, and foreign animal disease agents that threaten the nation's food supply and public health.

CONCLUSION

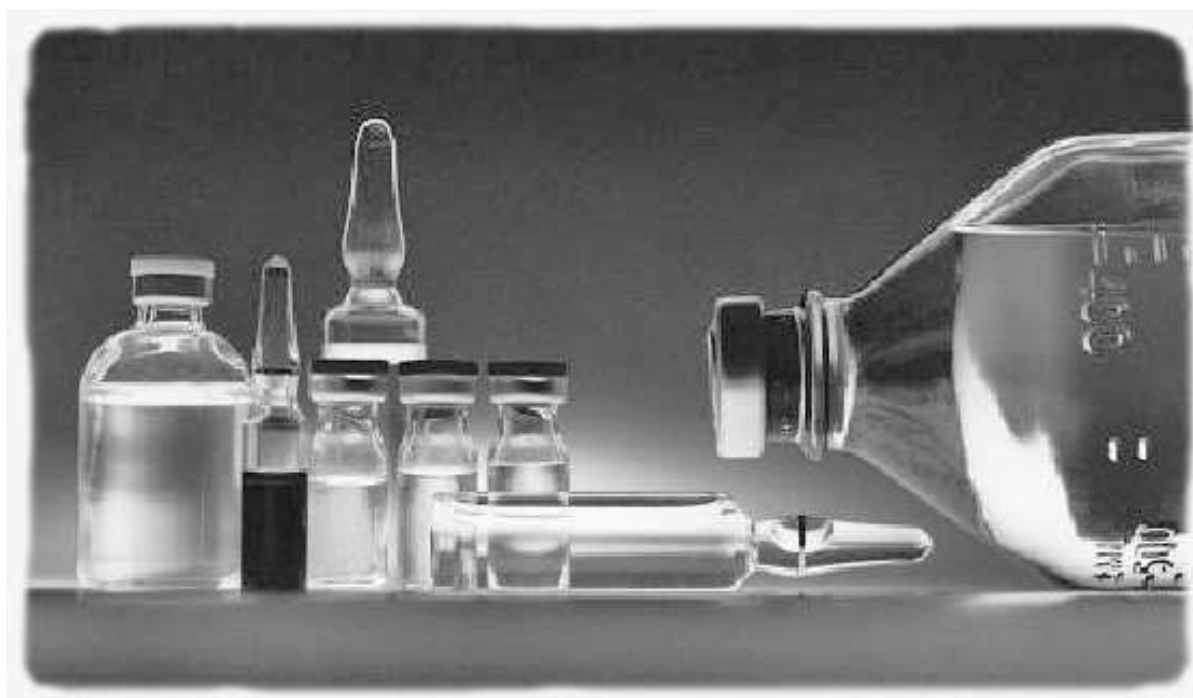
As part of its continuous quality improvement processes, the FADL strives to maintain strategic and operational networking, collaboration, and technical sharing among relevant public health partners including military, federal, state, and private agencies.

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Food and Waterborne Disease Threats

COL Marc E. Mattix, VC, USAR

The developed world enjoys the most varied, affordable, safe, wholesome and affordable food supply in the history of civilization. This is not by accident; the safety of the food chain is ensured through a complex, integrated network of local, county, state, federal, and Department of Defense organizations dedicated to mitigating the threat of unintentional contamination of our food supply from production through transportation and distribution to the consumer (Figure 1). From local and county health departments through federal agencies, including the Food and Drug Administration and the US Department of Agriculture Food Safety and Inspection Service and Veterinary Services, each link along the food chain is monitored and regulated with the goal of achieving healthy herds, flocks, crops, and communities, and a safe food supply. Yet even with this system in place, food and waterborne disease continues to be a significant health risk in populations throughout the world, including the United States.¹ A majority of the foodborne disease agents are zoonotic, that is, maintained in vertebrate animal reservoirs and incidentally infective to humans. We are intimately connected to animal populations through shared, or zoonotic diseases, the food chain, and the human-animal bond—our innate desire to surround ourselves with animals. In an era where many US citizens believe steak comes from the local supermarket, it is essential to remember that it is impossible to separate agriculture from food, and it is equally inadvisable to separate animal health from human health.²

The resurgence of the One Health Concept* has fueled improved connectivity in integrated surveillance and reporting for humans and animal diseases both within the United States and abroad. The risk for food and waterborne disease is greatest in regions with fractured public health and veterinary infrastructure, lack of a functioning national health surveillance system, and unknown incidence of endemic disease, factors present

in many locations around the world where the US military is deployed. The risk of foodborne disease is further increased in concentrated military populations composed of immunologically naïve Soldiers largely unaware of the host of disease agents present in local fare. Protecting our deployed Soldiers, Marines, Sailors, and Airmen from food and waterborne disease is the primary focus of the US Army Veterinary Service.

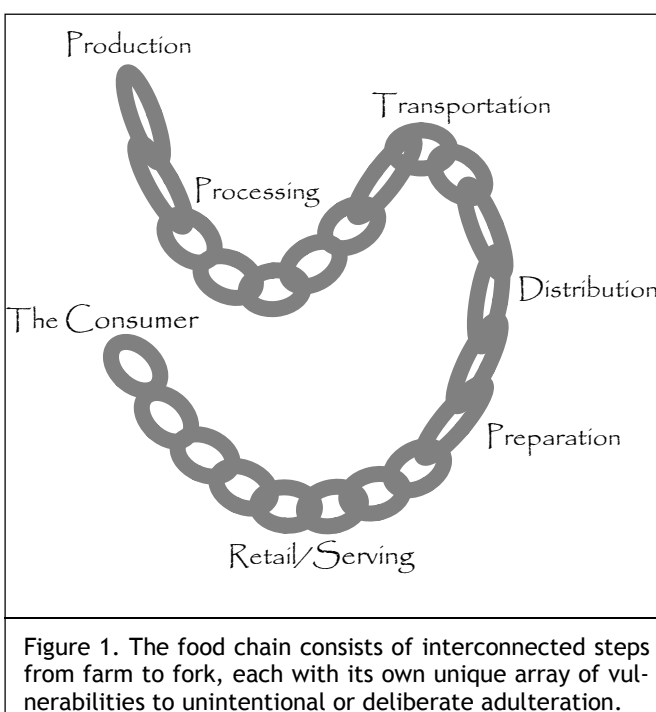


Figure 1. The food chain consists of interconnected steps from farm to fork, each with its own unique array of vulnerabilities to unintentional or deliberate adulteration.

It is impossible to overstate the importance of a safe and secure food supply, not only to the individual but also to nations. Public confidence in the food chain is essential; a loss of public trust carries significant social, economic, and political weight. Even the perception of an unsafe food supply creates serious social and economic consequences (Figure 2). The 1999 dioxin contamination of the Belgian poultry, meat, and dairy industries caused \$1.5 billion in lost revenues and was directly responsible for the peaceful ouster of the Belgian coalition government in general elections 6 weeks following release of the discovery. The full effects of potential chronic disorders such as teratogenesis, carcinogenesis, immunosuppression, and

*The One Health Concept, first articulated by early scientists such as Rudolph Virchow, recognizes the intimate relationship between human health, animal health and the environment, and calls for an integrative, collaborative approach to health by encouraging the collaboration between experts of diverse fields of study.³

liver or kidney failure is yet to be seen.⁴ One positive effect of the Belgian dioxin scare was that the removal of poultry products from the shelves resulted in an astounding 40% decrease in the incidence of *Campylobacter* infections, a bacterial agent ubiquitous in the poultry industry.⁵ The cause of dioxin contamination was determined to be intentional, criminal contamination of recycled cooking oil destined for animal feed. The use of dioxin in subsistence as an intentional politically motivated attack surfaced in 2004 with the alleged poisoning of Viktor Yushchenko, the Ukrainian opposition presidential candidate.

The agriculture-food industry is a highly complex, integrated, just-in-time system of massive concentrated production, transportation, processing, national and international distribution and retail. There are numerous critical control points uniquely susceptible to unintentional adulteration throughout the food chain. Similarly, the industry is an open “soft” target for intentional contamination for social, political, economic, or religious motivations. The January 2001 Department of Defense report, *Proliferation: Threat and Response*,⁶ was the first official document which identified that attacks on US food supplies could affect the economic stability of the country and erode military readiness. As outgoing Secretary of Health and Human Services, Tommy Thompson said in a 2004 interview that he worries “every single night” about “food poisoning” on a massive scale. He continued, “I for the life of me cannot understand why the terrorists have not attacked our food supply, because it is so easy to do.”⁷ Ensuring the safety of the food chain from intentional adulteration, termed food defense, is an emerging role of the US Army Veterinary Service.

Food and waterborne disease due to unintentional contamination remains a significant health threat, even in the United States. We are no further away from the great endemic diseases of the underdeveloped world

than an air transport of fresh vegetables destined for our grocery stores and restaurants. A typical restaurant meal contains ingredients from 30 countries and is handled by food service workers from no fewer than 4 countries. US citizens believe food safety is the responsibility of the vendor and regulatory agencies. In stark contrast, the entire developing world believes the responsibility for food safety lies with the consumer—*caveat emptor*. With this perception in the US, perhaps it is not surprising that 74% of US households failed to meet minimum sanitary standards in a recent Audits International survey.⁸ The risk lies not just with meats, but equally with fresh fruits and vegetables. For the first time, the incidence of foodborne disease due to consumption of produce equaled that due to contaminated meat, poultry, eggs, and seafood in 2000. Reports of large-scale outbreaks traced to spinach or lettuce have become as commonplace as ground beef recalls.⁹

Food and waterborne disease is responsible for an estimated 76 million cases of gastroenteritis annually in the United States alone, with 325,000 hospitalized patients and 5,000 deaths. Worldwide, food and waterborne diseases represent the most

commonly reported outbreaks to the World Health Organization. This is a staggering fact given the extent of infectious diseases abroad such as malaria, leishmaniasis, and tuberculosis. No doubt the incidence has always been high in the underdeveloped world. The increase in recognized outbreaks likely represents improved surveillance and reporting.¹⁰

The primary route of exposure is fecal-oral contamination of food and water due to poor food handler hygiene and the use of contaminated water and ice in processing. Raw and undercooked meat, poultry, eggs, dairy products, shellfish, and produce are the highest risk food items commonly consumed. Unpasteurized milk was responsible for 45 outbreaks in the United States from 1998 through 2005. Other means of infection are person-to-person via asymptomatic carriers and episodes of public



Figure 2. Loss of consumer confidence in the safety of the food chain carries significant social, economic, and political implications. Even the perception of unsafe food can potentially cause large-scale perturbations in global markets.

vomiting, through fomites or aerosolization. A review of 348 outbreaks of acute gastroenteritis reported to the Centers for Disease Control and Prevention revealed 39% were foodborne, 12% were person-to-person, 3% were due to contaminated water, and 46% were from undetermined sources.¹¹ Control of disease outbreaks is usually restricted to the identification and removal of the point source, and minimizing person-to-person transmission. Critical to the process is rapid, sensitive, and specific diagnostics. Agent detection in food and water systems poses unique diagnostic challenges. Water detection requires a large sample size and sophisticated concentration technologies. Many food items contain enzymatic inhibitors that reduce the effectiveness of assays. Development of new validated detection assays is an ongoing focus in the food and water diagnostic community.¹²

Many kinds of infectious agents are responsible for causing food and waterborne diseases, including viruses like Norovirus and Rotavirus, bacteria including *Salmonella*, *Campylobacter* and *Shigella*, metazoan parasites like trichinosis, and protozoal infections such as cryptosporidiosis. Many outbreaks are multifactorial, further complicating the diagnosis and tracing the origin of outbreaks. The majority of cases present as acute gastroenteritis: nausea and vomiting, cramps, fever, diarrhea, headache, and myalgia. Many diverse disease agents present with similar signs and symptoms, although the presence of blood in the stool should always raise concerns about a bacterial agent and inspire the attending health care worker to collect stool specimens for culture. Of interest, less than 60% of cases of acute gastroenteritis presented to physicians in the US are actually cultured for disease agents. While most cases of acute gastroenteritis resolve within a matter of days, a low percentage of cases develop serious complications, including hemolytic-uremic syndrome, thrombotic thrombocytopenic purpura, Reiter's Syndrome (consisting of arthritis, urethritis, and conjunctivitis), septicemia, dehydration, and electrolyte and acid-base derangement, shock and death.^{13,14}

SHIGA-TOXIN PRODUCING *ESCHERICIA COLI*

The enteric coliform organism, *E. coli*, is ubiquitous in animals and farm environments. Most strains exist as innocuous intestinal flora and serve as a useful indicator of fecal contamination. Some strains including O157:H7 and O153 produce a Shiga-like

toxin and are capable of causing severe gastroenteritis. The primary source is the mammalian intestinal tract. While many mammals carry this organism, human exposure is primarily from ruminants and contaminated environments. Products at greatest risk include raw milk, fresh produce, water sources, unpasteurized cider, and undercooked ground beef. The incidence of disease in the US is 2.8 per 100,000, with an estimated 73,000 cases per year. Disease outbreaks are commonly associated with large-scale recalls of regionally, nationally, or internationally distributed ground beef. Following a 2- to 5-day incubation period, affected patients develop a 6 to 10 day course of severe cramps, fever, and watery diarrhea that becomes bloody with time. Many recovered patients become silent carriers, capable of shedding organisms for protracted periods. Up to 4% of infected juveniles develop hemolytic-uremic syndrome, while a smaller proportion of adults develop thrombotic thrombocytopenic purpura. The cardinal signs of cramping and blood diarrhea always warrant a stool culture and strain typing. A typical isolation media is Sorbitol-McConkey agar. Shiga-like toxin is detected using a verotoxin assay. Treatment consists of supportive fluid and electrolyte therapy. Antibiotics appear to predispose for hemolytic-uremic syndrome. Antidiarrheal products like Imodium are contraindicated. Shiga-like *E. coli* is a reportable disease.^{15,16}

NOROVIRUS

Norovirus is a nonenveloped, single-strand RNA virus of the family Caliciviridae. It is resistant to drying, freezing, steam, and chlorination, and is the number one cause of acute gastroenteritis, responsible for over 50% of outbreaks in the United States. Detection was restricted to a few specialized research laboratories until recently, thus explaining the large proportion of historic foodborne disease outbreaks with undetermined etiology. This is a disease of high-density encampments, including everything from Naval vessels and cruise ships to military and youth training camps, and even a recent outbreak at a marathon dance contest. Oysters in contaminated waters filter and concentrate the virus in high titers. Transmission is primarily through contaminated food and water supplies, although the hardy nature of this virus explains many cases of person-to-person transmission and exposure via aerosolization following episodes of public vomiting. Diagnosis is made by

reverse transcriptase polymerase chain reaction technology.¹⁷

The symptoms are that of a typical case of gastroenteritis, with up to 30% of recovered patients becoming asymptomatic shedding carriers of the disease. A notable exception was the Norovirus outbreak in the British field hospital in Afghanistan in 2002. Twenty-nine patients and staff were affected by an unusually severe, acute disease characterized by headache, stiff neck, photophobia, listlessness, disseminated intravascular coagulation, and mild gastrointestinal symptoms. The disease presentation resembled a hemorrhagic viral disease like Rift Valley Fever more than a typical intestinal agent. Diagnosis was delayed for several days, resulting in a palpable operational paralysis in the sector.¹⁸ This outbreak speaks loudly for the need for forward-deployed, rapid, sensitive, and specific diagnostics to support military operations.

CRYPTOCOCCUS NEOFORMANS

Cryptococcus neoformans, the etiology of cryptosporidiosis is a minute, intracellular apicomplexan protozoal parasite (Figure 3). Reservoirs include humans, ruminants (especially calves), and even birds. Transmission is fecal-oral, and can be human-to-human, animal-to-human, foodborne, or waterborne. The most common source of outbreaks is a failure of solid waste management. The disease is self-limiting in the immunocompetent patient, with nausea, cramps, and an explosive watery diarrhea of 3 to 4 days duration following a 1- to 12-day incubation period. In immunosuppressed patients, cryptosporidiosis becomes a chronic diarrhea with persistent shedding of myriad organisms. Up to 20% of acquired immunodeficiency syndrome patients are affected by chronic cryptosporidiosis.¹⁹ While some outbreaks are truly due to a zoonotic strain spread from livestock to humans, the majority of cases are actually caused by genotype I, a strictly anthroponotic variant. Outbreaks have been reported from swimming pools and water parks and from the food service industry, including an interesting

case in Spokane, Washington, traced to contaminated green onions.²⁰ The most spectacular outbreaks are due to solid waste failures. The 1993 outbreak in Milwaukee, Wisconsin, affected 403,000 residents, and stands today as the largest public health outbreak in US history.²¹ At the time, dairy farms located along 2 rivers upstream from Milwaukee were blamed. However subsequent study of the causative organism revealed its nonzoonotic nature, thus implicating human fecal contamination of the drinking water supply as the likely source of infection.²²

Control and prevention must thus follow a 2-pronged approach, both directed at limiting the ingestion of food and water contaminated by ruminant fecal material, but also aimed at prevention and early detection of large-scale community waste management failures.

TRICHINOSIS

Trichinosis is caused by the nematode parasite, *Trichinella spiralis*, a member of the Class Adenophorea. Transmission is entirely from ingesting raw or undercooked meat. This nematode parasite is unique in that the infected human or animal serves as both the intermediate and definitive host. Reservoirs include rats, pigs, dogs and cats, horses, wildlife, and even marine mammals. The US commercial swine industry is likely free of the disease, however, backyard and foreign pork products should be considered contaminated.²³

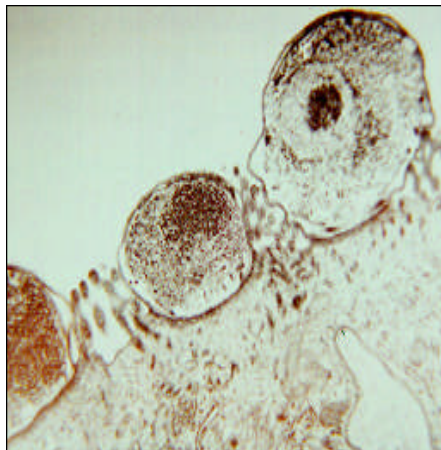


Figure 3. An electron micrograph of *Cryptosporidium parvum* organisms within an enterocyte.

After 5 to 15 days incubation, the patient presents with a triad of signs: myalgia, fever and fatigue, edema of the upper eyelids, and a stunning peripheral eosinophilia. Diagnosis is made via history of exposure, clinical examination, hematology, assays to detect elevated muscle enzymes such as lactate dehydrogenase and creatine phosphokinase, and muscle biopsy. Biopsies reveal coiled nonencapsulated nematode larvae eliciting minimal local tissue reaction (Figure 4). Suspect animal muscle tissue can be evaluated by

histopathology or a larvae per gram (LPG) digestion assay.²⁴

Outbreaks in the United States are most often due to ingestion of wild game jerky, including cougar and bear. A Montana outbreak was traced to bear jerky prepared following 6 months of freezing. The LPG assay revealed 212 larvae per gram!²³ Outbreaks in France and Belgium have been traced to consumption of raw horse flesh, and outbreaks throughout Germany are typically due to smoked pork sausage. A 2007 outbreak in Pomerania affected over 200 people, and was traced to raw pork from a single producer. Other outbreaks around the world were caused by ingestion of barbequed badger (Russia and Korea); dog meat (Russia, Kazakhstan, Slovakia, Thailand, and China); fox sausage (Italy); and barbequed leg of jackal (Algeria).^{25,26}

Prevention requires cooking all meat to 160°, or until it turns from pink to brown. Historically, freeze-resistant strains were restricted to the Arctic; however, the past 2 decades have seen increasing numbers of freeze-resistant strains responsible for outbreaks in the lower 48 states.²⁷

Judicious rodent control on farming operations is essential, as is sanitary disposal of garbage.

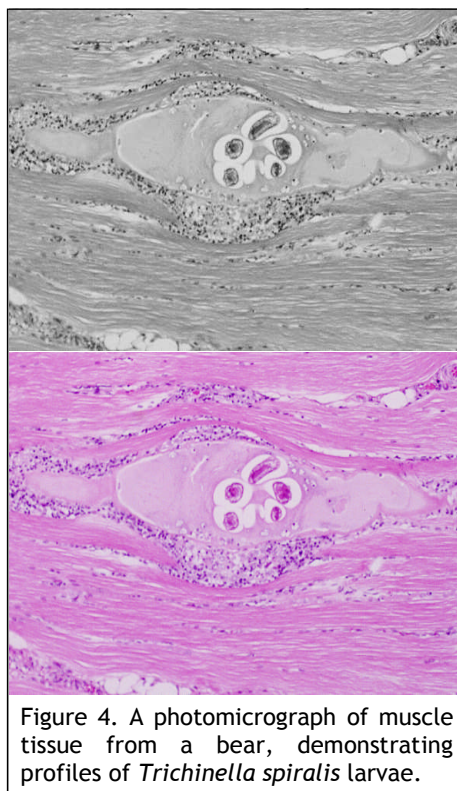


Figure 4. A photomicrograph of muscle tissue from a bear, demonstrating profiles of *Trichinella spiralis* larvae.

Food and waterborne diseases are easily preventable by following basic hygiene practices and having complete knowledge of the processing and products consumed. The US Army Veterinary Service maintains a worldwide directory of sanitarily approved food sources²⁸ to ensure that our Soldiers, Marines, Sailors, and Airmen are protected against incursions of food and waterborne disease. Food safety spans the entire food chain, from farm production through consumption in the dining facility. Unfortunately, the finest food safety network can be rendered ineffective through poor hygiene and high risk behavior. As Field-Marshal Sir William Slim wrote in his memoirs of command of the 14th Army in Burma in 1942,

Good doctors are no use without good discipline. More than half the battle against disease is fought, not by the doctors, but by the regimental officers.²⁹

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A Veterinary Service Squad Deployment In Support of Operation Iraqi Freedom

CPT Marla Brunell, VC, USA

INTRODUCTION

The 64th Medical Detachment (VS) deployed to southwest Asia and northeast Africa from January 2005 to January 2006 in support of Operation Iraqi Freedom. The unit was divided into squads providing veterinary services in 3 countries: Kuwait; Qatar; and Djibouti, Africa. A squad typically consists of a Veterinary Corps Officer, an animal technician (MOS* 68T), and one to 4 food inspectors (MOS 68R). The mission at each location consisted of food inspection, assistance with stray animal control, and medical care of military working dogs (MWDs).¹

The deployment offered Soldiers the experience of working in all 3 countries. Each location had a busy food mission. On a frequent basis, food inspectors recommended rejection of food delivered onto base due to decreased quality and condition. Stray animal control by euthanasia was routine work in all 3 locations as well. This is an unpopular task among Soldiers and difficult for veterinary services personnel, but it is absolutely necessary to protect Soldiers from zoonotic diseases. Many challenges were routinely faced while attempting to provide adequate care to MWDs. The treatment space and equipment at each location varied and was usually inadequate. This was largely overcome by coordination with human medical facilities. In fact, 3 MWD surgeries were performed at medical facilities on base.

FOOD MISSION

There are a variety of food facilities on a forward deployed base, for example, dining facilities, fast food establishments (Burger King, Subway, Pizza Hut), AAFES[†] exchange, operational ration storage, and prime vendor warehouses.

The food inspectors typically inspected from 200,000 lbs to 300,000 lbs of subsistence per month at each location. Support provided by food inspectors

included: receipt inspections, military-wide and local recalls, product shelf-life extension at the AAFES exchange and prime vendor warehouse, operational ration inspections, monitoring temperatures and expiration dates at the AAFES exchange, verification of approved sources, guidance on refrigeration failures, and attendance at monthly menu board meetings.²

Receipt Inspections

The majority of food inspection work consisted of receipt inspections. As trucks arrived at the base with food, the food inspectors checked the seals on truck doors; looked for evidence of tampering; measured the temperature inside; checked for approved sources; and inspected the quality and condition of food. Our squad found a substantial amount of food from unapproved sources as well as problems with the condition of food arriving on base. As a result of our initial findings, we implemented 100% receipt inspection, out of necessity, to ensure that only safe food entered the base.²

Food Trends. There were 3 common problems found with food arriving on base:

- Unapproved Sources. The *Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement*³ provides a list of acceptable manufacturing plants that may be used to obtain food sources for the military. In our experience, lack of compliance existed from the prime vendor. Products typically can be acquired more quickly and less expensively by the prime vendor from surrounding countries rather than by shipment from Europe or the United States. However, without evaluation of the sanitary practices and security of these plants, the products could pose a health risk to military personnel.
- Insect Infestation (Figures 1 and 2). Infestation occurred mostly in the pasta or flour which was stored for too long at higher temperatures,

*Military occupational specialty

†Army and Air Force Exchange Service

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allowing insect eggs in these products to hatch.

- Temperature Abuse (Figures 3, 4, and 5). The quality and condition of subsistence was frequently diminished due to improper temperature while in storage, during delivery, or at the search pit*.

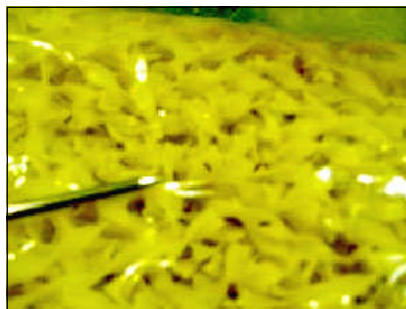


Figure 1. Beetles in pasta.

ANIMAL MISSION

Military Working Dogs

Depending on the location, a squad was typically responsible for 10 to 20 MWDs:

- Preventive Medicine. Dogs at home stations and those deployed are provided parasite prevention and routine vaccinations. MWDs deployed to southeast Asia, southwest Asia, and the Balkans are additionally provided doxycycline or tetracycline daily as prophylaxis against rickettsia and babesia infection.^{4(p33)}
- Physical Examinations. At a minimum, military veterinarians perform semiannual physical examinations of MWDs to detect and address problems or changes in the health of the animals.^{4(p26)}
- Sick Call/Emergency/Surgical Care. Military veterinarians and animal technicians are on-call 24 hours per day to care for MWDs. As mentioned earlier, each location varied, but most were inadequate for MWD treatment due to lack of equipment and/or space. Kuwait had an acceptable facility which included a designated veterinary trailer with a storage area, as well as a treatment room/laboratory with a sink and microscope. In addition, a surgery suite with anesthetic capabilities was provided. Upon the team's arrival in Qatar, the designated veterinary treatment room doubled as the dog food storage area. The room was too small to set up an exam table and be able



Figure 2. Insect in unopened, sealed bottle of water.

to move around and treat an animal. We usually worked where space could be found, offices, hallways or outside. An anesthesia machine and microscope was available, however, no dental, radiographic, or sophisticated laboratory equipment (ie, blood analysis) was available at either the Qatar or Kuwait locations. On a regular basis, radiographic and laboratory equipment was used at the

medical facilities on base. There was no veterinary treatment room and only sparse medical equipment was available in Djibouti. There was a very small number of MWDs in Djibouti, therefore, extensive equipment was not feasible. If a dog required further diagnosis or treatment, it could be flown to Qatar, and, depending on the case, to Germany if necessary. If an emergency arose, a civilian veterinarian off-base could be used.

Four MWDs required surgery during the deployment. Two aural hematoma repairs, an extraction of an abscessed tooth, and a root canal on a fractured canine tooth were completed. In 3 of the cases, we did not have the proper room or necessary equipment (ie, dental drill) to perform surgery. The medical personnel on base were cooperative and allowed us to use their facilities and equipment to successfully accomplish the procedures. When necessary, we had the option to fly dogs to the 51st Medical Detachment, our referral center in Germany, for treatment. However, if the opportunity existed to treat dogs in-theater, it was best to get the dog back to duty as soon as possible. Understandably, time was always a concern to the kennel masters who had a severe scheduling problem if they were short a dog team on the gate.

The availability of base funding was explored to address the need for more efficient treatment. We were very proud that the necessary funding was secured after 8 months, and we broke ground to build a treatment room/surgical suite with veterinary equipment for the dogs in Qatar. The room was built as an addition onto the dog

*A secure area outside and away from the entrance gate of a base where guards and bomb dogs search vehicles for explosives before allowing them to enter.

kennel and contained an isolation kennel and an area for food inspection. Equipment purchased included a surgery table/dental sink, centrifuge, surgery light, dental unit, and an autoclave.

- **Medical Evacuation.** As mentioned above, we had the option to coordinate with human medical facilities to fly an MWD to Germany for care if the dog required emergency care beyond our capabilities. However, that is more easily said than done. Patience is required as there is always much coordination with aeromedical assets as flight times can change frequently. Also, personnel rotate often so you must keep your points of contact roster current. Another factor to consider is the requirement to keep the patient stable until the flight, and then en route. The handler accompanies the MWD, however, the veterinary unit must decide if the handler can adequately monitor and treat the dog during travel, or if an animal technician is required to accompany the patient.

- **Kennel Inspections.** Kennel inspections were performed on a monthly basis to ensure MWD housing was adequate, clean, and safe. The kennels at the different sites also varied in size and quality, from very well built concrete structures with well-landscaped training yards and new obstacles, to dog crates stored in a tent with old worn obstacles in a dirt yard.⁵

- **Handler Training.** Training was offered to the dog handlers on various topics such as heat injury prevention, ear cleaning, first aid, bandaging, subcutaneous and intravenous fluid administration, and intravenous catheter placement.



Figure 3. Beef with freezer burn. Some packages were broken exposing raw meat.



Figure 4. Thawed and refrozen chicken. Evidence of "purge," frozen blood and juices outside the chicken.

MWD Trends. The 3 most common problems encountered with MWDs:

▷ **Otitis externa.** The dogs work in hot and dirty conditions, which provides an environment that favors bacterial and/or yeast infections and subsequent inflammation of the external ear canal. A complication of otitis externa is development of an aural hematoma. Dogs will head shake and scratch to try to gain relief from irritated ears. The result can be fracture of the cartilage and a hematoma originating from the auricular artery within the fractured cartilage. Our squad ensured that the handlers understood the importance of checking MWDs on a weekly basis and cleaning their ears, if needed, to help prevent infections.



Figure 5. Refrigeration unit failed in the truck transporting frozen meat en route (left). The outside air temperature was 120°F. Blood from thawed meat flowed from the truck when inspectors opened the doors (right).

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- ▷ Lameness. MWDs work long, hard hours jumping in and out of tall trucks in the search pit. Orthopedic examinations of lame dogs were usually unremarkable. Typically, there would be a grade I/IV lameness but a specific lesion could not be localized. Again, medical personnel from the clinic were very cooperative and allowed us use of their radiographic equipment, which enabled us to rule out orthopedic injuries such as fractures. Muscle injuries were presumed and 3 days cage rest with nonsteroidal anti-inflammatory drugs were curative in most cases.
- ▷ Dental disease. Two dental surgeries were performed. The first was extraction of a carnassial tooth, which had developed a root abscess. The second was a root canal on a canine tooth that was fractured at the gum line during training.

Stray Animal Control/ Rabies Bite Control Program

Excessive numbers of stray animals (mostly dogs and cats) come onto bases looking for food. Strays can carry disease and parasites to the human population. Rabies virus is transmitted in saliva via a bite to humans and is fatal unless treated with post exposure antibodies. The Department of Public Works had the responsibility of trapping stray animals on base and bringing them to veterinary services for euthanasia. Unfortunately, this was an almost everyday occurrence and was difficult at times for the veterinarian and technician to euthanize so many animals. There were several instances of Soldiers bitten while handling stray animals. These Soldiers were given post exposure antibody treatment as a precaution. The animals were captured, decapitated, and specimens sent to Veterinary Lab Europe in Landstuhl, Germany, for rabies testing. In all of our cases, the specimens were negative for rabies. It was important to obtain this information so the Soldiers who were bitten could discontinue the post exposure treatment.

Health Checks on Local Animals

Periodically, camels or falcons were brought on base to entertain Soldiers. Our squad did health checks on the animals prior to Soldiers handling them to look for any obvious signs of disease that could potentially be zoonotic.

CONCLUSION

Several trends in both the food and animal missions were noted. The 3 most common problems with food were temperature abuse, unapproved sources, and insect infestation. These were mostly due to lack of compliance to US standards by the prime vendor. By vigilant inspection and recommending rejection of food to facility managers, the prime vendor began complying and the food quality improved dramatically. The 3 most common reasons our squad saw MWDs were otitis externa, lameness, and dental problems. These were mostly related to the environment and working conditions the MWDs were experiencing. In Qatar, the treatment room was almost complete when we rotated from theater. While we did not get to use the facility ourselves, our successors benefited from it. Our experiences, challenges, and accomplishments are typical and similar to other Veterinary Service units deployed in support of Operations Iraqi Freedom and Enduring Freedom.

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Veterinary Civil Action Programs in Afghanistan: Pros, Cons, and How

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ABSTRACT

Veterinary civic action programs (VETCAPs) are short-term clinics that are conducted by military veterinarians to treat the local livestock. They are used successfully by military commanders and provincial reconstruction team leaders to prepare the battlefield for further engagements. Hundreds of VETCAPs have been conducted in Afghanistan since 2001. However, veterinary-focused, nongovernmental organizations working in Afghanistan contend that these programs decrease the sustainability of the veterinary infrastructure throughout the country. This paper presents a study conducted from March 2006 through February 2007 which seeks to quantify the effect of veterinary civic action programs on the local veterinary infrastructure in Afghanistan, and determine ways in which the military objective may be obtained while causing least damage to the veterinary infrastructure.

INTRODUCTION

The cooperative medical assistance (CMA) team is a small team composed of a doctor, medics, and physicians assistants, and may include a veterinarian, dentist, and/or optometrist. The purpose of this team is to provide social or political quick impact projects in the form of medical assistance to areas in countries without a well-developed medical, dental, or veterinary infrastructure. The team includes translators, and, in Afghanistan, male and female medical personnel as well. In Afghanistan, the team is on-call to provide single day clinics, usually in remote areas, at the request of the resident military or provincial reconstruction team (PRT) leaders. These short-term clinics are referred to as civil action programs (CAPs), or, more specifically, MEDCAPs (medical), VETCAPs (veterinary), and DENCAPs (dental), according to the services offered. The CMA team is hosted, protected, and supported by the military unit. The requesting unit determines the site, and performs all preparation for the event, to include advertising. Often, the resident unit augments the team with their own medical assets, although the CMA team has the discretion to determine the medical, veterinary, and dental procedures provided. Since the military unit or PRT is the entity with a long-term interest in the area, they are responsible for measuring the impact of the clinic on the local people.

Nongovernmental organizations, and even at times the requesting units, are often confused over the purpose

of the CMA team. It is not a substitute for local medical assets. It is not meant to replace the local veterinarian, doctor, or dentist. It is not meant to provide medical care for underserved communities. It is not meant to respond to disease outbreaks or become involved in control measures. Requests for such services are routinely denied by the CMA team leader. Although all those involved in the process hope that the VETCAP/MEDCAP adds to the health and well-being of the local community, that is not the primary function of their mission. It is, rather, a tool utilized by the combatant commander or the head of the PRT to gain access into the local community, or to provide recompense for perceived hardship borne by the community due to military operations. It is also a method by which military units may gain favor with the civilian population, who then may be more willing and able to provide information on local insurgents. It may occasionally be used as a show of force within areas that are closely controlled by insurgents, to show that the coalition forces are unafraid and able to provide aid despite the danger. It has also been used as a reward for good behavior when a community has been active in fighting the insurgency on their own. Therefore, while it may appear that the CMA team is only conducting humanitarian operations, that is an adjunct benefit to the accomplishment of military goals.

It is clear from follow-up interviews with military and PRT members that a successfully conducted MEDCAP/VETCAP generates goodwill within the

community. VETCAPs in particular create a bond between Afghan herdsmen and military units. Afghans are extremely appreciative when they see military personnel willing to wrestle sheep and risk kicks and bites in order to treat their animals. The operation itself also creates a mild chaos which is entertaining for the community, and a crowd always develops at the VETCAP site. This crowd and chaos provide an environment in which people may speak to Soldiers without raising undue suspicion. Lastly, the VETCAP provides a visible example of outreach which the locals will be talking about for a long time. Because of the lack of basic veterinary care, the vaccination and deworming of herdsmen's animals has an immediate beneficial impact on village health. This benefit extends beyond the direct benefit to the herdsmen.

Animals are intimately associated with the economic and social well-being of the Afghan people. Legal agriculture makes up 38% of the gross domestic product.¹ However, the impact of animals on the economic well-being of villagers is not fully demonstrated by this statistic. Animals are not just used for their meat, milk, and hides. They are used for transportation of goods along roads which are inaccessible to vehicles. Oxen are used for plowing and threshing grain. Horses are essential to the maintenance of the social fabric between tribes. How can it be detrimental if the vaccination or deworming of a herdsman's animals allows them to survive another year or reproduce one more offspring?

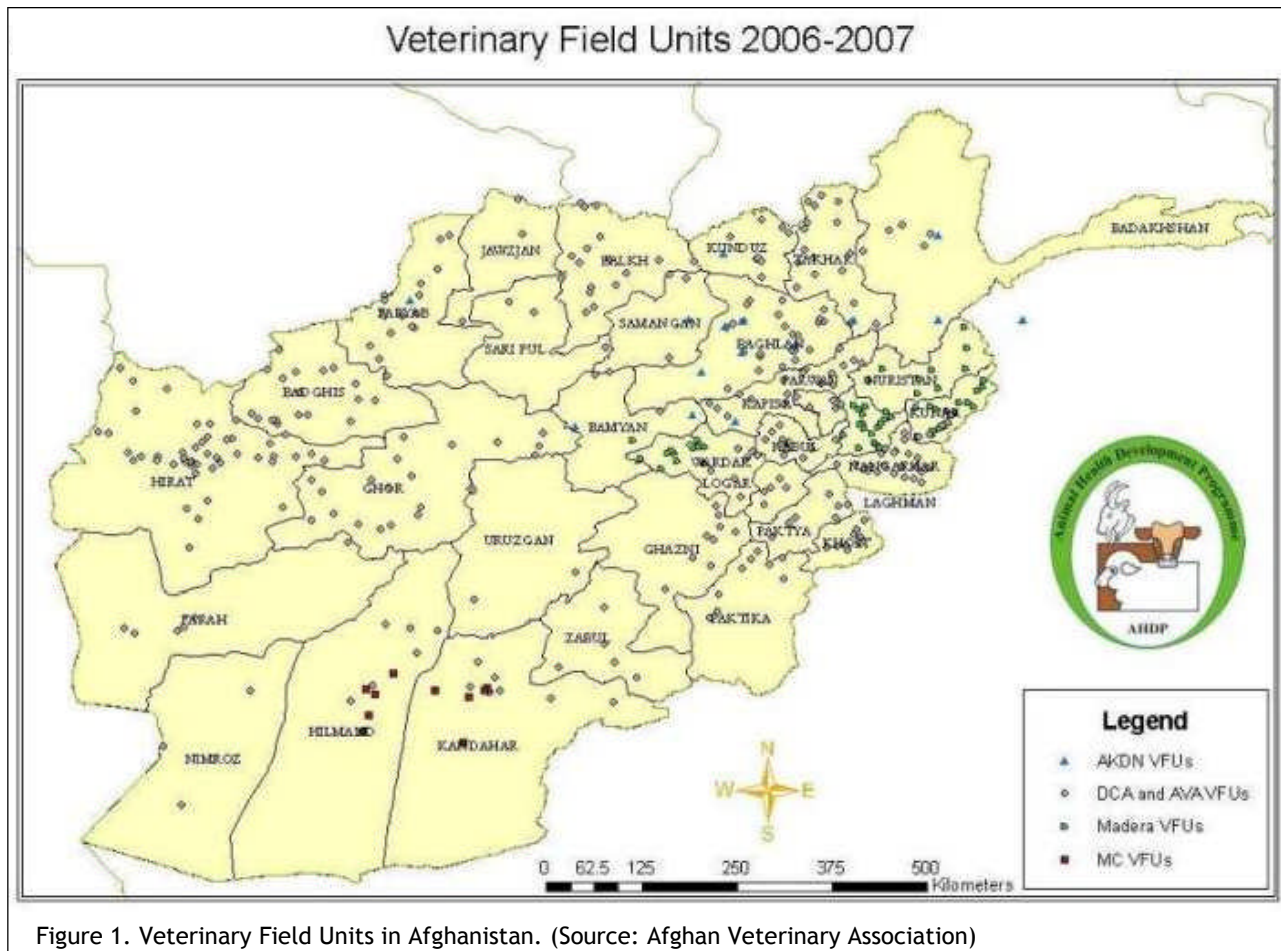
However, these operations have the potential to compete with the nascent veterinary service growing in Afghanistan. For many years, the government attempted to provide veterinary care for free. However, the system was poorly resourced, medications were rarely available, and veterinary training was poor. There was no incentive for veterinarians to do a good job, since their services were free. The modern government of Afghanistan, however, has realized that the old government-supported veterinary services were ineffective. They cannot afford to support all veterinary care throughout this agrarian country. Therefore, the majority of veterinarians today in Afghanistan work on a fee-for-service basis. This model has been generally successful, and as of 2006 there were 587 veterinary field units (VFU), each associated with one of 7 international nongovernmental organizations. These

VFUs employ over 800 veterinary professionals. As shown in Figure 1, the veterinary field units are moderately well distributed throughout the country, although some places are truly underserved. However, they represent a "new" model for veterinary services in Afghanistan, and the number of VFUs and their coverage across the country continues to grow.

In areas in which there is a veterinarian, the provision of free service is understandably detrimental to their business. Aside from the immediate competition, delivery of free veterinary service encourages the local inhabitants to seek free veterinary care, and to continue to regard free veterinary care as a right. Services provided for free to one group of people will spark complaints of herdsmen to veterinarians in other areas asking them why they charge for their services. The nongovernmental organizations are fighting against this mindset in order to create a sustainable fee-for-service veterinary infrastructure. If our actions disrupt this fight, we risk the end of sustainable veterinary services. This will have an enormous detrimental long-term impact. For this reason, we must be very careful in the performance of VETCAPs to ensure that we do not endanger the long-term viability of the local veterinarians. This research was conducted in order to determine the extent of impact our operations have on local veterinary infrastructure, and to investigate ways of fulfilling the military intent of the operation with minimal negative impact on the local veterinarians.

METHODOLOGY

This study was devised after extensive interviews with all the nongovernmental organizations known to be working in the veterinary field in Afghanistan. Prior to arrival at the VETCAP site, the location was checked against a list of known veterinarians which was provided by the nongovernmental organization working in the area. If security allowed, the local veterinarian was contacted prior to the VETCAP in order to inform him of the activities and ask if he would like to participate. On nearly every occasion, where this was possible, the veterinarian agreed to work with us. In these instances, the veterinarian was also interviewed to establish, from his perspective, the willingness of the local people to use his services. He was asked about his prices, and whether or not he was able to work full time as a veterinarian. He was also



asked to estimate the percentage of animals in his area that he had vaccinated.

On every mission, interviews were conducted of all herdsmen who brought their animals to the VETCAP site. They were asked from where they brought their animals, whether they had vaccinated their animals before, and if they knew of any local veterinarian. Note was made of the species and herd size of animals that they brought, and any outstanding illnesses or complaints.

RESULTS

Interviews were conducted at every VETCAP mission by the cooperative medical assistance team over a period of 7 months. Nearly 1,600 herdsmen were interviewed in 7 provinces over 30 mission-days. During this time, over 8,800 animals were seen. Ten local veterinary professionals and 5 veterinary students were also interviewed. Data was discarded from 2 missions, one in Kabul and the other in Ghazni, where

the principle investigator was absent. However, in both areas there was a general denial of the presence of a veterinary field unit (even though there was a large veterinary hospital very close by the site in Kabul), and vaccination rates were reported to be none (Kabul) or negligible (Ghazni). In Gardez, I was forced to use a translator from the local unit, whom I discovered at the end of the day had not understood the directions for interviewing properly. Therefore that interview data was discarded. The consolidated data is presented in the Table.

Herd sizes ranged from one to 230 animals. The majority of these were sheep and goats, although the species distribution was very site-specific. Cows were the next most prevalent, followed by equids, dogs, camels, and birds. Sheep and goats were often run in mixed herds and their numbers were not differentiated in this study. Approximately 10% of the herdsmen that brought their animals to the VETCAP said their animals had been vaccinated at least once previously. With the exception of horses, herdsmen would not

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bring their animals more than 7 km to get vaccinated or dewormed. The majority of animals seen were healthy. There appeared to be an inverse proportion of goats and sheep that were thin in any given area. This implies that mixed herd foraging areas have either good graze or browse but not both. Such herds would benefit from species separation, or elimination, but there may have been a time component associated with running sheep and goats together, in that one does better at certain times of year or under certain weather conditions.

A small percentage of animals coming to the VETCAP would be unwell. These were rarely due to disease, but rather due to mismanagement. Traumatic injuries, wounds (Figure 2), bloat (Figure 3), and “slipper feet” (Figure 4), presumably due to chronic laminitis, were the most common problems seen. Overloading pack animals and not allowing them to rest post-injury were the primary inciting causes.



Figure 2. Pack horse with open wound caused by poorly-fitted pack and poor body condition (Nangarhar). Owner complained that the local veterinarian was ineffective because he “couldn’t fix the wound” while allowing the animal to continue to work. “If I don’t take goods over the pass every day with my horse, my family doesn’t eat,” was his reply when I asked him to rest the horse.

Numbers of animals seen at VETCAPs in Afghanistan, August 2006 through February 2007 (minus those in Kabul & Ghazni*).

	Province						
	Balkh	Bamian	Gardez	Kapisa	Nangarhar	Panjshir	Kandarhar
Cattle	79	147	284	61	69	1210	51
Sheep/Goats	188	1690	759	312	29	2460	96
Donkeys	20	337	33	26	2	129	3
Horses	3	58	1	19	0	40	0
Dogs	2	0	14	5	4	9	5
Camels	0	0	0	0	45	0	0
% Access to VFU	0%	0.75%	Data	66%	100%	21%	No Data
Vaccination Rate [†]	4%	20%	Unreliable	13%	7%	4%	No Data

*The principle investigator was absent at those VETCAPs.

[†]Percent of herdsmen who reported their animals had ever been vaccinated.

The veterinarians interviewed were all from central and northern provinces. Of the ones interviewed, only two had a strong opinion of military VETCAPs. One disliked them, and thought they should stop, the other thought they acted as an enticement for future veterinary activity and wanted more of them. Both veterinarians were located in the Panjshir Province, where nearly a third of the VETCAPs were performed. The veterinary students in Nangarhar were simply pleased to have animals to work on, and the other veterinarians were happy to have us in their area of operations and did not appear to appreciate the potential conflict of loss of their business. The private veterinarians agreed that vaccination rates were low in their areas, while the provincial veterinarians in Gardez and Panjshir thought that vaccination rates were quite good. This contradicted our data from the VETCAPs.

DISCUSSION

Biases in Data Collection

It is important to note that the population interviewed was not randomly selected. They were all herdsmen, and they all brought their animals to the VETCAP site for vaccination or treatment. Since we did not make “house calls,” all animals had to be able to make the journey. Therefore we saw very few severely ill animals (although 2 animals subsequently collapsed upon arrival at the site). Sometimes we were able to inform the population prior to our arrival that we were coming, but sometimes not, and this had a strong

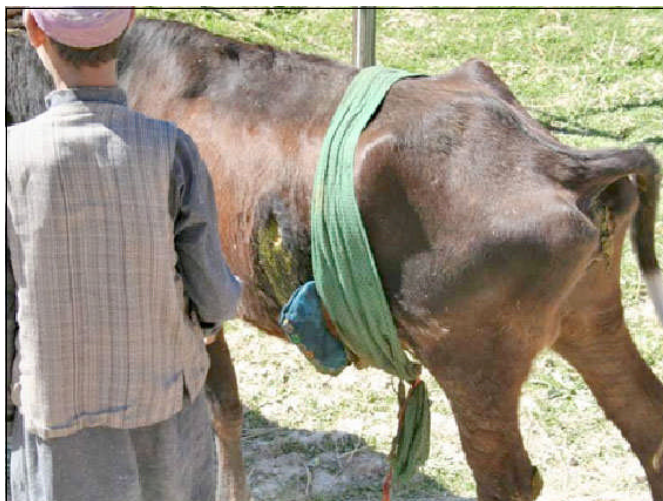


Figure 3: Bloat was surprisingly common. The locals in the small village in Gardez Province have discovered a cure. One downer cow also presented at this site in which the herdsman had put a knife through the omasum and into the lungs.

effect on what types of animals we saw. If we were unable to give forewarning, we saw significantly fewer small ruminants, as they would be already in the grazing areas which were distant from the villages where the VETCAPs were performed. Lastly, data on prevalence of vaccination and knowledge of access to a local veterinarian were collected by interview. This data is always subject to some skepticism, particularly knowledge of a local veterinarian. There was a suspicion on the part of the Afghan villagers that VETCAPs would not be performed if the coalition forces knew that there was a local veterinarian available. This often led to confusion when the military unit or provincial reconstruction team did their initial assessment. However, as stated earlier, the reasons for performing the VETCAP had little to do with providing veterinary service per se, but rather to gain influence or information. Asking the same question during the VETCAP itself, however, should give more reliable results, since it is clear that we were not going to close up the VETCAP for receiving a positive response. However, there were several instances when I knew there was a local veterinarian within a few kilometers, and yet the local people appeared unaware. It is unclear whether this response

was due to ignorance, politics, or a sense that this could damage one's chances to get another VETCAP later.* However, I believe more confidence may be placed in these onsite answers than would be prudent for answers obtained prior to the VETCAP. This indicates a need for better advertising on the part of some of the veterinarians, so that people become aware of the services they offer.

General State of Veterinary Services in Afghanistan

When this study was done in 2006, there were 587 veterinary field units (VFUs) registered in Afghanistan. While not completely covering the country, some areas had quite good coverage. Although many veterinarians were provided with motorcycles, they did not appear to use them to do farm-calls, but rather simply to get resupplies for their pharmacy. This may have been due to unwillingness of the veterinarian to pay for the needed fuel, or to the herdsmen themselves being unwilling to walk long distances to inform the veterinarian that his services were needed.† The location of a VETCAP, as previously stated, was unrelated to the presence of a local VFU, so places visited could be well or underserved. These veterinarians work on a fee-for-service basis, and are required to recover their costs in

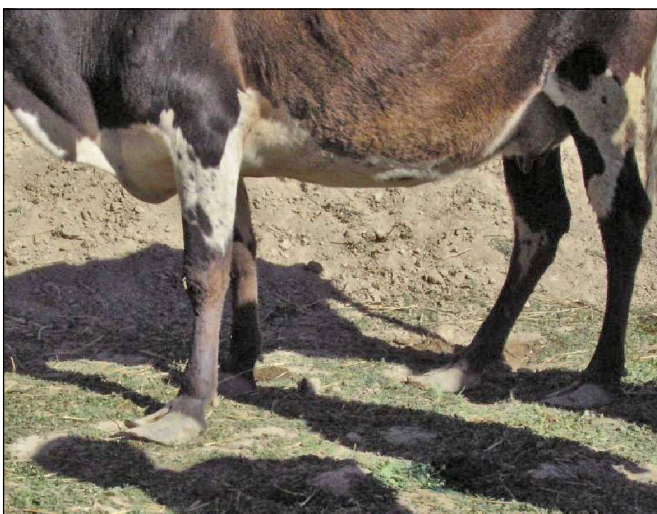


Figure 4. Chronic laminitis (photo taken in Gardez) may have caused "slipper feet" in cows. This was a common finding in Kandahar as well.

*Over the 3 years for which data was available, with the exception of Panjshir Province, the CMA team revisited an area near a previous site only once. During 2006, there were 3 missions to Panjshir, more than any other province, and there was some potential overlap in area of effect. This was done at the insistence of the provincial governor. However, there were virtually no visits prior to 2006. As long as site visits to the same areas do not repeat in subsequent years, the effect will be negligible.

†There was generally no cell phone or taxi service in the areas in which we worked.

order to replenish their medications. The veterinarians may be weighing the cost of procuring the medication, to include fuel for the motorcycle and possibly for the refrigerator, and hold off going into the capital to procure more drugs until there is additional reason to go.

Presumptive Competition

When the veterinary nongovernmental organizations heard of the military providing veterinary care free of charge, they were quite concerned about the level of competition this would pose for the free market veterinarians. Not only is there direct competition, where the VETCAP “steals” the business of the local veterinarian, but there is also a more subtle effect. The locals already have a sense of veterinary entitlement that remains from the Soviet era, and the VETCAPs serve to promote the idea that veterinary care “should” be free. Herders leave with the notion that the Afghan veterinarians are charging them for something which, in the developed world, as evidenced by the coalition-provided VETCAP, is normally free. This causes resentment, and makes it even more difficult for veterinarians to receive payment for their services. Therefore it is imperative that the unit requesting the VETCAP be very aware of the potential downsides to their actions, and the potential impact on long-term sustainability of veterinarians in the area.

What are the goals of VETCAPs? As stated previously, VETCAPs are not primarily about providing veterinary care, but rather about community access and good will. It is a highly visible form of local aid and its somewhat chaotic nature can be a useful distractor. According to commanders informally interviewed several weeks after each mission, the VETCAP was extremely effective in producing a more open and friendly community attitude toward the coalition forces. Therefore, asking these commanders to remove VETCAPs from their “toolbox” is unlikely to meet with success. However, there are ways to achieve the military objectives without sacrificing the local veterinarians or veterinary infrastructure.

Ways to Meet the Goals Without Sacrificing the Veterinary Community

In order to limit the negative effects of performing a VETCAP while still retaining the military objectives, the following standard operating procedure was developed based on this study:

- Distance of VETCAP site from a veterinarian. The study showed that herdsmen were unwilling to bring their animals more than 7 km in order to be vaccinated or dewormed. Therefore, if there is no veterinarian within 14 km, then there is no overlap between the coalition and local veterinarian’s sphere of influence. A veterinarian within 10 km of the VETCAP site would experience only very minor competition. Therefore, if there is a VFU within 10 km of the site, the local veterinarian should be requested to join the VETCAP. Due to security concerns, this sometimes has to be done on the morning of the operation. If he accepts, then he should be brought to the VETCAP site, provided with all the supplies needed, and perform the majority of the treatments. While coalition forces do mostly prophylactic treatments, sick animals are taken to the veterinarian. The VETCAP then becomes a focal point to show support for the local veterinarian.
- If there is a local veterinarian within 10 km and he is unwilling to join the operation, or, more likely, the military unit is unable to find him, then we must downgrade our operation to deworming only. All herdsmen are then advised to take their animals to the local veterinarian for vaccination (since the veterinarians uniformly identified vaccination as their primary source of income), and any sick animals should be referred to him for treatment as well. In this way, we cause minimal interference with the economic potential of the veterinarian despite working in “his space.”
- If there is no veterinarian within 10 km of the VETCAP site, then the site may be designated as underserved, and we provide full-service veterinary care.
- Fliers were distributed at every VETCAP, which explained that this event was a one-time gift of the Coalition Forces, and explained that further treatment and guidance was available from the local veterinarian. These fliers were very popular, and sometimes goaded kids into finding an extra animal just so they could get one.
- Very often, herdsmen request extra medication for their herds “just over the hill.” One must not grant this request. If one grants this request, then not only do you run out of medication much sooner

than expected, but, more importantly, you have now destroyed the 7 km “zone of influence.” The 7 km limit is determined by how far herds-men are willing to push, drag, or otherwise herd their animals to get to you. Treating animals beyond this zone does nothing to advance your mission of improving local relations, and can impact long-term veterinary care for everyone in the area. Do not do it.

OTHER WAYS TO ASSIST

There are other ways to assist and provide visible outreach to the community, thereby completing the military objective without impinging on the local veterinary infrastructure. Provision of a storage facility for grains is a cost-effective way in which to assist the local farmers and herds-men. Much of the grain harvested every year is spoiled by insects or weather. The Kuchis, a nomadic sheep-herding tribe similar to the Bedouin, particularly complained of having no way to store feed along their migratory routes pending their return. One can build a silo and paint “a gift from the American public” in large letters on the side, and it will be more permanently



Figure 6. Horse with hoof abscess which has extended into coronet area (Nangarhar).



Figure 5. White line abscess in a pack horse on the Afghanistan-Pakistan border.

appreciated within the community than any one-day VETCAP. Another way to assist is through literacy programs. Although 64% of adults were noted as “literate” by UNESCO* in 2000,² the majority of farmers with whom I worked were unable to read and write. This makes record-keeping very difficult, and, consequently, herd improvement programs are almost impossible to implement. Again, this will have a longer-lasting effect on the animal health in the area than a VETCAP, and education generally serves the cause of the moderates, which is also a strategic

objective in Afghanistan. Lastly, it was noted throughout the year that there were far more problems related to poor husbandry practices than to contagious diseases. Wounds due to poorly fitted tack and packs, white-line abscesses (Figure 5) that festered until they burst out the top of the hoof (Figure 6), bloat and chronic laminitis, poor forage selection, ignorance of pasture rotation or management, and even limiting access to water are far more serious to the entire animal industry (and compound any potential disease threat) than contagious diseases and parasites. Teaching herds-men the principles behind good husbandry practices will allow them to modify their procedures to get more and healthier animals. Another concept which is foreign to many Afghans is that it may be better to have fewer, healthy animals than many not-so-well-fed ones. However, an economic study should be done prior to recommending this course of action.[†] Other ways to assist herds-men with their animals that will be appreciated can be easily devised, and many will be specific to the site of implementation. It requires thought and preparation, but is ultimately more beneficial to both herds-men and coalition partners, as well as the veterinarians, than conducting another VETCAP.

CONCLUSION

The VETCAP is performed for the purposes of gaining favor within a community. It has been extremely effective in producing the desired results in

*United Nations Education, Scientific, and Cultural Organization

†In studies conducted among the migrating herds-men in Africa, the economic benefit of keeping a thin animal that could later be fattened outweighed the potential benefit of increased offspring due to more or better forage per animal.³

Veterinary Civil Action Programs in Afghanistan: Pros, Cons, and How

Afghanistan, as well as other countries that have a strong agrarian economy and poorly developed veterinary infrastructure. Therefore it is difficult to convince the military commanders to stop performing VETCAPs. However, by following the rules outlined in this paper, the negative impact of the VETCAP can be lessened, while still achieving the desired military result. The gold standard option, of course, is to

perform some other service which can have the same effect. These effects are often more resilient, and appreciated for a longer period of time, than the one-day VETCAP. Each area is unique in its attributes, and determination of the appropriate project will depend on the time horizon and resources available to the combatant or provincial reconstruction team commander.

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Overview of Combat Trauma in Military Working Dogs in Iraq and Afghanistan



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INTRODUCTION

Military working dogs face the same dangers in combat as human service members, and serious traumatic injuries are not uncommon in these dogs. Ballistic, explosive, and blunt trauma has occurred in many dogs and veterinarians in combat zones must be prepared to manage these cases. Even before reaching veterinary care, dog handlers, medics, and other human medical providers are faced with providing lifesaving treatment on canine service members at the point of injury.

DEPLOYED VETERINARY PERSONNEL

Historically, veterinary teams in deployed units tasked with caring for working dogs have not been trained, staffed, or equipped to manage major trauma, focusing instead on day-to-day care and medical management of working dogs in their respective theater of operations.¹ The majority of their work in theater actually focuses on food safety, which, overall, is the largest portion of their daily duties. Occasional serious injury or illness was considered the exception rather than the rule, to be dealt with when it occurs. Training given to Army Veterinary Corps officers and enlisted animal care specialists (veterinary technicians) to ensure proficiency in managing these cases was proportional to the likelihood of it actually occurring, which was considered unlikely. With occasional exceptions, veterinarians assigned to these units are usually veterinary field officers (AOC* 64A), often junior captains who usually have no formal clinical training after graduation from veterinary school. In rare cases, they entered the military after internship or residency training. Internship or residency training is not a requirement to practice veterinary medicine, and only a small percentage of graduate veterinarians pursue this advanced post-graduate training. The Veterinary Corps has an extensive program which allows veterinarians to complete clinical residency

training, but there are no assigned positions within the deployable units for residency-trained clinical specialists. Veterinarians preparing to deploy often complete the Army's Veterinary Clinical Proficiency Course, an intense 2-week classroom and hands-on review of common emergency and surgical treatments, along with certain diagnostic methods.

In both Operations Iraqi Freedom and Enduring Freedom, there are only a handful of veterinary treatment facilities among the extensive number of bases which house working dogs, and transport time to veterinary care may be anywhere from hours to days, depending on the situation. Human medical providers such as medics, physicians' assistants, and physicians are often faced with providing lifesaving care to injured working dogs until they can be transported to a location with a veterinary treatment facility in-theater.

Since 2005, a veterinary clinical medicine officer (AOC 64F), either a surgeon or internal medicine specialist, has been assigned to the deployed veterinary unit in Iraq to augment the existing veterinary capabilities. This has proven very helpful with serious medical and surgical cases, although some serious trauma cases still present to the veterinary field officers at remote forward operating bases throughout the theater. Thus, the veterinary field officer may be the only veterinarian in the area and is responsible for managing major canine trauma. A veterinary clinical specialist has not been specifically assigned to the Afghanistan theater. However, the Army Reserve has provided veterinary coverage in that theater. Many Army Reserve veterinarians are practicing clinical veterinarians in civilian life and therefore come to theater with extensive clinical experience.

The current conflicts in Iraq and Afghanistan have defied doctrine and the "status quo" of deployed veterinary operations. The likelihood of seeing a critically wounded military working dog increased

*Area of concentration

Overview of Combat Trauma in Military Working Dogs in Iraq and Afghanistan

profoundly with the rise of the insurgency. Veterinary officers and enlisted animal care specialists deploying with deployable veterinary units must be prepared for this occurrence. Despite the limitations in equipment, staff, and training, deployed veterinarians have adapted to the challenge and done an excellent job in managing these cases.

INJURIES AND WOUND DISTRIBUTION

There is currently no standardized database to capture injury data in working dogs, such as the Joint Theater Trauma Registry for injuries in human service members. Studies to analyze canine injuries or illness in theater have relied on massive data calls, word-of-mouth reporting, or screening records of deceased working dogs once the medical record is sent for archiving at the Department of Defense Working Dog Center at Lackland Air Force Base. Although several studies are currently underway, and a few have been presented as preliminary data, apparently none have been published since the beginning of Operations Iraqi Freedom and Enduring Freedom.

Preliminary data in a study of gunshot wounds in US military working dogs shows a survival rate of 33% in 21 dogs. Of the surviving dogs, there is a return to duty rate of 71%, with the remaining 29% undergoing continued care and expected to eventually return to full

duty. This data also shows that 5 of the 7 dogs that survived their injuries were considered in critical condition at some point in following their injuries, requiring advanced lifesaving care by medics in the field or by veterinarians at the deployed veterinary treatment facilities.²

Currently there is no standardized injury severity score methodology for dogs as there is for human trauma victims. However, classification of canine casualties for these studies is modeled as closely as possible to human studies. The terms killed in action (KIA), died of wounds (DOW), wounded in action (WIA), and disease, nonbattle injury (DNBI) are defined to allow comparison to human morbidity and mortality studies. A dog is considered KIA if it dies prior to reaching care of a veterinarian in a facility capable of resuscitative treatment or surgery. A dog is considered DOW if it arrives at veterinary care as defined above, but subsequently dies of the wounds, or are euthanized because death is imminent. The term WIA indicates the dog ultimately survived its wounds, and DNBI is used for cases of injury or illness not caused by combat action. According to the preliminary ballistic wound data, none of the injured dogs were categorized as DOW; they either died instantly from catastrophic trauma or survived to return to their home station.² One study of human combat casualties showed approximately 12% of patients died with injuries which were determined to be potentially survivable.³ That is, they suffered injuries from which, with proper identification and treatment of those injuries, they could possibly have survived. No canine casualties in the ballistic wound study have been identified in this category.

Wound distribution for these cases does not appear to mirror wound distribution for human combat casualties. For example, wounds to the thorax from



An animal care specialist provides postoperative physical therapy to a working dog who had received a gunshot wound to the shoulder. The dog underwent extended physical therapy at the DoD Dog Center at Lackland, Air Force Base, Texas, and returned to full duty.



This military working dog incurred a gunshot wound to the head. Following intensive care and treatment for skull fracture, detached retina, and traumatic brain injury, he recovered fully and returned to duty 4 months after the injury.

any cause (ballistic, explosive, blunt trauma) appear to be more common in canines than in human service members.^{3,4} This is probably due to several factors, including the four-footed, head-forward stance of dogs rather than the upright stance of humans, as well as the fact that dogs generally do not wear body armor. While it is commercially available, it is quite heavy, does not carry the same ballistic rating as human body armor, and is thought to contribute to fatigue and heat injury in dogs. The practicality of its use is limited. The US military does not issue body armor to its working dogs, although some improvised or commercially-acquired types have been used in theater.

Explosive injuries and blunt trauma make up the majority of other major combat trauma in dogs.⁵ Improvised explosive devices and mortar and rocket attacks have caused injuries in dogs as well, and, anecdotally, such events appear more likely to result in a combined mass casualty event where both human and canine casualties occur.

INTEGRATION OF VETERINARY CARE INTO THE HUMAN MEDICAL ASSETS IN THEATER

As mentioned above, deployed veterinary teams are not specifically equipped, staffed, or trained to manage serious canine trauma cases. Most locations lack diagnostic imaging and comprehensive laboratory equipment, and are minimally staffed with skilled veterinary providers. Integration with human medical resources such as a combat support hospital, Air Force theater hospital, or other human medical facilities is vital to providing advanced veterinary care to critically injured dogs.

In one notable case, a working dog and several human service members were seriously injured when an improvised explosive device caused a building to collapse, trapping the service members and the dog under the rubble. The dog was placed on the evacuation helicopter along with the injured humans, and taken to the Air Force theater hospital in Balad where they were treated side-by-side in the emergency department. Emergency department personnel were assigned to assist the veterinarian with emergency care of the dog until he could be stabilized and transferred to the veterinary treatment facility adjacent to the hospital. Separating the dog from the handler to go straight to the veterinary treatment facility, while the handler was sent to the hospital, would have caused

confusion with medical operations within the medical evacuation system, and would have required additional personnel to triage and transport the dog to a separate location. They treated the dog as another combat casualty, and brought the veterinarian into the emergency department as the veterinary provider. This allowed a smoother and more efficient flow in treatment of all of the casualties. In addition, proximity of the dog to an injured handler is important to morale of the team, and calmness of a potentially aggressive working dog.

In another case, a dog suffered multiple fragmentary wounds following a suicide bombing in close proximity to the dog and handler. The dog and handler were taken back to the forward operating base, where they were immediately separated. The handler was taken to the combat support hospital, while the dog was taken straight to the veterinary treatment facility. The veterinary field officer quickly recognized signs of shock and the need for emergency exploratory surgery which she felt was beyond her capabilities and that of her staff in their facility. She immediately transferred the dog back to the hospital where she performed lifesaving splenectomy and intestinal resection and anastomosis with the assistance of human trauma surgeons, a certified registered nurse anesthetist, and other surgical staff. This action effectively turned Level I veterinary capability into Level III capability at that location without costly addition to veterinary equipment or manpower.

Those are just 2 cases illustrating how the deployed veterinary teams are adapting to their situation to provide excellent care to dogs with combat trauma. Integration with human medical resources is vital and perhaps should be made doctrinal. Several individual cases have been reported of medical facility commanders refusing to allow dogs treatment in their facilities. An unwarranted and unscientific fear of contamination seems to be the driving cause of this. In reality, there are very few infectious or zoonotic diseases that can be transmitted from dogs to humans, and many of these are mitigated through prophylactic vaccinations (ie, rabies) and strict prophylactic antibiotic regimens that working dogs undergo while deployed.⁶ There has been no formal study in the military sector to support this, but it is likely that working dogs pose no more of a health threat to humans in the medical facility than other humans in that same facility. As long as routine body substance isolation and local decontamination measures are



A Veterinarian and human trauma team join forces to perform life-saving surgery on a working dog injured by an explosion.

followed, medical facility commanders should not use this as a reason to refuse dogs emergency care in their facilities.

TACTICAL CANINE COMBAT CASUALTY CARE: STANDARDS BASED ON EVIDENCE AND COMBAT DATA

Tactical combat casualty care for human casualties has well-defined standards of care, as does advanced trauma management, damage control surgery, and critical care. Standards exist for everything from use of tourniquets to use of fluids, blood, and blood products in resuscitation.⁷ These standards are based on casualty data and multiple formal studies on actual combat casualties and trauma management in the civilian sector.^{8,9} Since there has been no casualty database from which to compile and analyze data for canines, veterinarians in deployed environments have been left to manage these cases based on their own individual experience, “gut feeling,” or other available resources.

Similarly, until recently there was no standardized canine first aid training for working dog handlers, and no known formal military training available for human medical personnel who may be responsible for caring for dogs at the point of injury. Dog handlers and human medical personnel who requested this training from their area’s military veterinarian received training based on the comfort level and experience of that individual veterinarian. The reality, unfortunately, was that few veterinarians had been deployed and even fewer had experience with combat trauma. Virtually none had experience with point-of-injury, prehospital care, but were asked to train battle-experienced medics and human medical providers in this area. Add to that the fact that they were training these providers on guidelines that were neither evidence-based nor standardized, and the guidance was often conflicting.

Veterinarians were understandably reluctant to train nonveterinarians on life-saving procedures, such as needle thoracotomy, that they themselves had never performed on an actual patient. However, lessons learned from combat have shown that human medical personnel will improvise when faced with a critically injured dog far from veterinary care, extrapolating from their medical skills. There are multiple cases in which they have performed these lifesaving procedures on injured dogs with good success.² Because they will proceed with this care regardless of whether they have received training or not, a new thought is emerging about this training. It may be time to develop evidence-based standards of care that can be used by veterinary personnel as well as the human medical providers who provide prehospital canine care on the battlefield. Recently, Vogelsang’s excellent article¹⁰ summarized the basics of military working dog care for human medical providers who may be faced with this situation in deployed locations. This was the only article we could find in the literature to address this concept and it is likely the first of its type, a situation that only emphasizes the need for this type of training and information.

THE WAY AHEAD

The increase in severe combat trauma in dogs has led to a different way of thinking in the Army Veterinary Corps, and also with human medical providers and units employing dogs on the battlefield. Work is underway to develop a canine injury database similar to the Joint Theater Trauma Registry. Clinical training of junior veterinary officers and enlisted animal care specialists has increased immensely over the last few years, with new interest and focus on management of trauma and critical care transport. Special operations and flight medic students are given introductory instruction on managing canine emergencies. Several studies are underway regarding combat injuries, morbidity, and mortality of dogs in combat theaters, and of medical evacuation and en route care of working dogs from theater.

Recommendations for continued advancement in this area include creation of doctrine that specifies human medical facilities can be used in treatment of canine casualties, continued recording of canine morbidity and mortality statistics, and integration of brief standardized blocks of instruction for canine casualties in combat medic, flight medic, and other medical provider courses. In addition, prior to deployment, veterinary officers and animal care specialists should be required to gain hands-on training and experience in civilian veterinary emergency and critical care facilities through formal arrangements with veterinary teaching hospitals and veterinary specialty centers.

The area of canine combat trauma management lags behind its human counterpart in resources, standardization, and training, but certainly not in motivation or resourcefulness. Deployed veterinarians have done a fantastic job in adapting to their situation and providing excellent care to injured canine service members.

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Military Working Animal Chemical, Biological, Radiological, and Nuclear Protection and Medical Countermeasures

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INTRODUCTION

Protection for animals used by the military is part of history. A prime example is the development and use of armor for horses in the 15th century. But it was not until World War I when chemical protection for service members was developed that chemical protection for military working animals (MWAs) was also addressed. For the US military, that consisted of bags or containers for pigeons and masks for horses and dogs. The idea then, and now, is to provide MWAs with the same level of chemical, biological, radiological, and nuclear (CBRN) protection as is provided for US service members. For pigeons and dogs the basic concept was the same; protection of the animal during the CBRN attack or incident so that it could go back to work after the “all clear” was sounded, or moved out of the threat or contaminated area. Horses could continue to work through a CBRN attack or incident if necessary. Masks only provided respiratory protection for dogs and horses, leggings provided lower leg protection for horses, eye and ear protection was included for dogs, and no protection was provided for skin. For medical countermeasures, the same drugs available for service members have been used. Unfortunately, little research has been done to prove what dose is effective. Other countries such as the United Kingdom, Germany, Czech Republic, and Israel had CBRN protection and medical countermeasures for their MWAs, and there is limited work continuing in some countries.

PIGEONS

Since Roman times, pigeons have been used to deliver messages over long distances. In 1917, the US Army Signal Corps established a pigeon service. As the needs of the Signal Corps changed for the number of pigeons and employment, so did the designs for chemical protection. The Army Signal Corps worked with the Army Chemical Corps on the design and testing of various boxes and bags that would protect 2

to 4 pigeons and 12 to 20 pigeons. A small hand bellows (operated by the pigeoneers) and canister were part of the design to help force filtered air at specified time intervals into the bag or box (Figure 1). As communication technology advanced, the need for pigeons declined. The pigeon service was disbanded in 1957.¹

HORSES AND MULES

In almost any conceivable theater of operations, situations arise where the presence of horse cavalry, in a ratio of a division to an army, will be of vital moment.

General George Patton²

In contemplated operations in mountainous terrain, plans should include facilities for supply by pack train.

General Omar Bradley²

Horses and mules have, of course, been used throughout history as work animals, both in agriculture and normal transport, and on the battlefield. The earliest recorded use of horses in warfare occurred in Eurasia (modern day Ukraine, Hungary, and Romania) in the era 4000-3000 BC. The versatility and adaptability of horses and mules for transportation of



Figure 1. Pigeon Bag, M4 (E7R2), with PG 103 carrier, 1949. Note the hand-operated bellows with filters.

people, equipment, and supplies over various terrains is well known. Because of these qualities, US forces have used horses and mules in the Afghanistan theater of the war on terror. Horses are still routinely used by city and state police forces for crowd control and daily law enforcement activities.

The first horse gas mask was developed during World War I. The technology of the day used several layers of cheesecloth following the same line of thinking as that which had Soldiers cover their nose with a handkerchief. However, covering only the nose left the horse's eyes, legs, and skin vulnerable to chemical agents. It was believed at the time that eye protection was not needed for chemical agents (lachrymal gases). The design and material of the US M1–M3 series horse gas mask closely resembled the feed bags used for grain for horses and mules (Figure 2), thus many horses chewed holes in their gas masks. By World War II, the design had been changed and 2 different types of horse mask were manufactured, one for cavalry and one for the pack and artillery horses and mules. The difference between the designs was that the cavalry horse had 2 canisters on the right side of the neck (to balance the weight of the rifle on the left shoulder), and the pack and artillery version had one canister on each shoulder



Figure 2. Horse Gas Mask, Flannelette Type, M1, 1919.



Figure 3. Horse Gas Mask, Pack/Artillery, M4, with eye protection, 1940.

(Figure 3). Eye protection and lower leg protection were also added during this time. Motorized, mechanized, and aviation advances began replacing horse cavalry, pack, and artillery units. The horse gas mask program was almost canceled in 1943. However, as the war continued and horses and mules were transported by air into the China-Burma-India theater, the requirement to provide oxygen to animals in unpressurized airplanes became a major concern. In 1950, the Army determined that there was indeed a requirement for animal oxygen masks. As a result, in 1951, the Army modified the horse gas mask to function as an interim solution for an oxygen mask for flights in unpressurized airplanes.³ In the same year as the pigeon service was disbanded (1957), all horse units were deactivated, and the horse gas mask program cancelled.

DOGS

Dogs are man's best friend at home, and in battle. Unlike pigeons, horses, and other land animals used by the US military in the past, the military working dog (MWD) remains a vital part of the US armed forces. The first record of a dog in battle is from the Stone Age, a type of mastiff used in Tibet.⁴ Since then, various breeds and sizes have served a variety of functions from detection (explosives, narcotics, mines), patrol, sentries, messengers, casualty finders (search and rescue), and trackers to suicide bombers and even cigarette delivery dogs in World War I. As with the other 4-legged military working animals (ie, horses), CBRN protection for dogs was first developed during World War I. Lessons learned during development of the horse gas mask helped pave the way for the first dog gas mask with a few differences in design, in particular provisions for eye and ear protection (Figure 4). As with the horse gas mask program, not much work was done between World Wars I and II. After 2 years of development, the M6 (Figure 5) was ordered in 1944 for all dogs going into theater. After World War II, the M6 was not produced. In the mid 1960s, the Army Provost Marshall General validated the requirement for MWD chemical protection and requested the restart of M6 manufacturing or development of a suitable replacement item. This request included the investigation of collective (whole body) protection rather than only a mask (individual

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protection). However, in 1969 the dog mask program was declared obsolete, despite the nonconcurrence of the Army Provost Marshall General.

PRESENT DAY

Over the past 90 years, MWA CBRN protection development has only occurred when the threat dictated changes for service member CBRN protection. Presently, no CBRN protection for MWDs is available in the DoD system. The late 1960s concept that collective (whole body) protection is the best way to provide MWD CBRN protection is the main focus of today's protection development programs.

Great Britain has developed a 2-dog overpressurized protective shelter called FIDOS (Field Inflatable Dog-Kennel Operational Shelter), the specifications of which are proprietary to the British Secretary of Defence. The FIDOS was deployed to Iraq at the beginning of Operation Iraqi Freedom.

The Defense Threat Reduction Agency funded 2 small business innovative research projects in 2008 specifically for developing MWD CBRN collective protection. This is the first time in recent years that a US agency has specifically funded research and development for MWD CBRN protection. In a separate effort, the US Army Natick Soldier Center is working with a fabric for passive CBRN filtration. The advantage of passive CBRN filtration is the requirement for little or no power for CBRN protection, unlike the current US systems that require overpressure, special filters, and increased power. The collaboration of Natick, the industry partners, Army and civilian veterinarians, and US MWD handlers developed 2 prototypes using this technology. One prototype fits over an extra large vari-kennel, and the other is fold-out/popup prototype designed to be used during patrol or when away from other immediate protection. These prototypes are still in early development and require physiological parameter simulation and testing before the next stage of development. A CBRN collectively protected tent

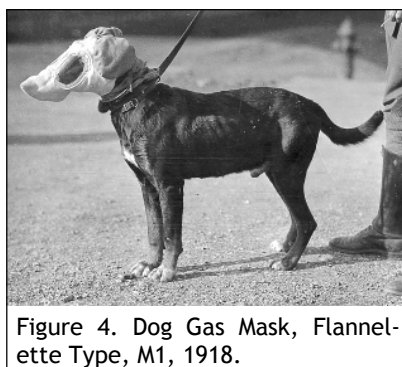


Figure 4. Dog Gas Mask, Flannel-ette Type, M1, 1918.

or shelter is required for the provision of veterinary medical care to MWDs in a CBRN environment. The Joint Expeditionary Collective Protection (JECPC) capabilities development document was approved in July 2008. It has specific language regarding the requirement to treat MWD casualties in a CBRN protected environment. The JECPC program is in the test and evaluation stage of development.

Although torso/body protection from projectiles/explosives has long been standard for Soldiers, neither the DoD MWD Program Manager nor the DoD MWD Veterinary Service approves the use of ballistic vests or any type of body armor for MWDs in today's operating environment. This is because of the resulting increased heat stress and decreased mobility.

MEDICAL COUNTERMEASURES

The provision of MWA medical treatment in a CBRN incident has been focused on the questions of what was humane for the animal, and would the animal be

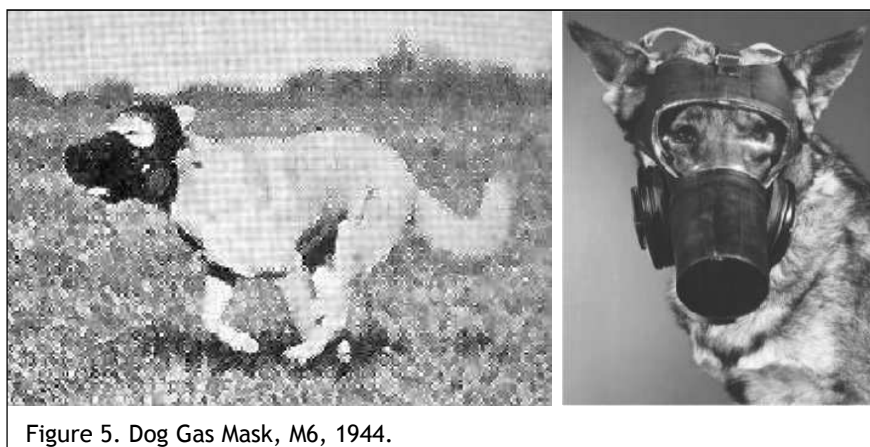


Figure 5. Dog Gas Mask, M6, 1944.

able to work after decontamination and treatment. As with CBRN protection, new CBRN drugs were developed when the threat to service members changed. Dr Jonathan Fradkin, a retired US Army Veterinary Corps officer, headed a group of veterinary toxicologists and internal medicine, critical, and emergency care specialists to determine the dosage of drugs available for US service members to use for MWD nerve agent treatment:

- Antidote Treatment, Nerve Agent Autoinjector (ATNAA)—atropine and 2 pralidoxime chloride

in one autoinjector (replaces the MARK I Antidote Treatment Kit, Nerve Agent)

- Atropine (atropine)
- Convulsant Antidote for Nerve Agent (CANA)—diazepam

The group's recommendations, incorporated into Army *Field Manual 4-02.18*,⁵ are based on extrapolations from human data rather than animal data. No research has been funded to prove or disprove the recommendations or evaluate a MWD's ability and effectiveness to work after CBRN treatment. In 2007, Army *Supply Bulletin SB 8-75-S7*⁶ included MWD initial issue requirements for ATNAA, Atropine, CANA, Skin Exposure Reduction Paste Against Chemical Warfare Agents, Reactive Skin Decontamination Lotion, doxycycline, and ciprofloxacin. In conjunction with the inclusion of the MWD issue list in *SB 8-75-S7*, a MWD handler's guide for using medical chemical defense material should be available in March 2009 (National Stock Number: 7610-01-564-2341).

CONCLUSION

Approximately 30 years passed between the development of the M1 horse and dog gas masks and the M4 horse and M6 dog gas masks. Over 40 years ago, both programs were declared obsolete. Although CBRN protection has come a long way from the days of handkerchiefs and layered cheese cloth for both service members and MWAs, much remains to be done to protect, decontaminate, and treat if necessary, and address other MWA unique issues. New threats such as toxic industrial materials make CBRN protection, decontamination, and treatment items even more essential to have in the field, but also more challenging to develop. Part of the challenge is to ensure that DoD senior leadership recognizes the importance and continued relevance of MWAs in today's noncontiguous battlefield* environment as vital force multipliers and force protection assets. The requirement for CBRN protection, decontamination, and treatment has been documented in several CBRN defense functional analyses at the DoD level. However, specific funding to address these gaps is not a priority, nor is evaluation of which current treatment and decontamination recommendations; or use of

equipment, drugs, or protocols developed for service members could be used for MWAs, with or without modifications. Discussions of this topic among academia, federal and state veterinarians, and other MWA stakeholders have produced agreement that the start of development of working dog CBRN equipment, drugs, and protocols will pave the way for the development of similar CBRN materiel and protocols for other animal species.

ACKNOWLEDGEMENTS

I thank Dr Jonathan Fradkin, DVM (MAJ (Ret), VC, USA) for his expertise and vision.

World War I and World War II photos are courtesy of the US Army Chemical Corps and the US Army Medical Research Institute of Chemical Defense historians.

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*Noncontiguous areas of combat operations do not share a common boundary.⁷

Validation and Operational Application of a Rapid Method for Rabies Antigen Detection

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Leslie Fuhrmann, MS

ABSTRACT

The Veterinary Laboratory Europe (VLE) deployed a direct, rapid immunohistochemical test (DRIT), developed by the Centers for Disease Control and Prevention (CDC), to the US military veterinary units in Iraq and Afghanistan. The test detects rabies virus antigen in fresh and frozen brainstem samples from various animal species. The goal was to conduct surveillance in 2 countries without current rabies diagnostic capabilities and little historical data on rabies prevalence. During the deployment the DRIT was evaluated, and Veterinary Corps officers and technicians were trained to operate the test. Civilian veterinarians from both Iraq and Afghanistan were organized for a lecture forum on rabies, a sample collection lab, and familiarization with the DRIT. Samples collected in Iraq and Afghanistan were tested in the field with the DRIT, and compared to the traditional laboratory standard utilizing direct fluorescent antibody testing at VLE and the CDC with 100% agreement.

INTRODUCTION

Reports of “vicious” or “mad” dogs first appeared in legal documents in Mesopotamia (modern day Iraq) about 2,300 BC.¹ Over 4,000 years later, this preventable disease is still killing people at an alarming rate. According to the World Health Organization (WHO), rabies is present on every continent except Australia and Antarctica as shown in Figure 1. Human deaths worldwide from rabies are estimated by WHO to number over 55,000 per year, predominately in Africa and Asia.² Rabies is transmitted by the bite of an infected animal, the majority of which are dog bites. Rabies is a zoonotic viral infection that results in encephalomyelitis, severe destruction of the central nervous system, and death. Once clinical symptoms are noticed, the disease is essentially 100% fatal.

Current worldwide deployment of US forces into the endemic rabies regions of Iraq, Afghanistan, and Africa pose an additional risk from this deadly, bullet-shaped *Rhabdovirus*. The Veterinary Laboratory Europe (VLE) in Landstuhl, Germany, is currently the only laboratory that provides diagnostic capabilities of potential rabies

exposure to US service members and civilians within the US Central Command, the European Command, and the African Command areas of operation. Veterinary Corps officers and technicians on the ground are the front line of defense for exposed individuals. Once a bite is reported, veterinary units are contacted, the animal is located, brain tissue is collected, and samples are submitted to VLE. Prior to shipment of suspect samples, immediate wound care of the exposed individual is performed by medical personnel, rabies immune globulin is infiltrated at the site of the bite, and a series of parenteral cell culture vaccines are begun. Once the sample arrives at VLE,

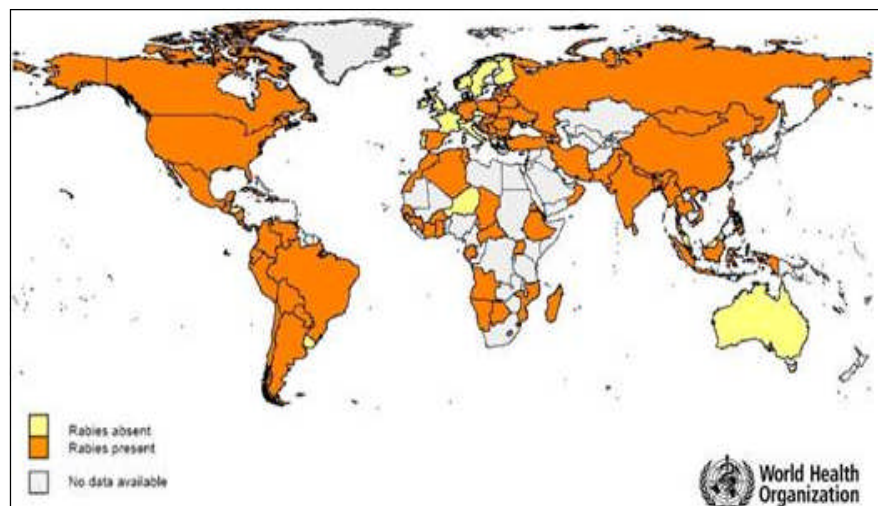


Figure 1. The presence of rabies worldwide. Source: World Health Organization. Available at: http://www.who.int/rabies/rabies_maps/en/index.html

the gold standard diagnostic test of direct fluorescent antibody assay (DFA) is performed. Within 4 hours, a result is generated to guide further treatment decisions. An additional confirmation test by cell culture is run via murine neuroblastoma (MNA) cell line with a final report in 4 to 5 days. With expedited shipping and timely results from VLE, the amount of unnecessarily administered post exposure vaccine and potential side effects, as well as the cost of this valuable and limited vaccine, are decreased substantially.

RABIES DIAGNOSTICS AT THE VETERINARY LABORATORY EUROPE

Since the initiation of military operations in Afghanistan and Iraq, submission of samples to VLE for evaluation of rabies has resulted in 16 positive samples from a total of 285 submissions to date, each case often affecting more than one person. These results, however, are likely to be only the tip of the iceberg for rabies prevalence in these countries, as these are only cases where an animal has bitten a US service member. The incidences of rabies in Iraq and Afghanistan are truly unknown, as the infrastructure and ability to test and report rabies by other than clinical symptoms are severely limited. Table 1 presents the total number of positive samples identified at VLE from Iraq and Afghanistan with the use of fluorescent antibody identification.

EVOLUTION OF THE DIRECT, RAPID IMMUNOHISTOCHEMICAL TEST

In February 2006, Lembo et al³ outlined and reported a preliminary study to compare the results of the direct rapid immunohistochemical test (DRIT) performed in the field in Tanzania, and the gold standard DFA performed at the CDC. The DRIT showed a sensitivity and specificity equivalent to those of the DFA, which approaches 100%.

The standard operating procedure for the DRIT outlines the steps used during the procedure.⁴ The test begins by making a touch impression of the brainstem on a glass slide. The slide is then processed through 10 dipping wells, as shown in Figure 2, containing various chemicals and incubation times. The test's core component is a cocktail of highly concentrated and biotinylated antinucleocapsid monoclonal antibodies that recognizes all genotype 1 variants of rabies virus (RABV) antigen.³ After one hour of processing through the wells, positive rabies antigen is

Table 1. Total number of samples from Iraq and Afghanistan testing positive for rabies which were identified at the Veterinary Laboratory Europe using fluorescent antibody identification, from 2004 through October 2008.

IRAQ			AFGHANISTAN		
Year	Species	Positive Test	Year	Species	Positive Test
2005	Canine	1	2004	Canine	1
2007	Canine	3	2005	Canine	5
2007	Mongoose	1	2005	Pig	1
			2006	Canine	3
			2008	Canine	1
Total		5	Total		11

identified as magenta inclusions within the impression smear using a standard light microscope. An example is shown in Figure 3.

Given the results cited by Lembo et al³ and the fact that this is a relatively simple and fast test requiring little infrastructure, VLE decided to deploy and utilize the DRIT to capture rabies data on animals not involved in human exposure cases. This test will enable the US military veterinary units as well as civilian veterinarians in Iraq and Afghanistan to conduct surveillance and support the "One Health"* initiative. As stated by Lembo et al:

First, this technique could greatly enhance epidemicologic surveillance in remote areas where rabies incidence data are difficult to obtain. Second, the test could improve the ability to respond to outbreaks with effective management decisions. Third, it could be extremely valuable in guiding decisions regarding rational use of rabies PEP [post exposure prophylaxis].^{3(p312)}

In February 2007, VLE invited experts from the CDC to train the diagnostic division and staff on this new test, as well as to test known positive cases banked at VLE. Preparations were made to deploy the DRIT to selected US Army Veterinary Units in Iraq and Afghanistan. During the subsequent year, all samples submitted to VLE for rabies diagnostics were tested with the DRIT along with the standard DFA and MNA testing with 100% agreement. Development of positive and negative controls from known DFA tested samples

*The One Health Concept, first articulated by early scientists such as Rudolph Virchow, recognizes the intimate relationship between human health, animal health, and the environment, and calls for an integrative, collaborative approach to health by encouraging the collaboration between experts of diverse fields of study.⁵

Validation and Operational Application of a Rapid Method for Rabies Antigen Detection

were added that were fixed in 10% buffered formalin, and stored in phosphate buffered saline.

PREDEPLOYMENT

Prior to deployment, PowerPoint instructional aids and collection material were forwarded to designated Veterinary Corps officers in Iraq and Afghanistan to instruct personnel on how to properly obtain the section of brainstem needed for testing, as well as detailing the storage of all samples to be tested. Predeployment collection of samples allowed for numerous samples to be stockpiled and available for testing during the training timeframe. All supplies and testing equipment were then packaged in a deployable ruggedized forward test kit that provided enough testing for 500 samples, with ongoing resupply provided by VLE.

DEPLOYMENT

In March and June of 2008, VLE deployed a veterinary pathologist to Iraq and Afghanistan respectively to field the DRIT, conduct rabies surveillance, and provide training to selected individuals. The goals of each deployment were:

- Evaluate the DRIT in the field.
- Train selected US Army veterinary units on the testing procedures
- Familiarize key civilian veterinarians to this new potential asset.
- Provide a link to the CDC through key governmental organizations for potential ongoing civilian veterinary surveillance.

After initial training of military personnel was completed and stockpiled samples were tested, respective military units organized a rabies forum with local key civilian veterinarians. During the forum, a rabies lecture was provided, and a hands-on collection and testing laboratory was conducted utilizing the DRIT, as well as microscopic evaluation.



Figure 2. A representation of the direct rapid immunohistochemical test with 10 unknown samples and a positive and a negative control slide.

Furthermore, an exchange of ideas and information between US military and their civilian counterparts was made, linking their common interest and future coordination regarding rabies surveillance in Iraq and Afghanistan.

RESULTS

Table 2 presents the breakdown of animals collected and tested in Iraq and Afghanistan during the period February through June 2008. The chart simply represents a snapshot of the rabies prevalence during that period in selective locations within Iraq and Afghanistan. Data continues to be collected from both

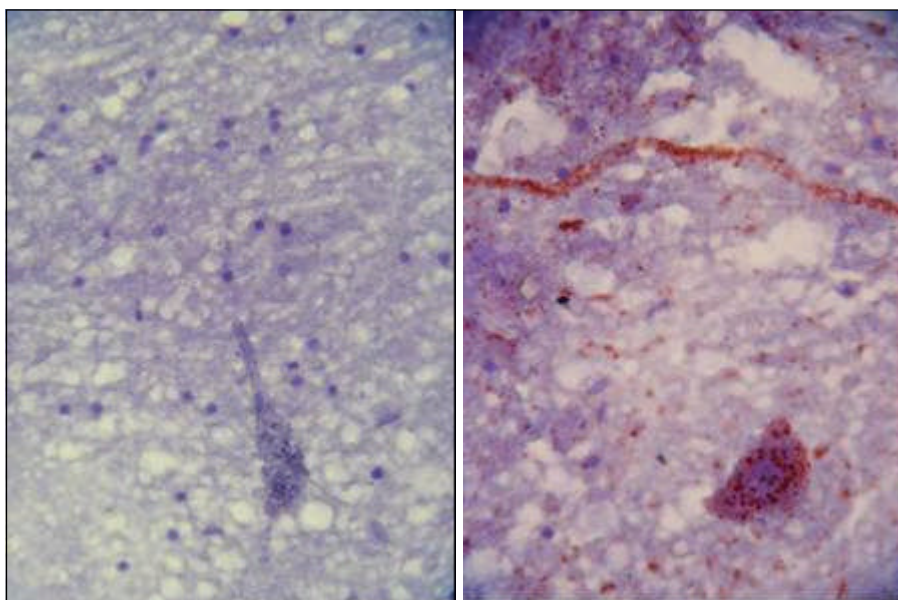


Figure 3. Results of a direct rapid immunohistochemical test. Left: Negative brain touch impression. Right: Positive reaction. Rabies virus antigen appears as magenta inclusions against a neuronal hematoxylin counterstain

Table 2. Animals tested for rabies in Afghanistan and Iraq using the direct rapid immunohistochemical test, February through June 2008.

IRAQ			AFGHANISTAN		
Specimen	Total Tests	Positive	Specimen	Total Tests	Positive
Cat	147	0	Cat	49	0
Dog	62	1	Dog	52	1
Fox	17	0	Jackal	8	0
Jackal	36	1	Monkey	3	0
Rabbit	2	0	Total	112	1
Cow	4	4			
Total	268	6			

of these countries by US veterinary units, along with ongoing analysis by VLE and the CDC.

CONCLUSION

Veterinarians are the first line of defense in the education, prevention, and diagnosis of this fatal zoonotic disease, and a critical link to the appropriate treatment of exposed individuals. Surveillance is only the first piece to a much broader approach toward control of rabies that will likely involve education, animal control, and mass parenteral and oral vaccination. Much of the developed world has held rabies at bay through this type of multifactorial approach toward elimination of this deadly disease. Infrastructure, stability, and funding within Iraq and Afghanistan are significant obstacles to overcome before rabies can be managed appropriately. However, with the advent of this cost effective and relatively simple test, much needed surveillance information can be gathered and managed by the military and the

respective governments of Iraq and Afghanistan to help the global initiative to eradicate this preventable and costly disease.

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B Virus (Cercopithecine Herpesvirus 1)

Therapy and Prevention Recommendations

LTC Christopher E. Keller, VC, USA

INTRODUCTION

There are many herpesviruses of nonhuman primates and other animal species, but B virus stands alone as a documented zoonotic hazard. B virus, also known as Cercopithecine herpesvirus 1 (CHV-1), Herpesvirus simiae, Herpes simiae, or Simian B disease, is considered endemic among monkeys of the genus *Macaca*.^{1(p747)} B virus is a large, double-stranded DNA α -herpesvirus that has a predilection to invade the central nervous system causing fatal encephalomyelitis in humans.² The historical fatality rate of untreated human infections is 70% to 80% if not treated promptly.³ There are approximately 40 known deaths,⁴ most, if not all, occurring among biomedical research personnel working with captive monkeys or their tissues. Cercopithecine herpesvirus produces a mild clinical disease in monkeys similar to human herpes simplex viruses (HSV-1 and HSV-2). Animals can shed the virus through oral, ocular, and genital secretions with or without visible lesions or open skin lesions.³ Macaques are the most common monkey used in biomedical research and are found in more climates and habitats than any other primate except humans.⁵ This disease is important to physicians and veterinarians who provide medical care during deployments as well as those who provide occupational medical oversight in biomedical research facilities. Many of the recommendations that follow in this article are from the 2002 report of the B Virus Working Group: Recommendations for Prevention of and Therapy for Exposure to B Virus (Cercopithecine Herpesvirus 1).² Readers are highly encouraged to read the report as it is the definitive, most current source of information on this virus.

RESERVOIR AND INCIDENCE OF DISEASE IN MONKEYS

There are 16 to 19 species of *Macaca* monkeys^{5,6} which are part of a larger group of primates taxonomically classified as Catarrhini in reference to their elongate muzzle with a narrow, turned-down nose (similar to humans). They are indigenous to Africa,

Asia, and extreme southern Europe (introduced to Gibraltar) and some possess ischial callosities for sitting.^{1(p680)} Several of the more common species found in Asia are shown in Figures 1 through 5.

B virus is ubiquitous in macaques which experience an age-related increase during adolescence with the incidence of disease approaching 100% by the end of the first breeding season. Latency is established in the ganglia of the sensory nerves serving the region in which the virus was introduced.⁷ Once there, the virus remains in the sensory neurons for the life of the host and results in a persistent, subclinical infection. Periodically, the virus can reactivate due to stress from social challenges, transportation, immunosuppression, breeding, illness, or new housing; travel down the neuronal axon to the mucosal epithelium; replicate; and be shed.³ Infected monkeys often have no or very mild symptoms.⁸ The frequency of active viral shedding appears to be low at 2% to 3%.³ Virus infection in humans is rare.² Macaques with primary infection may develop lingual or labial vesicles or ulcers (Figure 6) which heal in 1 to 2 weeks.^{7,9} Keratoconjunctivitis or corneal ulcers might also be noted.^{7,9}

MODE OF TRANSMISSION

The transmission of B Virus to humans from monkeys primarily occurs by exposure to contaminated saliva through bites and scratches from animals.⁹ Exposures to B Virus can also occur from contaminated tissues or fluids, needles, scalpel blades, or scratches from contaminated cages or objects in a biomedical research environment. There is one documented case of human-to-human transmission from an infected animal handler and spouse who applied hydrocortisone cream to his skin lesions and subsequently applied the cream to an area of contact dermatitis under a ring on her finger.¹⁰ One fatal case of a female worker at a primate center occurred after an ocular exposure to biologic material (possibly fecal) from a rhesus macaque.¹¹

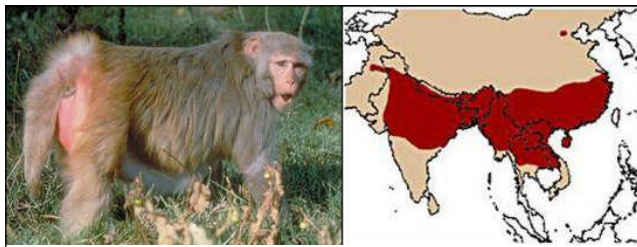


Figure 1. Rhesus macaque (*M. mulatta*)*

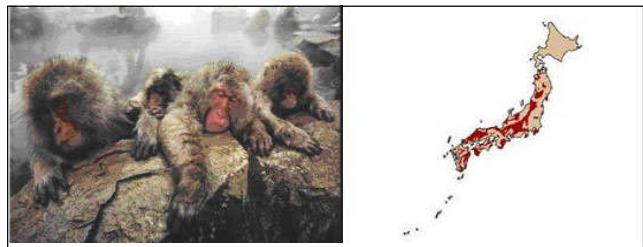


Figure 2. Japanese macaque (*M. fuscata*)*

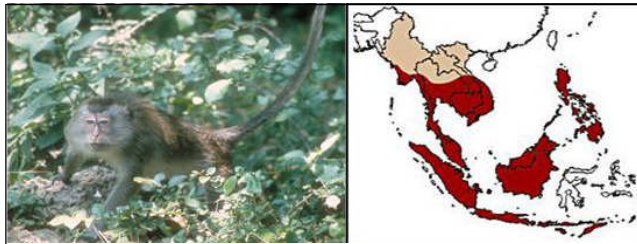


Figure 3. Cynomolgus macaque (*M. fascicularis*)*

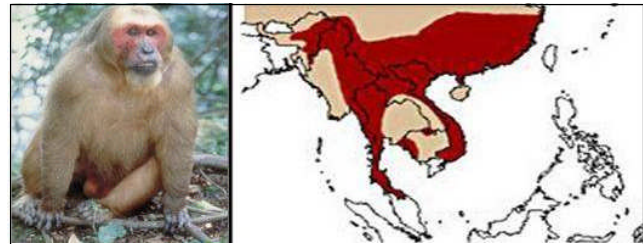


Figure 4. Stump-tailed macaque (*M. arctoides*)*



Figure 5. Pig-tailed macaque (*M. nemestrina*)*

CLINICAL SIGNS IN HUMANS

The incubation period for B virus is reported to be from 2 days to 5 weeks after exposure. Most well-documented cases present 5 to 21 days after exposure.² With its varied onset of incubation and clinical signs, the description in assorted references of clinical signs of B virus is varied as well, as shown in the following examples:

- After exposure to B virus, humans might develop a herpetiform lesion at the site of inoculation. Early clinical signs and symptoms include myalgia, fever, headache, and fatigue followed by progressive neurological disease with numbness, hyperesthesia, paresthesia, diplopia, ataxia, confusion, urinary retention, convulsions, dysphagia, and an ascending flaccid paralysis.⁷
- Some patients present with a progression of symptoms that first appear near the site of exposure (vesicular rash, tingling, itching, pain, or numbness at the site). Some patients may develop lymphadenopathy proximal to the site of inoculation. However, many patients have no symptoms at the site of infection. Others present with symptoms limited to the peripheral nervous system or central nervous system. Within the first 3 weeks after exposure, paresthesia may develop and proceed proximally along the affected extremity. Associated symptoms can include fever, myalgias, weakness of the affected extremity, abdominal pain, sinusitis, and conjunctivitis. Other organs, including lung and liver, may be involved. The virus spreads along the nerves of the peripheral nervous system to the spinal cord and the brain. Symptoms can include meningismus, nausea, vomiting, persistent headache, confusion, diplopia, dysphagia, dizziness, dysarthria, cranial nerve palsies, and ataxia. Seizures, hemiplegia, hemiparesis, ascending paralysis, respiratory failure, and coma occur later in the course of infection. The presentation of late stage disease is that of brain stem encephalomyelitis evolving into a diffuse encephalomyelitis during its terminal stages. A third presentation involves flu-like illness with fever, chills, myalgias, and other nonspecific symptoms, no focal findings, later followed by an abrupt onset of central nervous system signs.²
- Symptoms include “vesicular skin lesions at or near the exposure site; aching; chills and other flu-like symptoms; persistent fever; nausea; lethargy; chest pain and difficult breathing; and neurological

*Photos and geographic distribution maps courtesy of the National Primate Research Center's Primate Info Net. Available at: <http://pin.primate.wisc.edu/factsheets>

B Virus (Cercopithecine Herpesvirus 1) Therapy and Prevention Recommendations

symptoms such as itching or tingling at or near the exposure site, numbness, dizziness, double vision, difficult swallowing and confusion.” Other symptoms may occur as well. Treatment is critical, as coma, respiratory failure and death quickly result otherwise.¹²

The various possibilities for presentation could be problematic for medical practitioners if they are unfamiliar with recognition of the symptoms and disease in humans before the central nervous system is infected. Also, medical practitioners must recognize that deep puncture wounds which are difficult to clean; inadequately cleansed wounds; and wounds sustained on the face (especially the eye), neck, or thorax pose greater risks of infection. Inoculation of those sites with the virus allows little time for treatment before the virus ascends to the central nervous system by the infected axon.² Many persons surviving B virus infection have residual neurologic sequelae, and progressive neurologic deterioration can also occur.³

DIAGNOSTIC CHALLENGES

Research with B virus is limited, given the rarity of human infections, the lack of federal funding, and the biosafety levels 3 or 4 containment requirements¹³ to work with the virus. Currently only 2 human diagnostic laboratories exist, one in the state of Georgia and the other in England.² No true B virus specific serologic assays are available at this time as diagnosis of human infection is difficult for a number of reasons. First, while serologic tests are the mainstay, they are unable to detect antiviral antibodies until 7 to 10 days after infection. Also, in most adults infected with HSV-1/HSV-2, anti-HSV antibodies will react with B virus antigen due to an anamnestic response of their immune system.² Another problem is that if a suspected exposure occurs and is treated prophylactically, the treatment with antiviral drugs could impede B Virus replication or lessen the development of an immune response in the patient. PCR (polymerase chain reaction) tests are not useful at this time due to the infrequent and intermittent viral

shedding.² Furthermore, as there are different genotypes of B virus and the average amino acid sequence of homologous B virus and HSV proteins is 62.5% (range 26.5% to 87.5%),¹⁴ the exquisite sensitivity of PCR testing becomes its limitation in identifying B virus.

INITIAL TREATMENT

Both adequacy and timeliness of wound or mucosa cleansing are the most important factors for reducing the risk of B Virus infection after a known or suspect exposure. First aid consists of washing the bite, scratch, or exposure to any secretion for at least 15 minutes with povidone-iodine, chlorhexidine, or detergent soap within 5 minutes of exposure.² Potential eye or mucous membrane exposure should be irrigated immediately with sterile saline or water for 15 minutes immediately after exposure. After that, a qualified health care provider should carefully examine the exposed area to determine the likelihood that an exposure occurred and the exposed area should be cleansed again.² For

each primate exposure, the health care provider needs to assess 4 variables²:

- The source of the exposure should be determined. Macaques are the only primates known to transmit B virus.
- The timeliness and adequacy of first aid for the wound should be assessed. Was the wound cleansed within 5 minutes of exposure and was the duration of cleansing a full 15 minutes?
- The type of wound or exposure, the depth of the wound, and the location of the wound should be determined. Deep punctures are likely to result in inadequately cleansed wounds and pose a higher risk of infection; superficial wounds and scratches that are easily cleansed are therefore usually considered low risk.
- Was there an exposure to materials that have come in contact with macaques, such as needles, scalpels, or cages?



Figure 6. Macaque monkey with a lingual vesicle due to B virus.

(Photo courtesy of Dr J. K. Hilliard, Viral Immunology Center, Georgia State University, Atlanta, GA)

Incising or biopsy of the wound is not recommended as it could lead to further infection of the site. The wound or exposure site should be cultured for B virus after cleansing. While cultures of the wound or site of exposure are usually negative, a positive wound culture does indicate an exposure occurred and that antiviral treatment is indicated.² Some experts debate the value of serum blood testing. If performed, enough blood must be collected to ensure that there is enough serum for serial testing. Lastly, safely examine the monkey if possible. While this is not likely outside a research environment, within a research facility it is possible for the veterinarian and staff to perform a physical examination for active herpetic ulcers and to culture mucocutaneous membranes. Also, testing for B virus is usually performed on a scheduled basis within the facility and the B virus status of the macaque might be known. If the monkey is positive and is actively shedding as evidenced by lesions or culture, antiviral treatment should be initiated.

Antiviral therapy should be started within hours of the exposure if used for prophylactic treatment. While there are pros and cons of their use as described in the 2002 Clinical Infectious Diseases report,² the drug of choice would be valacyclovir (1 g orally 3 times a day for 14 days).² An alternative drug would be acyclovir (800 mg orally 5 times a day for 14 days).² The most frequently reported adverse effects of oral acyclovir use are nausea, headache, diarrhea, and rash. Neurologic complications of confusion and dizziness have occasionally been reported with acyclovir use.² Ganciclovir is poorly absorbed orally and should not be used for prophylactic treatment. A suggested schedule for follow up appointments is 1, 2, and 4 weeks after exposure, or anytime there is a change in clinical status.² Further, if serologic testing is considered or performed, it is recommended 3 to 6 weeks after initial exposure and at later points (eg, 3 months) to check for rising titers. Additionally, culture of materials obtained from the conjunctivae, oropharynx, and any unhealed skin lesions might be performed 1 to 2 weeks after discontinuation of antiviral medication to detect viral shedding.²

TREATMENT OF VIRAL DISEASE

Treatment with intravenous (IV) antiviral therapy for B virus should be initiated with the presence of any signs or symptoms of B virus, or a positive culture other than the initial postcleansing wound culture. If

central nervous system symptoms are absent, treatment with acyclovir (12.5 to 15 mg/kg IV every 8 hours) or alternatively with ganciclovir (5 mg/kg IV every 12 hours) should be used.² With peripheral nervous system or central nervous system involvement, ganciclovir is the recommended treatment (5 mg/kg IV every 12 hours). Proper hydration must be ensured and acyclovir must be administered slowly to avoid precipitation in renal tubules and renal insufficiency.² Serum levels of creatinine must also be monitored in patients receiving high doses of acyclovir and adjusted accordingly. The increased toxicity (myelosuppression) with ganciclovir must be balanced against the potential benefit of the drug. The dose of ganciclovir should be adjusted accordingly for renal insufficiency, and white blood cell and platelet counts should be monitored closely.² Intravenous therapy should be continued until symptoms resolve and 2 or more sets of cultures yield negative results after having been held for 10 to 14 days.² Some experts believe patients should then be switched to oral prophylactic treatment. Other experts believe that lifelong suppressive therapy is needed, while others recommend treatment be discontinued at some point.² In reality, no good data exist to aid in the determination of when or whether treatment should be discontinued, and antiviral therapy generally has not been effective in patients with advanced encephalomyelitis. Standard blood and body fluid precautions should be used in the care of patients undergoing treatment for B virus or those otherwise known or suspected to be shedding virus.²

CONCLUSION

B virus stands alone as a documented zoonotic hazard and all macaques should be considered positive for B virus until proven otherwise. B virus produces a mild clinical disease similar to human herpes simplex in monkeys but produces a life threatening disease in humans that has resulted in several deaths. The transmission of B virus to humans from monkeys primarily occurs by exposure to contaminated saliva through bites and scratches. Following exposure, humans may develop a herpetiform vesicle at the site of inoculation followed by a disseminated viral infection leading to ascending paralysis, encephalitis, and death in about 70% to 80% of cases. Given the prevalence of disease within the natural reservoir and the public health aspects of this disease, physicians and veterinarians should be well versed to recognize and provide initial treatment. The wound, if any,

B Virus (Cercopithecine Herpesvirus 1) Therapy and Prevention Recommendations

should be thoroughly cleansed as first aid is most critical for the prevention of B virus. Serum samples and cultures should be considered for serology and viral isolation. Initiation of antiviral therapy with valacyclovir, acyclovir, or ganciclovir may be warranted if the history and/or symptoms are compatible with B virus infection.

Of the 16 to 19 species of *Macaca* monkeys, the vast majority are found in the Asia Pacific region. This presents unique public health aspects for medical planners with the increasing deployment of military personnel into the Asia Pacific region. To protect deploying personnel, medical planners should be aware of this zoonotic disease and consider it in their force protection planning or survey estimate. Planners must understand that macaques are to be avoided as B virus is an ubiquitous disease, often with no overt clinical signs, and macaques have a wide geographical distribution. Education of deploying personnel and medical staff of signs, symptoms, and treatment of this disease should be planned and presented prior to deployment and appropriate antiviral prophylactic medications should be stocked in medical kits. The best preventive measure would be to educate all deploying members on the virus, and to leave all animals alone while deployed. Lastly, it is recommended that medical providers and veterinarians read the 2002 Clinical Infectious Diseases report,² and check the Centers for Disease Control and Prevention and B virus laboratory web sites for the most current information.

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Directed Energy (Laser) Induced Retinal Injury: Current Status of Safety, Triage, and Treatment Research

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INTRODUCTION

Directed Energy (DE) in the form of electromagnetic radiation refers to the application of electromagnetic energy at a single or a band of wavelengths (or frequencies) on a target. Sources of DE such as a common flashlight, a laser, or a high powered microwave transmitter can emit electromagnetic radiation at single wavelength (or frequency) or at multiple wavelengths with emission powers from nanowatt to megawatts, and emission durations from femtoseconds to continuous wave. Military uses of DE sources include lasers and high powered microwave or radio frequency radiation. The word laser is actually an acronym for light amplification by stimulated emission of radiation, a process that facilitates the production of a collimated beam of radiation that is easily directed toward a target. Military applications of DE include range finders, target designators, live-fire training devices, illuminators, and battlefield contaminate detection systems. Nonlethal weapons/deterrent applications of directed energy include the millimeter wave active denial systems or visible laser dazzlers. For some time now, medical specialties have used lasers or “directed energy devices” to cut, heat, ablate, or produce photochemical/phototoxic reactions to produce a desired effect on biological tissues. Medical applications also include numerous diagnostic applications such as pulsed oximeters, otic thermometers, and advanced retinal imaging technologies including scanning laser ophthalmoscopes and optical coherence tomography imaging. The use of lasers on the modern battlefield has become common in recent years, particularly to assist in the accuracy of target identification and fire control systems. With the maturation of DE technology, additional military applications will emerge (eg, the use of high energy lasers to produce adverse

target effects) and DE systems will continue to be an integral part of US military technology.

The most important biological sensor on the modern battlefield, the human eye, is extremely vulnerable to injury from military lasers.¹ In an instant, and without any sound or warning, temporary or permanent visual impairment can be produced at tactical ranges and beyond. Specifically, the retina is extremely susceptible to injury from common military lasers that operate in the retinal hazard wavelength region (400 nm – 1400 nm) where direct exposures can produce temporary or permanent visual impairment including blindness. Common military laser rangefinders and designators operating near 1064 nm can produce a vitreous hemorrhage in the unaided eye at a range of several hundred meters and minimal retinal lesions out to nearly 2 km (Figure 1). Optical aids (ie, binoculars, targeting scopes with magnification) in use at the time of the exposure increase the range at which the eye is susceptible to injury. Visible and near infrared laser illuminators are used in Iraq and Afghanistan to

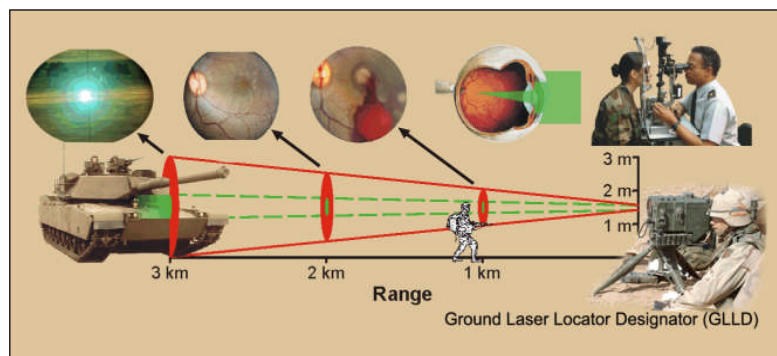


Figure 1. Ocular hazard distances for common military lasers extend to tactically significant distances. The top row images (left to right) show the approximate effect (visual or resulting retinal injury) to distance relationship for the GLLD. The fourth image indicates that the collimated laser energy is focused to a small spot on the sensory retina due to imaging properties of the eye. Ocular exams by an ophthalmologist are indicated in symptomatic exposure patients even though the patient may not have any concurrent overt physical trauma.

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illuminate or “point out” specific targets in much the same way a laser pointer is used in a lecture hall. Visible laser illuminators are also used to warn noncombatants and deter suspected combatants from approaching fixed positions such as a checkpoint or the end of a **convoy** (Figure 2). Persistence in approach might then imply malicious intent and warrant the use of more lethal force. Most laser illuminator ocular hazard distances are between 50 m and 100 m, however, intrabeam exposure beyond those distances appears extremely bright and may result in a flash effect or after-image that persists for a few minutes, but will not result in an injury. The “bright light exposure” causes the exposed to wonder if he/she were injured and triggers self vision checks or a request to see an eye care specialist. On the other hand, intrabeam exposure to these illuminators within a few feet can result in significant retinal pathology and visual dysfunction.

The general lack of familiarity with the actual ocular hazards of lasers leads to patient apprehension of actual or potential visual impairment which can seriously degrade force effectiveness. Most laser exposures are accidental and caused by misuse of the system or neglect of safety guidance. Predictably, the large number of devices currently deployed has

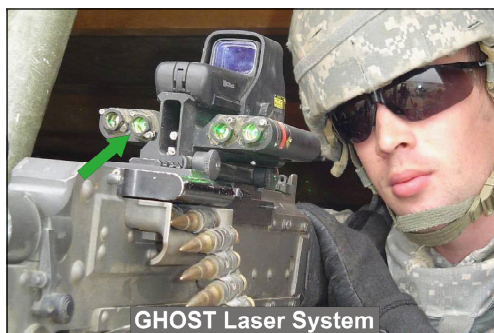


Figure 2. A GHOST green handheld optical surveillance and targeting device is shown mounted on a machine gun. Laser illuminators are deployed to Afghanistan and Iraq for both target designation and nonlethal deterrent applications.

resulted in a number of inadvertent and even intentional exposures. Therefore a rapid, accurate assessment is important to minimize false positive claims while assuring the ocular health of the unit.

Diagnosis of potential laser incidents in a deployed setting is challenging since some laser injuries cause minimally visible (via ophthalmoscope) retinal lesions and require tertiary level diagnostic capabilities such as fluorescein angiography and optical coherent tomography. Location of a very small retinal lesion within the fovea can cause noticeable dysfunction, whereas a lesion outside the macula may go unnoticed. More severe laser-induced retinal injury (eg, retinal or vitreous hemorrhage) can result in a dramatic psychological effect with the immediate onset of visual dysfunction. Secondary effects (with later onset) to laser-induced retinal injury such as retinal hole formation, retinal traction and scar formation, nerve fiber layer loss remote from the lesion site, intraretinal scar concomitant with multiple lesions in proximity, and choroidal neovascularization have been observed in human laser accident cases¹ (Figure 3). Presently there is no consensus on treatment of laser-induced retinal injuries. However the mission of the US Army Medical Research Detachment of the Walter Reed Army Institute of

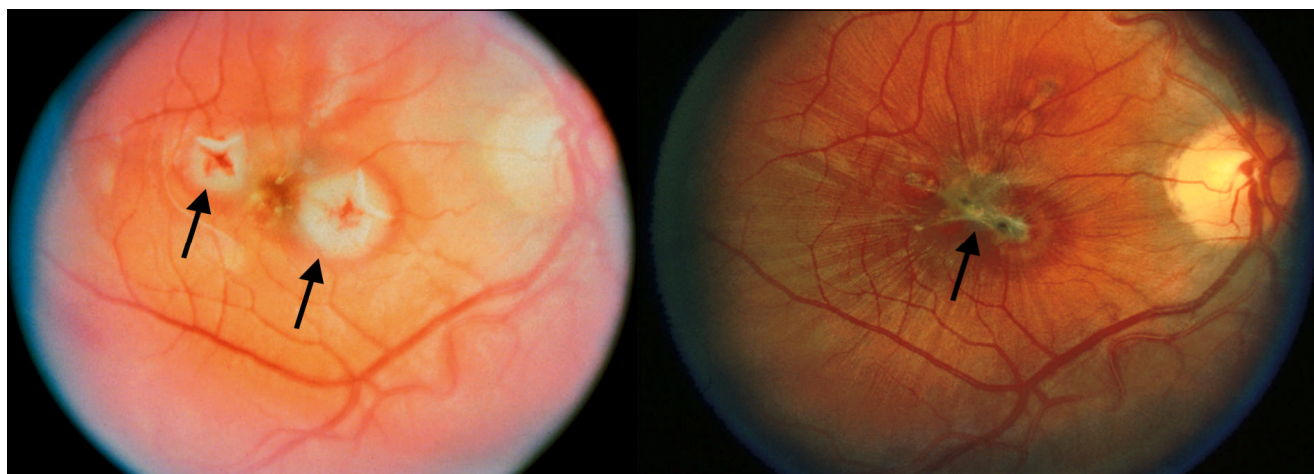


Figure 3. Accidental ocular laser exposure case. Left image: Four days post injury in the right eye of a patient self exposed to a military pulsed laser. The two black arrows indicate two large areas of lesions. Right image: Two months post injury of the same patient. The black arrow indicates bridging of scar formation between discrete lesions within the fovea.

Research is to conduct research that establishes safety threshold guidelines for Department of Defense (DoD) lasers and optical systems; as well as pursuit of effective triage capabilities and treatment countermeasures for laser induced retinal injuries.

LASER INJURY MECHANISMS

The biological effect produced by exposure to laser radiation is basically determined by the amount of energy per unit area delivered to and absorbed by the target tissue for a given exposure duration. Hence, a beam's power (watts), exposure duration (seconds), and irradiance diameter or spot size (in cm^2) must be known to determine the exposure dose or radiant exposure ($\text{Joules}/\text{cm}^2$). The irradiance or the rate of energy delivery to the tissue per unit area is given in watts/cm^2 . The radiant exposure is simply the irradiance times the exposure duration. This exposure dose or radiant exposure coupled with the relative absorption of the target tissue determines the magnitude and lateral extent of tissue temperature rise of an applied laser beam.^{1,2} The eye is more susceptible to injury from the energy in the laser beam than to direct exposure of the dermis or skin primarily because of the focusing of energy onto the retina and to some extent the relative absorption and transmission

of specific laser wavelength by the outer ocular media.³⁻⁶ For visible wavelengths or wavelengths in the retinal hazard region (400 nm to 1400 nm), the cornea and lens focus light to a fine spot on the retina. For short pulse lasers, typical in lasers used in fire-control devices (laser rangefinders and designators), the beam is transmitted through the outer ocular media (cornea, aqueous humor, lens, vitreous humor) to a small spot on the retina, resulting in a localized, intense temperature elevation or even a plasma formation that can disrupt membranes and produce a small hemorrhage.² If one is looking directly into and toward the laser, the fovea, (the center of the visual field where one has high acuity and color vision) can be injured. Cornea and lens refraction of laser beams produce retinal irradiances that are up to 10^5 times greater than the corneal irradiances.⁶ This results in the retina being highly susceptible to injury.

Laser radiation can damage the eye by photodisruptive, photothermal, or photochemical mechanisms.⁶⁻⁸ Photochemical injury results usually from ultraviolet or visible light and results from chemical bonds being broken by the laser energy. This usually results in opacities of the cornea or lens. Photothermal injury on the retina is due to the small, spot-sized focusing effect which results in a rapid 10°C to 20°C rise in tissue temperature, which denatures the tissue protein. Photodisruption results from formation of a plasma and shock wave that disrupts the site and surrounding tissue. Tissue is fragmented, perforated, or distorted immediately by a photodisruptive injury.^{1,9} It is useful to differentiate between these mechanisms, but more than one effect may be involved in any particular injury. Secondary to the actual injury, inflammatory and ischemic pathways are activated that lead to further tissue injury and death.

CURRENT ARMY RESEARCH ON SAFETY, TRIAGE, AND TREATMENTS

Research at the Army Medical Research Detachment (USAMRD) is directed towards both defining and understanding thoroughly the mechanisms of laser-induced retinal injury, retinal injury thresholds, and the implication of laser exposure on the visual system, as well as exploring effective triage and treatment options. The establishment of the science base to develop exposure limits or guidelines for a next generation of laser exposure conditions inherent to military use and operations is necessary for the safe



Figure 4. Fundus photo of multiple experimentally induced laser retinal lesions demonstrating variable visible injury. Left to right: Significant foveal lesion with overt hemorrhage into the vitreous; middle lesion with red rim and white center is indicative of retinal hemorrhage; upper right circular white lesion indicative of a minimal visible lesion. Injury variability is a function of the exposure dose and its location on retina, as well as the variables of the laser, including wavelength, pulse duration, retinal irradiance diameter and pulse repetition frequency.

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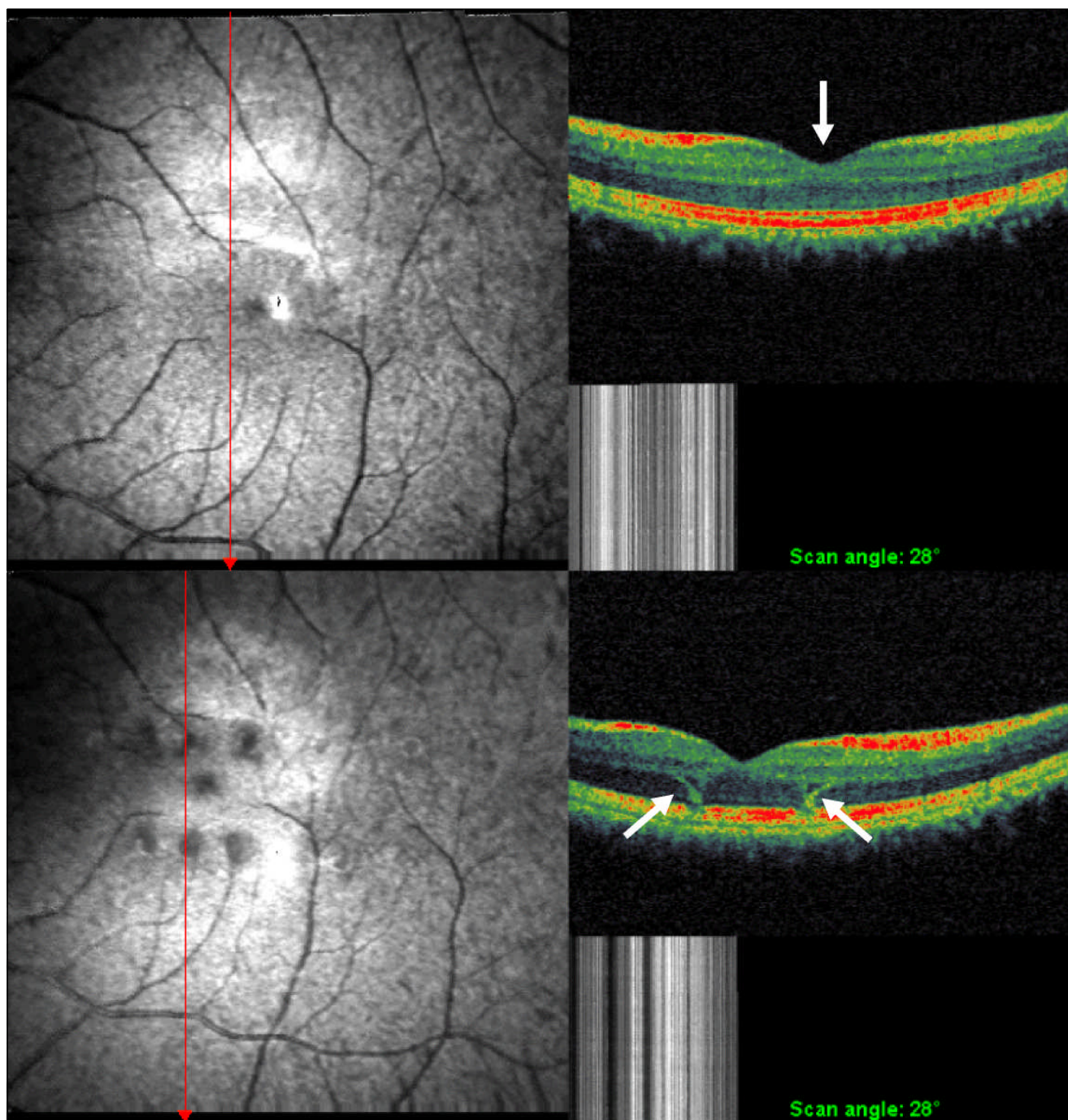


Figure 5. Diagnostic imaging: Scanning laser ophthalmoscope (SLO) and optical coherence tomography (OCT) images of experimentally induced Argon laser injury. The top panel indicates normal noninjured SLO/OCT scan with the vertical arrow on the SLO (left) image indicating section scanned to generate the OCT image to the right of it. The white arrow on the OCT image indicates the normal depression of the foveal pit. The bottom panel shows same area of the retina scanned after multiple lesions were created. The 2 white arrows indicate 2 lesions within the retina on either side of the foveal pit that are disruptions of the photoreceptor and retinal pigment epithelial layers.

use of directed energy systems in both training and operational scenarios. This research also enables the development of new, effective systems that pose reduced risks of injury to the Soldiers who use them.

Laser-induced injury threshold doses are determined predominately in animal models as a function of laser wavelength(s), exposure duration, irradiance diameter at the target tissue, and the additive effects of

repetitive pulse exposure or repeated exposure¹⁰ (Figure 4). Biophysical models or cellular models are used to characterize the interaction of the radiation with the target tissue.¹¹ From these data and theoretical considerations, maximum permissible exposure doses or limits are established and adopted by *ANSI Z136.1*.¹² Historical and recent research at the USAMRD, in collaboration with the Air Force Research Laboratory, has established a robust biological effects data base which is assessed to set the exposure guidelines. Recently, such collaboration has focused on determining the ocular and skin effects for infrared radiation,¹³ resulting in a recommendation to adjust the exposure guideline to assure the safe testing and use of the advanced laser systems designed for use in selected DoD high energy laser systems.

One tool developed at the USAMRD for clinical evaluation/triage of potential and actual laser induced retinal injury patients is the Aidman Vision Screener* and Amsler Grid† card. This field triage aid allows combat medics and other forward deployed medical personnel to perform a preliminary vision function screening to assess an injury that may only be obvious to the patient because overt external injury may be absent. Ongoing research is investigating retinal tissue biomarkers for early identification of retinal injuries that have minimal or no initial visual acuity dysfunction (outside of fovea).

Several research approaches are being investigated to evaluate multiple therapy approaches to laser related retinal injury. Ongoing protocols are assessing new pharmacological agents for treatment and prophylaxis of laser retinal injury, including advanced neuro-protectants to prevent retinal and nerve fiber cell injury/death. Drug delivery techniques are being developed to research treatment approaches for first responder field administration as well as for specialist level care¹⁴ (Figure 5). Cell and molecular approaches are being explored to identify principal protein markers of retinal cell injury for potential prognostic applications.

The spectrum of treatment modalities being investigated is designed to establish immediate and long term treatment recommendations. Currently, there is no specific universally accepted/recommended therapy for laser induced retinal injuries. Historically,

anecdotal therapeutic approaches that have been used to treat patients with ocular laser injuries have typically included systemic nonsteroidal and steroid regimens.¹⁵ The responses were variable and not consistent with clinical expectations. Based on the accumulative research at USAMRD in a nonhuman primate model, response to therapy differs based on the type of laser involved and the exact area(s) of the retinal structures that are injured, and the dosage of medications varies as a function of these variables. Specifically, recent research indicates that nonhemorrhagic retinal injuries created by Nd:YAG lasers respond to a moderate dose of steroid, while hemorrhagic lesions respond better to indomethacin.¹⁶ This degree of variability no doubt has lead to the mixed clinical responses in some of the historical cases.¹

RELEVANCE FOR PATIENT CARE

The Army Medical Research Detachment evaluates potential laser incident patients as requested for follow-up to assist in differentiating actual laser retinal injuries from other causes of visual acuity loss. Based on the history and clinical findings of several recently evaluated patients from both Afghanistan and Iraq, it is apparent that in spite of training and warnings to the contrary, occasional intentional illumination occurs. It is important for primary care providers to realize that a patient with solely a laser retinal injury will otherwise appear uninjured and initially may have subtle visual disturbances. *Army Field Manual 8-50*¹⁷ provides guidance and a decision tree for the assessment of laser-induced injury.

CONCLUSION

Lasers and other directed energy devices are being deployed extensively on the modern battlefield. Military lasers do pose a significant ocular hazard if inadvertent or intentional exposure occurs. The extent of injury and duration of effect are dependent upon the type of laser, the distance from the source, and other factors (ie, binoculars) that affect the amount of energy deposited on the retina. Presently there is no universally accepted therapeutic treatment regimen in the medical community for confirmed retinal laser lesions. Responses to anecdotal therapy in the past have been variable due to the multiple factors that

*Information available from the Defense Technical Information Center: <http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA232777>

†<http://eyecareamerica.org/eyecare/conditions/macular-degeneration/amsler.cfm>

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affect the extent and type of retinal injury. Research is ongoing at the US Army Medical Research Detachment of the Walter Reed Institute of Research to provide evidence-based medical and as-needed surgical therapeutic treatment recommendations. Clinical therapeutic approaches under evaluation include first responder and tertiary treatment options. Further basic research is in progress to find therapy modalities utilizing cell based neuroprotection treatment options that will potentially be of use in the future. Additionally, research is ongoing to evaluate potential diagnostic capabilities such as retinal specific biomarkers that will improve the detection of early and subtle laser induced retinal injuries. This could enhance forward-deployed diagnostic capabilities, allowing early initiation of therapy and minimize evacuation for specialist level diagnostics.

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Opportunities for Military Medical Officers: The Epidemic Intelligence Service at the Centers for Disease Control and Prevention

CPT Kristina McElroy, VC, USAR

The Epidemic Intelligence Service (EIS) was established in 1951 at what is today the Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia. The EIS is a unique, 2-year post-graduate training program of service and on-the-job learning for health professionals interested in the practice of epidemiology. The EIS program is primarily a postdoctoral-level fellowship, with most officers* holding PhDs or doctoral degrees in medicine, veterinary science, or dentistry. The program accepts a small number of nondoctoral candidates with a master of public health (eg, nurses, physician assistants) and doctor of pharmacy degrees. Each year, approximately 80 officers complete the EIS program, and 70% to 75% of graduating officers remain in the field of public health.

From its initial purpose as an early warning system against biological warfare and man-made epidemics, the mission of the EIS has expanded into a surveillance and response unit for all types of epidemics, including chronic disease and injuries. EIS officers serve on the epidemiologic frontlines, conducting epidemiologic investigations, research, and public health surveillance nationally and internationally. Over the past 57 years, nearly 3,000 EIS officers have responded to requests for epidemiologic assistance within the United States and throughout the world. EIS officers have played pivotal roles in combating the root causes of major epidemics such as smallpox eradication, polio, and HIV-AIDS. EIS officers were directly involved in the emergency response for hurricanes Katrina and Rita, establishing active medical surveillance programs for infectious diseases. More recently, EIS officers have responded internationally to outbreaks of Ebola and Marburg fever, and investigated whether domestic disease outbreaks were in any way related to bioterrorism.

One example of a topic that is important to the global operations of the Department of Defense (DoD) is the emergence of H5N1 avian influenza in southeast Asia. The concern is that this avian strain may spread to humans and cause a global pandemic. EIS officers have been actively engaged in planning and emergency preparedness for pandemic influenza. They are also performing influenza surveillance by monitoring rates of respiratory and influenza infection. Additionally, the CDC is closely watching the currently circulating strains of seasonal influenza for drug resistance to the antiviral medications oseltamivir (Tamiflu) and zanamivir (Relenza). While Tamiflu and Relenza are used to treat seasonal influenza, they have also been stockpiled by many countries for use in a pandemic. EIS officers are working behind the scenes to analyze the rates of antiviral resistance. The recent discovery that influenza is showing signs of resistance to Tamiflu may have an adverse impact on the DoD's Tamiflu stockpile for pandemic influenza.

Modeled after a traditional medical residency program where the bulk of the education occurs through experiential learning, the EIS program provides valuable training to the officers and a vital service to CDC and the agency's public health partners. Throughout the 2-year program, EIS officers are required to complete 8 core tasks. They evaluate a public health surveillance system, conduct an analytic epidemiology project, make an oral scientific presentation to a local or national meeting, write a scientific paper for a peer-reviewed journal, and write an article for the weekly *Morbidity Mortality Weekly Report* published by the CDC. EIS officers must participate in an acute public health response and investigation called an Epi-Aid.¹ In addition, EIS officers are required to respond to public inquiries. These 8 tasks are supplemented by training in applied

*The CDC uses the term "officer" to designate a participant in the EIS (Source: <http://www.cdc.gov/eis/about/factsheet.htm>). Consequently, in this article, appearance of the term officer does not refer to military personnel unless it is used as such directly in context. *The Editor*

Opportunities for Military Medical Officers: The Epidemic Intelligence Service at the Centers for Disease Control and Prevention

epidemiology, surveillance, communications, pandemic flu preparedness, and other topics. EIS officers train in all major subject areas of public health science at the CDC.

The EIS program has partnerships with several federal agencies such as the Department of Agriculture, the Food Safety and Inspection Service, and DoD. The agencies select participants from applicants. The selectees are assigned to the EIS program for 2 years, returning to their sponsoring agency upon completion of the fellowship. Since 1994, the Air Force has sent 14 Biomedical Science Corps* officers and 2 physicians, the Army has sent 2 veterinarians and 1 physician, and the Navy has sent 2 physicians. While military nurses and environmental officers with a master of public health degree are eligible to apply to the program, thus far, only physicians and veterinarians have participated in the DoD sponsorship. Active duty personnel have follow-on assignments to the Air Force Institute for Occupational Health, Walter Reed Army Institute of Research, Armed Forces Medical Intelligence Center, and the DoD Global Emerging Infections System. In addition, there are several DoD-CDC liaison positions available.

In addition to active duty medical personnel participating in EIS, eligible US Army and Air Force Reserve and National Guard officers have also completed EIS training, benefiting their civilian employers as well as the DoD. Those participants apply for the EIS program with their civilian credentials.

Anyone interested in the EIS program may obtain more information at <http://www.cdc.gov/EIS/>, or

EIS Program
Centers for Disease Control and Prevention
Mailstop E-92
1600 Clifton Road NE
Atlanta, GA 30333
(404) 498-6110 eisepo@cdc.gov

The application for active duty personnel differs among the military services. US Air Force officers

apply for EIS through the Air Force Institute of Technology. Interested Army Medical Department (AMEDD) officers must apply for EIS through the Long Term Health Education Training program. AMEDD officers should contact both the Army Personnel Management Directorate and their Corps-specific branch proponent office located at Fort Sam Houston, Texas.

The Epidemic Intelligence Service benefits global health and the DoD. Military medical officers who participate in the program strengthen the collaboration between the CDC and the DoD. Graduates of the program are trained epidemiologists who can analyze a population and apply the statistical results to prevention, treatment and management of chronic and infectious diseases, as well as occupational and environmental health. From surveillance of communicable diseases to injury prevention to bioterrorism response, military EIS alumni directly influence health promotion, disease prevention, and force health protection. Ultimately, EIS alumni, whether Active Duty or Reserve, provide a ready force of qualified public health professionals and epidemiologists who can meet the demands of the current operational tempo, while enhancing and increasing the DoD's capacity to respond to public health emergencies.

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*The Air Force Veterinary Corps was disbanded in 1980 and the 272 veterinarians were transferred to the Biomedical Science Corps. The veterinary career field was eliminated in fiscal year 1983. (Source: http://airforcemedicine.afm.mil/sg_newswire/jan_05/BiomedicalSciencesCorpsCelebrates.htm)

The 3rd Army Rescue of the Lipizzaners

MAJ Boris Brglez, VC, USA

Nation building activities and stability operations conducted by the United States military are essential to the success of newly established democracies such as Iraq and Afghanistan. US Army Civil Affairs units spearhead the rebuilding of countries by developing engineering projects, force protection and public health programs, and agricultural development. US Army veterinarians, in conjunction with various US governmental agencies and host nation equivalents, establish vaccination programs to prevent the spread of zoonotic diseases, develop livestock husbandry programs to stimulate the economy, and educate the local populace in animal and public health issues to improve the overall health of the country.

Currently, the US is fighting religious extremism and fundamentalism in the middle and far east. In the past, the US fought against the spread of Nazism, fascism, and communism. In order for democracies to flourish, it is essential the US and its allies prevent the destruction of irreplaceable national resources, such as healthy populations, cultural treasures, historical monuments, agriculture, and heavy industry. One such historical example of cultural preservation is the seizure and protection of the great Lipizzaner breed of horses by US military intervention late in World War II.

In April 1945, General George Patton's 3rd Army was leading the American advance into Bavaria, Germany to combat German Field Marshall Ferdinand Schoerner's 7th Army. The 11th Panzer Division was the 7th Army's largest and most effective remaining combat unit, responsible for defending western Czechoslovakia from the advancing Russians and Bavaria from the approaching Americans. Unknown to the advancing Allies, at the geographic center of the upcoming battlefield was Europe's finest collection of horses, the Lipizzaners, a majority of which belonged to the Spanish Riding Schools in Austria, Slovenia, and Italy, but were then under the control of the German Army.

The German Army had been breeding and training horses in Czechoslovakia for assignment to German

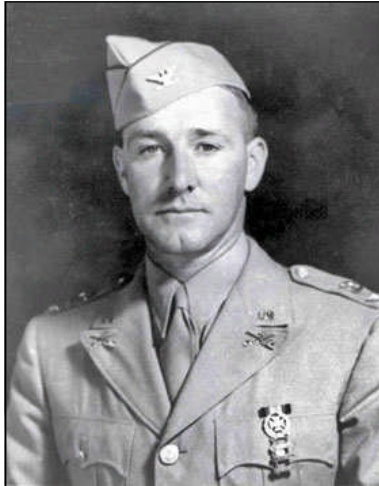
cavalry regiments in Hostoun (Hostau), Czechoslovakia, since October 1938. Unlike the Americans, the German Army continued to use horses to move troops and equipment, and in combat operations. In 1943, about 800 German veterinarians were responsible for the supply and management of 500,000 to 1,000,000 horses.¹ Since the US Army was primarily mechanized, as few as 170 US Army veterinarians were involved in the European conflict.² However, veterinarians were needed to prevent the loss of animals and to ensure the safety of meat, dairy, and eggs essential to feed the malnourished survivors freed from Nazi concentration camps, impoverished German citizens, and fatigued US troops.

The presence of the Lipizzaners in Czechoslovakia led to the collaboration of former enemies to save the herd.³ Two German Army veterinarians, Captains Rudolph Lessing and Wolfgang Kroll, managed the irreplaceable herd of breeding and performance horses in Hostau. On April 26, 1945, Captain Lessing, from the 11th Panzer Division, riding a Lipizzaner and leading an Arabian, risked his life to negotiate a surrender to the 2nd Cavalry Group. Captain Lessing had volunteered to contact the Americans without the approval of Lieutenant Colonel Hubert Rudolfsky, the German commander of the breeding/training facility in Hostau.

Captain Lessing, and Captain Thomas Stewart, a US Army intelligence officer in the 42nd Squadron of the 2nd Cavalry Group, developed a plan on April 26, 1945, to rescue the horses. Colonel Charles Hancock Reed, commander of 2nd Cavalry Group (Mechanized) and an old cavalry officer and rider, supervised the planning of "Operation Cowboy." The goal of the operation was to return the Lipizzaners to their rightful owners, Austria, Slovenia, and Italy. Colonel Reed had become aware of the presence of the Lipizzaners, and a number of prisoners of war (POWs) who tended the herd in Hostau, from captured documents and the interrogation of a recently captured Luftwaffe officer, Walter H. Oberst.

The 3rd Army Rescue of the Lipizzaners

Operation Cowboy required the authorization of General Patton, whose approval to allow US Army operations in Czechoslovakia represented a substantial military and political risk. At the Yalta Conference in February 1945, Soviet Premier Josef Stalin, US President Franklin Roosevelt, and British Prime Minister Winston Churchill agreed that Russia would occupy western Czechoslovakia upon defeat of the Germans. It was not until 0730 on May 4, 1945, that General Omar Bradley, commander of the 12th Army Group which included the 3rd Army, gave General Patton the green light to attack Czechoslovakia.



COL Charles Hancock Reed.
(Photo courtesy of the Lipizzan Association of North America⁴)

Colonel Reed agreed to allow Captain Stewart to accompany Captain Lessing to Hostau, hoping to negotiate a peaceful surrender with the Germans, as well as obtaining the release and evacuation of the POWs who were caring for the herds.

On the evening of 26 April, beneath a full moon, Captains Stewart and Lessing crossed the Czech-German border on horseback. Captain Stewart had ridden horses in his native Tennessee prior to the war and managed to keep up with Captain Lessing in their ride across the countryside, including jumping obstacles on the journey. After a short night's sleep, Captains Stewart and Lessing were able to negotiate the peaceful surrender of Hostau, despite Lieutenant Colonel Rudolfsky's initial intent to fight the advancing Americans. On the evening of 27 April, Captain Lessing accompanied Captain Stewart to the American lines.

Task Force Reed, commanded by Major Robert P. Andrews, was formed from the 42nd Squadron, 2nd Cavalry Group, and consisted of infantry, tanks, and assault guns to facilitate Operation Cowboy. Task Force Reed crossed the Czech-German border on the morning of 28 April. Most of the German troops surrendered without a fight, however, a group of Schutzstaffel (SS) troops posted near Hostau refused to surrender and challenged Task Force Reed. Miraculously, the Americans suffered only 2 seriously wounded casualties, Sergeant Owen Sutton and Private Raymond Manz. Both died from their wounds soon

afterwards. Private Manz was awarded the Distinguished Service Cross posthumously. The significance of this operation and their sacrifice was memorialized on September 16, 2006, when the Czech citizens of Bělá nad Radbuzou, a small town near Hostau, erected monuments to Sergeant Sutton and Private Manz in memory of their heroic acts during the operation.⁵

By midafternoon of 28 April, US troops occupied Hostau, liberating about 400 American, British, Yugoslavian, French, and Polish POWs. The Americans seized a number of horses, including approximately 300 Lipizzaners, over

100 Arabians, 200 thoroughbred and trotting horses, and 600 Cossack horses. The Austrian Lipizzaner herd had been divided, the majority of the mares were in the breeding farm in Hostau, while the stallions were located at St. Martin, Austria. A contingent of Task Force Reed departed on 29 April to rejoin the 2nd Cavalry Group for other missions. Captain Stewart remained in command of the defense of Hostau, commanding German troops, Cossacks (white Russians), and Polish prisoners to assist in its defense. On 30 April, the remaining SS troops in the area attacked Hostau and were defeated by the end of the day. Germany surrendered to the Allies on 7 May. Within days of the surrender, senior Russian officers visited Hostau, making inquiries regarding the horses.



A Lipizzaner mare in front of the stables at Hostau, Czechoslovakia, 1945. (Photo courtesy of the Lipizzan Association of North America⁴)



US Army Soldiers loading Lipizzaner mares and foals onto trucks for transport from Hostau, Czechoslovakia to Schwarzenburg, Germany, May 12, 1945. (Photo courtesy of the Lipizzan Association of North America⁴)

On 7 May, Austrian Colonel Alois Podhajsky, Commandant of the Spanish Riding School in Vienna, asked General Patton for the responsibility to protect all displaced Lippizzaner herds. He was granted this honor and privilege. On 12 May, under Patton's orders, all horses were moved from Hostau to Schwarzenburg in Bavaria. Mares and foals were transported in trucks, and the remainder of the herd traveled on the hoof.⁶ On 18 May and 25 May, more than 200 horses, predominantly Lipizzaners of the Piber (Austria) herd, were returned to St. Martin, Austria, and placed under the direct supervision of Colonel Podhajsky.^{7(p127)}

The remaining 700 horses, consisting of Arabians, Slovenian Lipizzaners, thoroughbreds, trotting horses, and some Cossack horses, were transferred to a large German breeding establishment at a Remount Depot in Mansbach, Germany. All of the horses were war "booty" belonging to the US Army and were even-

tually shipped to the United States for use by the US Army Remount Service. Descriptions of this legendary rescue has been recorded in various documents, such as Colonel Reed's 1970 memoirs,³ documented discussions with Captain Stewart, and in Captain Lessing's biography,⁸ which discussed his employment by the US Army for one year after World War II. Captain Lessing took care of the horses in US Army's custody, including the transport of the horses to the port of Bremerhaven, Germany, for shipment to the United States. Colonel Podhajsky's memoir states that the horses were accompanied on the ship bound for the US by a US Army Veterinary Corps officer.^{7(p132)} Although historically inaccurate, the 1963 movie entitled "Miracle of the White Stallions" was loosely based on Colonel Podhajsky's book. The movie succeeded in capturing

the daring and spirit of the rescue, as well as the cultural significance of the horses and the appreciation of the local populace for the rescue operation.

General Patton certainly deserves the credit he received for his foresight in authorizing the risky rescue and protection of the Lipizzaners and other horses held by the Germans. However, he apparently never publicly discussed Colonel Reed's successful execution of the mission. In his autobiography,⁹ his only mention of the Lipizzaner horses is his description of an exhibition he attended with Under Secretary of War Robert P. Patterson on May 7, 1945 in St. Martin, Austria, during a trip to the headquarters of General Walton Walker's XXth Corps. He describes the maneuvers taught to the horses and their military significance, such as the courbette (half rear) and volte (leap in the air). Patton concluded that the Imperial Spanish Riding Academy and the training of the



Lipizzaner horses in transport to Schwarzenburg, Germany, May 12, 1945. (Photo courtesy of the Lipizzan Association of North America⁴)

The 3rd Army Rescue of the Lipizzaners

Lipizzaners, which was established in the 16th century during the reign of King Charles V, was an art form which should not be allowed to perish, no matter how esoteric.⁹

The history of the Lipizzaner rescue and the high survival rate of the horses, avoiding disease and physical injury, is testimony to the role military veterinarians play in preserving people's culture and agricultural resources liberated from tyranny and oppression by the US military and its allies. Veterinary vigilance prevented outbreaks of zoonotic diseases such as glanders, encephalitis, rabies, and Q fever spreading to people, horses and other livestock. The significant role that military veterinarians play in the preservation of cultural assets, the promotion of security and public health, and assistance in the rebuilding of economies in ruins is fundamental to the ability of newly established democracies to thrive and eventually stand on their own, becoming productive and contributing members of the global community.



General Patton riding the Lipizzaner stallion Favory Afrika in Salzburg, Austria, in 1945. The horse had been selected by Adolph Hitler himself to be a gift to his Axis ally, Emperor Hirohito of Japan.⁶ (Photo courtesy of the Patton Museum)



One of the groups of Lipizzaner and other horses moving under US Army control from Hostau, Czechoslovakia, to Schwarzenburg, Germany, May 12, 1945. (Photo courtesy of the Lipizzan Association of North America⁴)

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General Patton and Colonel Alois Podhajsky, Commandant of the Spanish Riding School, May 7, 1945, in St. Martin, Austria.⁶ (Photo courtesy of the Lipizzan Association of North America⁴)

Fresh Frozen Plasma

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INTRODUCTION

For years, much has been said and written concerning the transfusion practices in the massively bleeding patient. It makes intuitive sense to transfuse whole blood in the massively bleeding patient since that is exactly what the patient is losing. However, since whole blood is not a product that is available for common hospital use, crystalloids and packed cells are commonly infused to treat the massively bleeding. Infusing a crystalloid solution (normal saline or lactated Ringer's solution) or stored packed red blood cells without clotting factors into a hemorrhaging patient will dilute the clotting factors and can actually make the patient more coagulopathic.¹⁻⁶ Clearly, the severely injured patient does not bleed crystalloid.

There have been a lot of recent discussions on the benefits of fresh frozen plasma (FFP) in combat wounded. This paper provides some basic information on FFP.

WHAT IS FRESH FROZEN PLASMA?

When a donor gives a unit of whole blood, the blood is separated into several components parts. The major components are packed red blood cells (pRBC), FFP, and sometimes platelets. The FFP can be further separated into cryoprecipitate and what is known as "cryo-poor plasma," a product rarely used for therapeutic means. Plasma is the liquid, noncellular portion of blood, and contains water, electrolytes, and proteins. The proteins in plasma include the major clotting factors and intrinsic anticoagulants. The plasma is separated from whole blood after donation and then frozen. To be

considered "fresh," the plasma must be placed into the freezer within 8 hours of collection and stored at minus 18°C or lower, otherwise it is just frozen plasma (another product rarely used for therapeutic means). FFP can be prepared either by separation from whole blood or collection via plasmapheresis.

Fresh frozen plasma contains the majority of all known coagulation factors, but essentially no cells (eg, red blood cells or white blood cells) nor platelets. In addition to the coagulation factors, FFP also contains approximately 500 mg of fibrinogen. Of note, the fibrinogen in 1 unit of FFP is approximately equal to the amount of fibrinogen found in 2 units of cryoprecipitate.⁷ These clotting factors and fibrinogen are critical for normal hemostasis.

COAGULOPATHY AND DAMAGE CONTROL SURGERY

Damage control surgery is the method of treating severely wounded patients in the combat zone. It applies the principles of an abbreviated operation to stop bleeding without completely restoring anatomy and returning the patient to the intensive care unit for resuscitation, warming, and correction of coagulopathy (inability to form clot) before returning to the operating room.⁸⁻¹⁰ The civilian data on damage control patients reveals a clear correlation between coagulopathy and mortality. Macleod et al demonstrated an increased mortality (19% mortality) if a trauma patient has a documented elevation in their prothrombin time (PT) versus those patients with a normal PT (5% mortality) on admission to the emergency department.¹¹ Furthermore, if a patient returns to the intensive care unit after the

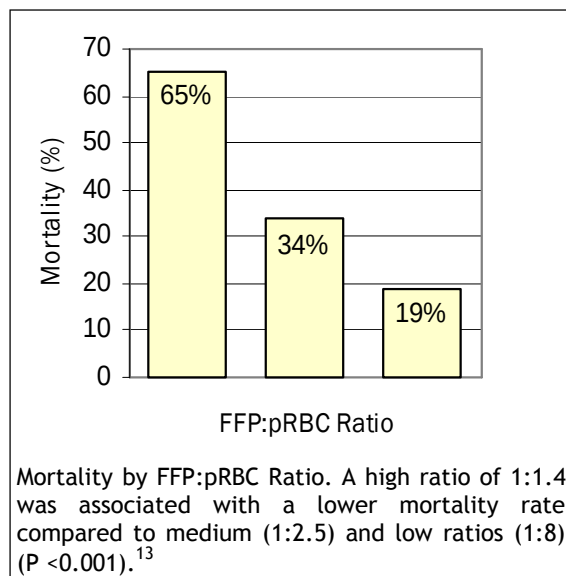


Fresh Frozen Plasma

abbreviated damage control operation and is coagulopathic, the probability of death is much higher and correlates with the degree of coagulopathy.¹²

COMBAT DATA

Combat wounded patients have severe soft tissue injuries and amputations not often seen in civilian trauma; and the coagulopathy seen in trauma patients may be even more of a consequence in these patients. Retrospective analysis from a combat support hospital has revealed a mortality benefit associated with infusing FFP to pRBCs in a 1:1.4 ratio (clinically, in the chaos of treating a hemorrhaging trauma patient this is transfused in a 1:1 ratio) in severely injured patients.¹³ In this study, mortality for each of the FFP:pRBCs ratios increased as more pRBCs were



transfused for fewer units of FFP. With an FFP:pRBC ratio of 1:8, the mortality was 65%. The mortality was 34% for the FFP:pRBC ratio of 1:2.5, but the high FFP:pRBC ratio of 1:1.4 resulted in a mortality of 19%.¹³ The data is presented in the Figure. From these retrospective data, it appears evident that the severely injured, coagulopathic patient needs not only oxygen carrying capacity and volume from packed red blood cells, but also clotting factors from FFP in a high ratio approaching a 1:1 ratio.

FFP STORAGE AND PREPARATION

When frozen FFP is maintained at -18°C , it is good for 12 months. Food and Drug Administration regulations require that FFP be stored at a temperature no higher

than -18°C , and according to the standards published by the American Association of Blood Banks, "Fresh Frozen Plasma shall be prepared from a whole blood or apheresis collection and frozen at less than or equal to -18°C ."¹⁴ Most commercially available small freezer units can easily maintain temperatures of -20°C , making FFP available for extended storage at all far forward medical facilities.

Thawing FFP is a simple process. It is the widely accepted practice to place the desired units in a warm water bath of 30°C to 37°C for 20 to 30 minutes with gentle agitation. Von Heymann, et al evaluated the effects of 2 commercially available thawing devices and running warm water (43°C) on the activity of clotting factors, inhibitors, and activation markers in fresh-frozen plasma. From 1 hour to 6 hours after thawing, no significant differences in the activity of the investigated coagulation markers dependent on the thawing procedure were found.¹⁵ If the thawed FFP is immediately transfused, it remains rich in clotting factors. This product can be rapidly infused intravenously through a warming device set at 37°C to 40°C . If the thawed FFP is not infused immediately it can be maintained at room temperature for up to 4 hours, or stored for up to 5 days at 1°C to 6°C .

THAWED PLASMA

If thawed FFP is not transfused within 24 hours, it is considered a distinct product termed "thawed plasma." While most clotting factors are stable in thawed plasma, some factors including V and VIII (termed *labile factors*) degrade over time and this degradation accelerates while plasma is stored in the liquid state. The advantage of having thawed plasma on hand is that it is immediately available for infusion to the severely injured patient. Many stateside blood banks have adopted this policy of maintaining thawed plasma for immediate release. In an effort to decrease request-to-infusion times, some larger trauma centers even maintain thawed plasma at 1°C to 6°C in the operating room.

UNIVERSAL FRESH FROZEN PLASMA DONOR

While it is common knowledge that O- is the universal donor for pRBCs, the same cannot be said for FFP. The A and B antigens of the blood are found on the red cells themselves. The type O individual is devoid of these proteins on the red cells. Plasma, on the other hand, contains the antibodies to the corresponding

absent protein. For example, a blood type A individual has Anti-B antibodies in his blood. Type O plasma has both Anti-A and Anti-B antibodies and is incompatible with about 55% of the population. However, an individual with type AB blood has neither Anti-A nor Anti-B antibodies. This makes the AB plasma ideal for universal use when the blood type of the patient is unknown. The Rh status is irrelevant because any plasma with Anti-D (the D protein is commonly referred to as Rh) is destroyed at the manufacturing stage. Considering the fact that only 4% of the population is blood type AB (and thus, the donor pool for the universal donor is very small) the best FFP to transfuse is blood type "compatible" based on the blood type determined in the blood bank and should replace the universal donor as soon as possible.

FUTURE

The future direction for combat damage control resuscitation will likely include synthetic hemoglobin as a replacement for pRBCs, especially in far forward environments. In the canine model this product is already available in the form of Oxyglobin® (Biopure Corporation, Cambridge, MA) and is actually used by veterinarians during canine trauma surgery today.¹⁶ This "synthetic blood product" consists of chemically stabilized hemoglobin in a balanced salt solution. When administered intravenously, this stabilized hemoglobin immediately circulates in the plasma and delivers oxygen to the body's tissues and organs. It is only a matter of time before this type of product is available for human use. Freeze-dried clotting factors or a combination of recombinant clotting factors like NovoSeven® (Novo Nordisk, Inc, Princeton, NJ), a recombinant factor VII, will possibly replace FFP (or act in synergy with FFP). Freeze dried or cryopreserved (frozen) platelets may someday replace our current platelets (platelets currently have a 5 day shelf life!). All of these components will need a long shelf life and preferably be heat stable to provide the full benefit of blood and blood product support for severely injured service members far forward in an austere combat environment.

CONCLUSIONS

Coagulopathy clearly correlates with mortality in severely injured damage control patients. Combat injured casualties represent a unique subset of these patients often with massive tissue injury. While

administering packed red blood cells replaces oxygen carrying capacity, it is deficient in coagulation factors. Whole blood administration accomplishes both red cell and plasma replacement, but is both labor and time intensive. Aggressively replacing the lost clotting factors approaching a 1:1 ratio of FFP to pRBCs should be a goal in all abbreviated damage control operations and intensive care unit resuscitation of all severely injured patients undergoing a massive blood transfusion (>10 units of pRBCs in 24 hours) in the combat zone. This is accomplished by assuring FFP is readily available and pushing FFP far forward to surgical facilities on the battlefield.

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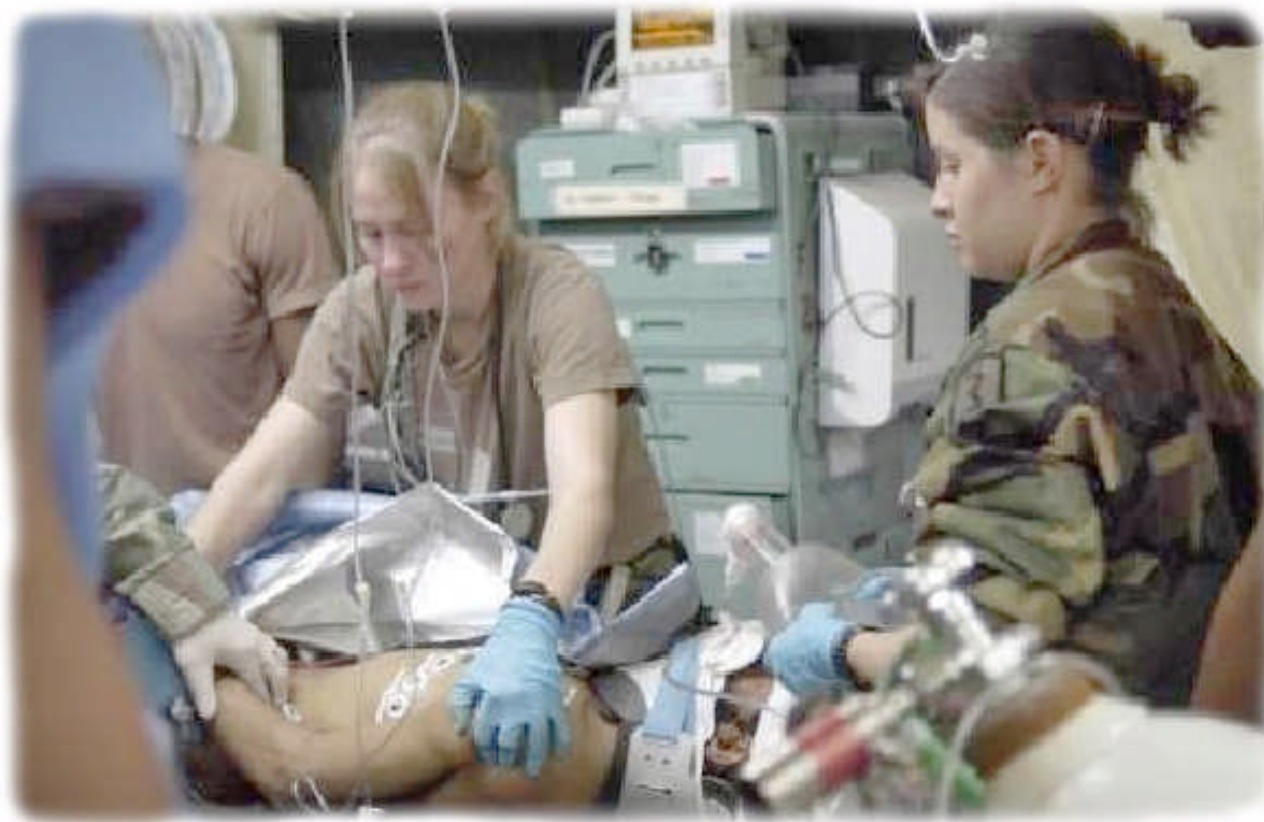
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Total Intravenous Anesthesia on the Battlefield

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INTRODUCTION

The current conflicts in Afghanistan and Iraq have demonstrated the impressive advancements in warfighting technology at the military's disposal. The US military in the 21st century is an awesome warfighting machine that is continually looking to improve its capabilities. The military medical system has also displayed its robust capabilities, though there is still room for improvement. Surprisingly, the delivery of anesthesia on the battlefield is still accomplished with fairly simple gas delivery systems. Is there a better, smarter, and safer way to deliver anesthesia to our wounded warriors? Total intravenous anesthesia (TIVA) has particular application in combat medicine because it accomplishes the goal of general anesthesia while it decreases the equipment necessary to provide inhalation anesthetics. The focus of this article is to review historical milestones in combat anesthesia, develop the basic concepts of TIVA, explore some of the purported benefits, particularly in combat trauma, and briefly describe some future trends in intravenous anesthesia. The goal is to demonstrate the safety, simplicity, scientific principles, and small logistical footprint of TIVA.

COMBAT ANESTHESIA: HISTORICAL PERSPECTIVE

Throughout history, attempts have been made to allay the suffering of injured Soldiers on the battlefield. In the Middle Ages, people sought pain relief in herbs, roots, seeds, flowers, opium, mandrake, hemlock, the mulberry tree, and even the garden lettuce, among other remedies.¹ A sea sponge saturated with the juices of soporific plants became the major analgesic of the time. By the middle of the 17th century, whiskey, gin, and rum had replaced most drugs, considered unsafe since there was no way to standardize the dose, although occasionally physicians used opium.¹ Colonial surgeons relied on speed and medications

such as opium, rum, or cider vinegar when available.² In the mid 1800s, the inhalation of ether anesthesia was recommended for military use. The first combat use of ether was by American forces in Buena Vista, Mexico, early in 1847, and then again at Vera Cruz.³ In the US Civil War, the Army Medical Service reported employing surgical anesthesia in no fewer than 80,000 cases. Surgeons preferred chloroform most of the time, although a mixture of ether and chloroform was also described, as well as alcohol and opiates.¹ Throughout WWI and WWII, continuous advances were made to provide gas anesthetic agents to the austere conditions of the battlefield. Ether continued to be the anesthetic of choice although intravenous Thiopental gained popularity during WWII.¹ However, Thiopental fell from favor after the attack on Pearl Harbor where surgeons noted that many Soldiers who were in hemorrhagic shock died after receiving the anesthetic. New vaporizers, airway equipment, and blood transfusions for treatment of shock were other battlefield advances made during WWII.¹ Anesthetists in the Korean War exercised the added benefit of intravenous muscle relaxation with the introduction of succinylcholine and tubocurarine. In Vietnam, intravenous barbiturates (pentobarbital, secobarbital) and morphine with atropine or scopolamine were used preoperatively.¹ The induction agent of choice was sodium thiopental used with a relaxant. The most common gas anesthetic agents included diethyl ether, halothane, methoxyflurane, and nitrous oxide—oxygen in conjunction with narcotics such as morphine and meperidine.¹ The common problem faced throughout all of these historical conflicts remains today. Front line surgeries are performed in austere environments within the constraints of logistical supply trains. While attempting to provide the safest anesthetic as far forward as possible, providers are still hampered by the same question, “What do we bring to war and how do we carry it there?”

TOTAL INTRAVENOUS ANESTHESIA VS GENERAL

Total intravenous anesthesia is the method of providing general anesthesia without the use of volatile anesthetic gases. General anesthesia, whether intravenous or inhalational, is recognized as analgesia, amnesia, absence of movement and autonomic stability. With the intravenous anesthetics available today, combat trauma patients can be safely induced and maintained without the use of volatile anesthetic gases. The avoidance of inhalational agents adds a significant degree of safety on the battlefield, as intravenous anesthetics do not trigger malignant hyperthermia, whereas the inhaled gases do. Furthermore, the pharmacokinetic and pharmacodynamic properties of most modern drugs makes them very titratable and suitable for continuous infusion, even in the most austere environments. Drugs like ketamine, propofol, midazolam, and newer synthetic, short acting opioids allow for predictable pharmacokinetic modeling, making TIVA an attractive alternative on the battlefield.⁴

Physiologic advantages of TIVA include improved maintenance of hemodynamic stability and temperature conservation, particularly with ketamine. Intravenous ketamine provides dissociative anesthesia, which provides amnesia and excellent analgesia. The ketamine-induced rise in blood pressure and heart rate seen in the normotensive patient can be beneficial in the trauma patient by attenuating further hemodynamic compromise. Furthermore, the peripheral vasoconstriction caused by ketamine can decrease core to periphery heat loss.⁵ Total intravenous anesthesia may also be beneficial in patients who have experienced a traumatic brain injury. In July 2005, an article in the American Society of Anesthesiologists newsletter reported that TIVA was provided to over 100 patients requiring craniotomy or craniectomy.⁶ Further, the article also indicated that a decrease in mortality of 50% was reported when compared to similar neurotrauma patients receiving volatile gas anesthetics. A related study reported that the hemodynamic stimulation induced by ketamine may improve cerebral perfusion and that ketamine does not increase intracranial pressure when used under conditions of controlled ventilation and coadministration of a benzodiazepine.⁷

Compared to inhalational anesthesia, TIVA has also been shown to attenuate the body's stress response to surgery. Analyzing the complete intraoperative period

at 7 event-related time points, it was demonstrated that larger plasma concentrations of stress hormones occurred in an inhalation regimen than in a TIVA regimen.⁸ Propofol administration may inhibit lipid peroxidation and restore antioxidant enzyme levels in extremity surgery requiring tourniquet application.⁹

Perhaps the most documented benefits of TIVA are a reduced recovery time and reduction in the incidence of nausea and vomiting. Propofol TIVA resulted in a clinically relevant reduction of postoperative nausea and vomiting compared with isoflurane-nitrous oxide anesthesia.¹⁰ Ozkose et al¹¹ reported a reduced recovery time in TIVA patients and a significantly reduced incidence in nausea, vomiting, and pain. They also concluded that TIVA patients required fewer additional drugs and showed the lowest additional costs in the post-anesthesia care unit. Hofer et al¹² demonstrated similar TIVA improvement in early postoperative patient well-being and reduced incidence in postoperative nausea and vomiting. The high-quality emergence usually seen with TIVA results in fewer interventions in the postoperative period, thus serving as a force multiplier.

WHY TIVA IN COMBAT

Even in the most austere conditions, most providers would never compromise on the monitors necessary (electrocardiogram, pulse oximetry, capnography, blood pressure monitors) to provide an anesthetic. However, space, superfluous equipment, and electricity can become issues. Furthermore, logistical resupply and disposal of waste gases are also major issues. In the current theaters of both Iraq and Afghanistan, TIVA has become a reliable alternative to general anesthesia with volatile agents. With TIVA, there is less dependency on anesthetic machines and electricity. Currently, the military fields the Narkomed M anesthesia workstation (Dräger Medical Inc, Telford, Pennsylvania) and Ohmeda PAC draw-over vaporizers (Datex-Ohmeda Inc, Madison, Wisconsin) for delivery of inhalation anesthetics in the combat zone. Both are reliable for delivery of inhalation anesthetics, but there are significant drawbacks to each. The Narkomed M is supplied in 2 containers weighing 75 kg and is rather large and bulky (see Figure 1). It requires electricity (battery back-up less than 3 hours) and compressed oxygen for continuous operation. The Ohmeda PAC vaporizer, although small, has a one-way circuit that prevents the absorption of CO₂ and recirculation of anesthetic

Total Intravenous Anesthesia on the Battlefield

gases, resulting in an increased use of volatile agent. Both the Narkomed M and the Ohmeda PAC require some sort of scavenging system to remove waste gases, and both are dependent on the availability of volatile agents (isoflurane and sevoflurane) from supply channels.

On the other hand, TIVA requires very little equipment to administer a general anesthetic. Whether using a bolus technique or a continuous infusion through a pump, TIVA can be employed without the use of an anesthesia machine. Basically a TIVA technique uses the same intravenous medications used for anesthetic induction continued throughout the maintenance phase of the anesthetic. Several syringe infusion pumps available on the market, (eg, Alaris (CardinalHealth Inc, Dublin, Ohio), Baxter (Baxter Inc, Deerfield, Illinois) (shown in Figure 2), Bard (C.R. Bard, Inc, Deerfield, Massachusetts)) are quick to set up, and simple to operate. Most run reliably on batteries for several hours and are easily packed in the pocket of a rucksack. Induction medications such as ketamine, propofol, and etomidate can be titrated or continuously infused throughout the maintenance phase of the anesthetic. Adjuncts such as narcotics and muscle relaxants can also be easily titrated or continuously infused. Given preemptively, scopol-

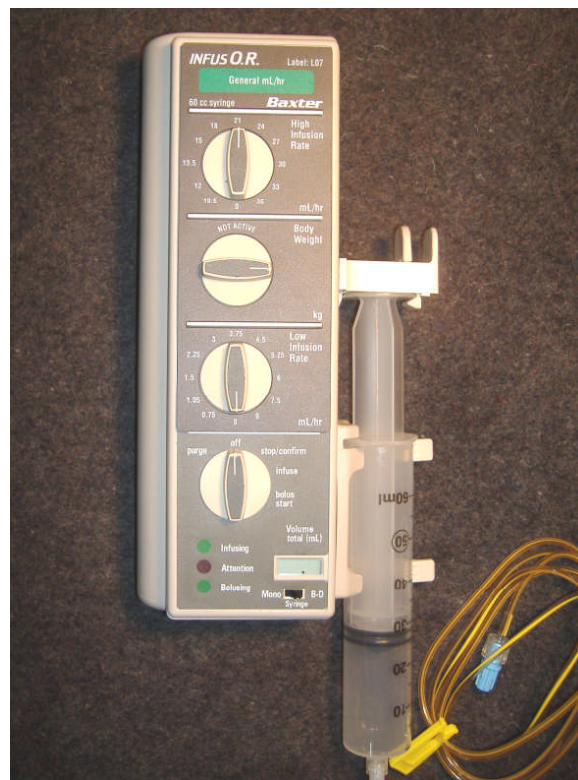


Figure 2. A Baxter syringe infusion pump.

amine and midazolam provide sedation and amnesia with little hemodynamic compromise.¹³



Figure 1. Narkomed M anesthesia workstation at the 399th Combat Support Hospital in Iraq.

Battlefield trauma patients often require multiple surgical interventions with intermittent intensive care stabilization. Another important benefit of TIVA over inhalation agents is that battlefield trauma patients can be maintained on the same intravenous medications, although at decreased doses, throughout the intensive care unit period. Multiple trauma patients often remain endotracheally intubated following damage control surgery, through the resuscitation period, and often through transport to a higher echelon of care. Utilizing a continuous infusion of amnestics, hypnotics, narcotics, and muscle relaxants, patients can be transported with minimal equipment while maintaining enroute hemodynamic stability and comfort. The above advantages of TIVA in the combat setting can be summarized as the “Four Ss”: simple, safe, scientific, and a small logistical footprint.

FUTURE DIRECTION

Military anesthesia educational programs have recognized the importance and increasing role of

TIVA on the battlefield. In the past few years, programs for both nurse anesthetists and anesthesiologists have integrated TIVA as part of their residency training. This effort to increase the use of TIVA on the battlefield was led by the Triservice Research Group Initiative on TIVA, or TARGIT Center. The TARGIT Center has delivered thousands of total intravenous anesthetics over the past 5 years, and have shared their expertise with the global anesthesia community. The reply from the US military anesthesia community to the TARGIT Center's admirable efforts has been impressive. In 2006, the program director of the US Army Graduate Program in Anesthesia Nursing (LTC Thomas Ceremuga, oral communication, March 2008) conducted an informal survey of 105 Army and Air Force combat experienced certified registered nurse anesthetists regarding anesthesia techniques and skills. They identified TIVA as one of the top 10 areas of critical importance in the education of nurse anesthetists at the AMEDD Center and School. An article in the American Society of Anesthesiologists March 2007 newsletter reported that

...military programs make it a requirement that all graduating residents understand the use of TIVA in both minor and major elective surgical cases during their residency, along with didactic training on the use of TIVA techniques in a combat setting.¹⁴

As TIVA becomes more popular, innovations in infusion pumps and delivery systems make intravenous anesthesia more practical in combat. Ongoing developments in advanced biomedical technology result in pumps that are smaller, lighter, and have extended battery life. Perhaps the most exciting innovation in TIVA administration is the target controlled infusion system currently being used in Europe (not yet approved by the US Food and Drug Administration for use domestically). It is a microprocessor-controlled syringe pump that automatically and variably controls the rate of infusion of a drug to attain a defined target medication level in the patient.⁴ It is analogous to using an inhalational gas analyzer to measure delivery of volatile gas agents, but has shown a greater degree of precision and accuracy. Current infusion pumps simply deliver a preprogrammed amount and do not automatically adjust to maintain steady state anesthetic drug levels in the bloodstream. Target controlled infusers are light,

compact, and show great promise for use in treating combat trauma patients. There are exciting new initiatives underway in the US military. The previously mentioned TARGIT Center was created to develop techniques and strategies that will lead to the advancement, research, education, and implementation of total intravenous anesthesia on the battlefield and in austere environments.¹⁵

CONCLUSIONS

The field of anesthesia has evolved tremendously from the days of ether and chloroform. Anesthetic administration on the battlefield has also evolved, with continuous efforts to minimize equipment and compensate for the effect of extremely austere environments. Many of the concerns and obstacles faced by early anesthesia providers continue to exist today. The needs for safety, rapid set up, mobility, and availability of logistical resupply are all concerns for military anesthesia providers. Intravenous general anesthesia decreases dependency on an anesthesia machine and minimizes equipment, compressed gas, and electricity requirements. Total intravenous anesthesia has emerged as a practical, reliable method of delivering anesthesia to patients injured in battle in any location. Given the safety, simplicity, scientific nature, and small logistical footprint of TIVA, the Department of Defense would be wise to consider TIVA as the battlefield anesthetic of the future.

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Should We Teach Every Soldier How to Start Intravenous Fluids?

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The recent mandate by the US Army Training and Doctrine Command requiring all Soldiers entering Basic Combat Training after October 1, 2007, to be combat lifesaver (CLS) certified is an outstanding step to improve training across the Army in lifesaving first-aid skills.¹ However, the requirement for all Soldiers to be competent in placing an intravenous (IV) line and initiating treatment with IV fluids, per the current CLS standards, may not be the best use of precious training resources in the light of the most recent medical research and battlefield experience.

The outcome of a battle casualty will often be determined by whoever provides initial care. In most cases this will be a fellow Soldier, not a medic. The CLS course was developed to bridge the gap between self-aid or buddy-aid until care could be provided by the platoon combat medic (military occupational specialty 68W).² The CLS concept has been further refined over the last decade to reflect the concepts of Tactical Combat Casualty Care (TC3), which focuses on treating the leading causes of preventable battlefield death while minimizing the risk to first-aid providers and the tactical mission.³ The TC3 concept is possibly the most significant advance in point of injury care since the distribution of the individual field dressing in the late 1800s.⁴

The most important battlefield first-aid skill is controlling hemorrhage, by far the leading and most preventable cause of battlefield death in modern warfare. Bellamy showed 9% of those killed in action during the Vietnam conflict died of potentially preventable extremity hemorrhage.⁵ A similar fatality rate from compressible extremity hemorrhage in Iraq was demonstrated by Cuadrado et al.⁶ Proper tourniquet application is the most important method in the control of severe hemorrhage in the tactical setting.

Other lifesaving skills emphasized in the TC3 include needle decompression of a tension pneumothorax and airway management, the second and third leading causes of preventable battle field deaths, causing 4% and 1% of all fatal injuries respectively.⁵⁻¹⁰

The main purpose of performing IV catheterization in the setting of trauma is to administer fluids or blood products to treat hemorrhagic shock. Seven percent of patients on the battlefield require aggressive resuscitation.¹¹ Current transfusion protocols emphasize fresh whole blood and procoagulants rather than crystalloids to restore organ perfusion, prevent the dilution of clotting factors, and avoid hypothermia.¹¹ For patients in significant hemorrhagic shock, aggressive hemorrhage control at the point of wounding, followed by expeditious transport to surgical care, is most important. Evacuation and subsequent surgical management of noncompressible truncal hemorrhage should not be delayed by attempts to place an IV.

In the management of shock, the traditional strategy of early fluid resuscitation beginning in the field and continuing into the operating room has been challenged, specifically in the context of penetrating thoracic trauma. In 1994, a prospective trial by Bickell et al¹² compared immediate versus delayed fluid resuscitation in hypotensive patients with penetrating torso injuries. They reported that patients in whom fluids were restricted until arrival in the operating room had lower mortality, fewer postoperative complications, and shorter hospital length of stay. In a follow-up prospective trial, patients were divided into either restrictive resuscitation (goal systolic blood pressure (SBP) greater than 80 mm Hg) versus liberal resuscitation (goal SBP greater than 100 mm Hg). There was not a significant difference in mortality between groups, but hemorrhage did take longer to control in the group with the liberal fluid strategy.¹³

These studies were largely responsible for significant changes in the management of injured Soldiers on the battlefield and were adopted by US military and Israeli Defense Forces.¹⁴⁻¹⁸ In 2003, Holcomb¹⁴ introduced the term “hypotensive resuscitation” in his article about lessons learned in Somalia. Current military prehospital doctrine now emphasizes the restriction of IV fluids in casualties who have controlled hemorrhage, normal mental status, and stable vital

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signs or even mild hypotension (systolic blood pressure greater than 90). A relatively small percentage of all combat casualties are likely to benefit from IV fluid resuscitation on the battlefield. These include patients with significant hypotension resulting from severe hemorrhage that has been controlled; and those with hypotension or severe hemorrhage and a head injury. All other casualties with uncontrolled hemorrhage and signs of shock may be challenged with a very limited amount of IV fluid (1000 mL of Hextend). Further fluid administration is likely to be detrimental. The practice of permissive hypotension is designed to prevent “popping the clot” off an injured vessel, as well as the dilution of clotting factors with massive amounts of crystalloid fluid.

IV placement is a skill that requires significant time to train. In the current CLS course, the IV portion is the longest, most resource and instructor intensive block of training. This is precious training time that could be used for tactical casualty scenarios and practicing sustainable, life-saving skills, such as hemorrhage control techniques. In the civilian sector, Basic Emergency Medical Technicians (EMT-B) are not taught IV insertion. The first level of civilian EMT to have IV placement in their scope of practice is EMT-Intermediates. The national standard curriculum for EMT-I requires 300 to 400 hours of classroom and field instruction after EMT-B certification. EMT-I students are required to place a minimum of 25 IVs on live patients of various age groups under instructor supervision to be considered competent in this skill.¹⁹ The current AMEDD *CLS Course Instructor Guide*²⁰ does not specify the number of successful IV catheterizations required to certify a CLS in this skill. It is left to the unit’s medical officer. Certification as a CLS will not mean that these Soldiers are competent at placing IVs. At best, it will mean they are familiar with the procedure.

Casualties presenting in overt shock typically have difficult intravenous access. They are often extremely diaphoretic and their peripheral vasculature is constricted. Placement of an IV in a trauma patient in a moving ambulance by an experienced EMT-I or higher level provider takes 10 to 12 minutes and has a 10% to 40% failure rate.²¹ Paradoxically, starting an IV in those patients who would most benefit from limited fluid resuscitation will be extremely difficult for even the most skilled medical provider. During a hostile tactical situation combined with darkness, fatigue, and

fear, it will be very unlikely that a Soldier without significant medical experience will be able to place an IV under battlefield conditions. For this reason, TC3 guidelines emphasize sternal intraosseous catheter placement for fluid resuscitation.²²

Insertion of an IV catheter is not without risks. Complications include local and systemic infections, thrombophlebitis, catheter embolism, and injury to associated nerves, tendons, and arteries.²³⁻²⁵ Complications are inversely related to the skill and experience of the medical provider.

Based on the available literature and the lessons being learned from both Iraq and Afghanistan, it is clear that IV placement is not a critical life-saving skill, while hemorrhage control is. Training all Soldiers to start IVs without the requisite understanding of the indications, contraindications, risks, and benefits of who would benefit from IV fluids and who could be harmed could result in many receiving unneeded or detrimental care on the battlefield. If Soldiers spend the vast majority of their first-aid training time learning IV placement, the most time-consuming skill in the CLS course, yet one that does not save lives, which tool will they reach for under the stress of combat? Will Soldiers be killed by snipers as they waste precious minutes starting IVs? Will evacuation be delayed while attempts to “get the IV” are made? Will proper tourniquet and dressing application be neglected while focusing on the more “technical” and “high-speed” IV insertion?

While most Soldiers will not benefit from IV training, it may have a place in some units. Units operating far forward with little or no organic medical support, such as Special Operations Forces, may benefit from this training. These units are often small and have the time and resources to train to a high standard in advanced first-aid skills.

Many line commanders likely participated in “IV training” led by their unit medical officers during their formative years. Insertion of an IV on the “first stick” is considered by many as the quintessential battlefield medical skill. It is not. Rapid hemorrhage control is. Additional medical training for all Soldiers is much needed. The Training and Doctrine Command has taken an excellent first step. Our battlefield commanders want robust first-aid training for our Warriors. We must continue to synthesize the tactical and medical lessons from the present conflicts to guide our training. It is the duty of the Army Medical

Department and military health care providers to develop best practices of battlefield care and advise our combat commanders how to implement them. Together we can save lives on the battlefield and accomplish the Army mission.

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Abstracts from the US Army-Baylor Doctoral Program in Physical Therapy

The following research abstracts were presented on June 6, 2008, as part of US Army-Baylor University Doctoral Program in Physical Therapy Research Day at Fort Sam Houston, Texas. The research abstracts were prepared as part of a capstone event for the doctoral student class of 2009 that highlights their involvement in faculty directed research.

The research projects support the mission of the Neuromusculoskeletal Injury Prevention and Rehabilitation Research Program (NIPRRP):

Promote Warrior readiness and human performance through systematic research and the advancement of evidence-based practice related to neuromusculoskeletal conditions.

The NIPRRP focuses on optimal prevention, diagnostic, and intervention strategies associated with neuromusculoskeletal conditions. NIPRRP accomplishes this mission by integrating the results of clinical and applied research to help achieve the ultimate goal of minimizing disability and maximizing performance for beneficiaries of the military healthcare system and the overall population. Target populations include healthy individuals and patients with a broad range of neuromusculoskeletal conditions such as extremity overuse injuries, low back and neck pain, and neuropathic conditions.

The Influence of Sex, Height, and Weight on Trunk Muscle Thickness and Endurance (NCT00373009)

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Purpose/Hypothesis: Trunk muscle endurance may have an important role in the prevention and treatment of low back pain (LBP). Direct assessment of trunk muscle function is not feasible. Therefore, muscle morphometry has been used as an indirect measure. The purpose was to describe how sex, height, weight, and body mass index (BMI) influence trunk muscle thickness and endurance times and to provide reference data for trunk morphometry in Soldiers.

Subjects: Soldiers (144 male, 46 female, 21.6 ± 4.0 years; 24.7 ± 2.9 kg/m²) attending combat medic training without a history of LBP were enrolled.

Materials/Methods: Ultrasound images were obtained bilaterally at rest for the following trunk muscles: rectus abdominis, transversus abdominis (TrA), internal oblique, and external oblique, and lumbar multifidus at L4-L5. The following 4 endurance tests were assessed: supine flexor endurance test, prone extensor endurance test, and right and left horizontal side support. Independent t-tests were performed to determine if muscle thickness, muscle symmetry, or endurance times differed based on sex. Pearson product moment correlations were performed to determine the associations between height, weight, and BMI with muscle thickness values. Sex and weight were included in regression analysis to determine their contribution to the variance in trunk muscle thickness. Finally, sex, weight, and muscle thickness values were included in a regression analysis to determine their contribution to the variance in endurance times.

Results: Muscle thickness was greater in males than females ($p < 0.006$). However, the TrA accounted for 10% of total abdominal muscle thickness regardless of sex. Muscle symmetry ranged from 6.6%-19.8% but did not differ based on sex ($p > 0.34$). Asymmetry was $> 12\%$ for the lateral abdominal muscles. Weight had a stronger correlation ($r = 0.28$ to 0.54) to muscle thickness as compared with height and BMI ($p < 0.001$). Weight and sex were able to account for 23-30% of the variance in muscle thickness values while they only accounted for 6% of the variance in endurance test times. Males were able to hold the 4 endurance test postures about a minute longer than females ($p < 0.002$). However, there was no difference in trunk extensor endurance time between the sexes ($p > 0.20$). Relationship between endurance time with sex, height, BMI, and muscle thickness were low ($r < 0.20$).

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Conclusion: Muscle thickness and symmetry values were consistent with findings of prior researchers. Sex and weight were significantly associated with muscle thickness, thus their possible confounding effects should be examined and their potential role as covariates considered in future research. Sex, height, weight, BMI, and muscle thickness values were poorly related to endurance hold times.

Military/Clinical Relevance: Asymmetry of muscle thickness values was found in individuals without a history of LBP; its use as a clinical indicator or predictor for LBP requires further inquiry. This study also provides normative data for trunk muscle size and symmetry, which could be used for comparison studies in a similar population with LBP.

Supports: Neuromusculoskeletal Injury Prevention & Rehabilitation Research Program

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The Effects of Traditional Sit-Up Training Versus Core Stabilization Exercises on Sit-Up Performance in US Army Soldiers: A Cluster Randomized Trial (NCT00373009)

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Purpose/Hypothesis: Despite the longstanding tradition of performing sit-ups in the US Army, it has been postulated that this exercise increases lumbar spine loading, potentially increasing the risk of injury and development of low back pain (LBP). To address these concerns, health professionals commonly recommend “core stabilization” exercises, based on evidence it improves abdominal and trunk muscle strength and performance without excessive spine loading and may decrease the incidence of LBP. However, core stabilization exercise programs (CSEP) have not been widely adopted in the US Army because of the perceived deleterious impact on sit-up performance on the Army Physical Fitness Test (APFT). Therefore, the purpose of this study was to determine whether performing CSEP in lieu of traditional sit-ups has detrimental effects on APFT sit-up and push-up performance and pass rates.

Subjects: Participants included healthy Soldiers between 18-35 years of age participating in Advanced Individual Training (N=2616). Soldiers with a previous history of LBP or other serious condition that precluded participation in physical training were excluded.

Materials/Methods: Companies of Soldiers were cluster randomized to receive traditional exercise program (TEP) or CSEP. TEP consisted of exercises that target the rectus abdominus, oblique abdominals, and hip flexor musculature. CSEP was comprised of exercises that target the transversus abdominus and multifidi musculature. Soldiers completed their exercise program during unit physical training 4 times per week for 12 weeks. Performance on the APFT was assessed at baseline and 12 weeks. Descriptive statistics were calculated to summarize the data. Independent variables were Group, Quartile, and Time. Dependent measures were scores and pass rates for sit-up, push-up, and overall APFT. A 2×4×2 repeated-measures ANOVA with pairwise comparisons using the Bonferroni inequality was performed to examine differences in the overall and sit-up scores. Differences in pass rates were assessed with a chi-square.

Results: The mean age of subjects was 21.9 ± 4.3 years of age. Both groups performed sit-ups outside of unit physical training at equal rates (TEP: 69.5% and CSEP: 65%, P=0.067). Both groups demonstrated significant improvements in their overall and sit-up score and pass rates over time (P<0.05). There were no significant between group differences in overall scores (P=0.142) or sit-up performance (P=0.543) on the APFT after 12 weeks of training. CSEP and TEP improved their sit-up pass rates by 5.6% and 3.9%, respectively (P<0.05). The NNT for CSEP was 56.

Conclusion: CSEP did not have a detrimental impact on APFT scores or pass rates. There was actually a small but significantly greater increase in sit-up pass rate in the CSEP (5.6%) versus the TEP (3.9%). Therefore, incorporating CSEP into Army physical training does not increase the risk of suboptimal performance on the APFT.

Military/Clinical Relevance: A company with 400 Soldiers performing CSEP would actually result in 7 additional Soldiers progressing from a failure to a pass on the sit-up component of the APFT compared to TEP.

Supports: Neuromusculoskeletal Injury Prevention & Rehabilitation Research Program

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**Median and Ulnar Neuropathies in US Army Dental Assistants (MOS* 68e)
Pre- And Posttraining as Preventive Dental Specialists (MOS 68e-X2)**

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Purpose/Hypothesis: Dentists and dental hygienists have been reported as having a high prevalence of upper-extremity musculoskeletal disorders, including carpal tunnel syndrome (CTS). Unfortunately, previous research has not involved dental assistants or the impact of dental training. Therefore, the purpose of this study was to determine the presence of median and ulnar neuropathies in US Army dental assistants pre- and post-training as preventive dental specialists.

Subjects: Forty-two US Army dental assistants, enrolled in the preventive dental specialist course, volunteered to participate in the study. Thirty-five preventive dental specialist students (mean age 23.3 ± 5.8 yrs; 11 male, 24 female) completed both the pre- and posttraining data collections.

Materials/Methods: Subjects were evaluated during the first and last weeks of their 12-week 68E-X2 course. Subjects completed a history form, were interviewed, and underwent a physical examination. Nerve conduction status of the median and ulnar nerves of both upper extremities were obtained by performing motor, sensory, and F-wave nerve conduction studies (NCS). Descriptive statistics for subject demographics and nerve conduction study variables and Chi square analysis for NCS comparison studies were calculated.

Results: Twelve of the 35 subjects (34%) presented with abnormal electrophysiologic values suggestive of median mononeuropathy at or distal to the wrist. Eight subjects had findings pre- and posttraining, 3 subjects had findings pre-training only, and one subject had findings post-training only. Four of these 12 subjects had clinical examination findings (special tests) consistent with the electrophysiological findings. The ulnar nerve electrophysiologic assessment was normal in all subjects sampled. Additionally, there was no statistically significant shift in the prevalence of median neuropathies following the 12-week training program (Chi-square, 0.280; $p = 0.60$).

Conclusions: The prevalence of median mononeuropathies in this sample of US Army dental assistants closely mirrors the prevalence reported for other dental professionals. This study demonstrates that for this sample, the 12-week training program did not appear to affect the electrophysiologic status of the median or ulnar nerves.

Military/Clinical Relevance: A high prevalence of musculoskeletal disorders including median neuropathy at or distal to the wrist or carpal tunnel syndrome have been reported in dental personnel including dentists and dental hygienists. The presence of median neuropathy at or distal to the wrist is also prevalent in this sample of dental assistants; however, the 12-week 68E-X2 training program did not appear to affect the electrophysiologic status of the median or ulnar nerves.

Supports: Neuromusculoskeletal Injury Prevention & Rehabilitation Research Program

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Dynamic Plantar Pressure Parameters Predictive Of Static Foot Posture

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Purpose/Hypothesis: The Foot Posture Index (FPI-6) is a static assessment of foot posture based upon 6 observations. Extreme FPI-6 scores have been associated with increased risk for overuse injury. However limited knowledge exists about the relationship between static FPI-6 scores and dynamic plantar pressure distributions during gait. This study was conducted to explore which dynamic plantar pressure measurements are associated with FPI-6 classifications. A secondary purpose was to describe normative data regarding FPI-6 scores.

Subjects: Participants were ($n = 1,000$, 566 males, 434 females) predominately active adults (30.6 ± 8.0 years, 26.2 ± 3.7 kg/m²) who ran 3.1 ± 1.4 days/week.

Materials/Methods: FPI-6 (scored from -12 to +12) was assessed during bilateral stance and was categorized based on established cut-off values. Additionally, subjects walked across a capacitance-based pressure platform, with an average of 5 steps representing the dynamic pressure pattern. Descriptive statistics relating to FPI-6 total and subscale scores were calculated. The plantar pressure system sampled a total of 246 variables describing the dynamic foot. A significant Pearson product moment correlation ($r > 0.2$ and $p < 0.01$) was used to narrow the number of variables of interest. A hierarchical stepwise backwards regression analysis was then performed to determine the most parsimonious set of variables associated with total FPI-6 score.

Results: The mean FPI-6 score was 3.4 ± 2.9 (range: -6.0 to 11.0); resulting in the following classifications: 13 highly pronated, 220 pronated, 669 normal, 93 supinated, and 5 highly supinated feet. Very few subjects ($n = 31$) scored a -2 on any of the FPI-6 subscales. Pearson product moment correlations yielded 45 variables with an r -value > 0.2 . Regression analysis resulted in 15 variables of interest. Seven variables were removed from the model based on multicollinearity. The resulting 8 variable model ($R = 0.59$, $R^2 = 0.35$) had an average residual between the predicted and measured FPI-6 scores of 0.0 ± 2.3 on the 25 point scale.

Conclusions: The range of FPI-6 scores was limited, with only 2% of subjects being classified as having an extreme foot posture. Mathematically based cut-off values based (i.e., > 1.5 SD from mean to define highly pronated and supinated) would result in a more normal distribution of scores (74 highly pronated, 158 pronated, 527 normal, 143 supinated, and 98 highly supinated). A multivariate model generated using dynamic plantar foot parameters was able to predict total FPI-6 scores. The difference between measured and predicted FPI-6 values was just slightly larger than the interrater standard error of the measurement (1.7 points).

Military/Clinical Relevance: The multivariate model predictive of FPI-6 scores consisted of variables that appear to be biomechanically plausible and informs the association between static foot posture and foot posture during gait. Future researchers should assess the ability of FPI-6 scores and the newly proposed cut-off values to identify individuals at risk for lower extremity overuse injuries.

Supports: Neuromusculoskeletal Injury Prevention & Rehabilitation Research Program

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Dynamic Plantar Pressure Parameters Predictive of Static Arch Height Index

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Purpose/Hypothesis: Although extreme values of arch height have been associated with increased risk for overuse injury, knowledge is limited regarding the association between arch height and plantar pressure distributions during gait. The purpose of this study was to determine if a multivariate model from plantar pressure parameters during gait could be used to predict dorsal arch height and arch height index (AHI).

Subjects: Participants ($n=1,000$; 566 male, 434 female) were predominately active adults (30.6 ± 8.0 years, 26.2 ± 3.7 kg/ m^2) who ran 3.1 ± 1.4 days/week.

Materials/Methods: Dorsal arch height at 50% foot length divided by foot (toe-to-heel) length was used to calculate AHI in bilateral stance. Dynamic plantar pressure measurements were obtained using a capacitance based pressure platform. The plantar pressure system sampled a total of 246 variables describing the average of 5 steps from the right foot during gait. A significant Pearson product moment correlation ($r > 0.3$ and $p < 0.01$) was used to narrow the number of variables of interest. A hierarchical stepwise backwards regression analysis was then performed to determine the most parsimonious set of variables associated with arch height. The plantar pressure parameters predictive of arch height and

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Dynamic Plantar Pressure Parameters Predictive Of Static Foot Posture (continued)

foot length were used to define a dynamic AHI. Correlation and residual analysis were performed to assess the association between statically and dynamically determined arch height indices.

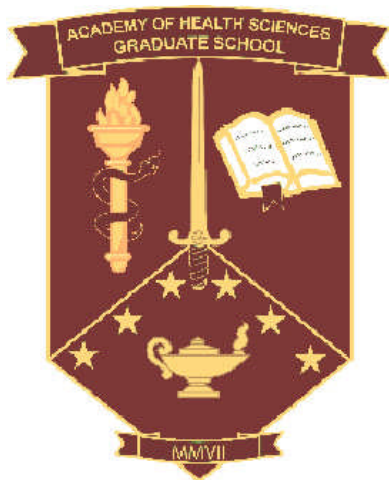
Results: Pearson product moment correlations ($r > 0.3$) yielded 39 variables. The regression analysis resulted in 19 variables of interest; 14 were removed from the model based on multicollinearity. The resulting 5-variable model ($F = 296.6$; $P < 0.001$) was able to predict static arch height ($R = 0.77$ [95% CI = 0.75 to 0.80]), with a mean residual of 0.00 ± 0.39 cm. Variables in the final model indicated an association between a higher arch and an increase in area between the foot axis and gait line, an increase in forefoot width, larger force-time integral (impulse) values for the lateral hindfoot and 1st metatarsal region, and greater mean pressure in the lateral forefoot. The correlation between the static and dynamically determined arch height indices was $r = 0.60$ (95% CI = 0.53, 0.63), with a mean residual of 0.000 ± 0.015 .

Conclusions: The results of this study provide a biomechanically plausible multivariate model predictive of arch height based on plantar pressure parameters and inform the association between static arch height and dynamic foot posture. Specifically, plantar pressure parameters were useful in predicting static arch height, foot length, and AHI based solely on these kinetic and geometric measures of the foot obtained during gait.

Military/Clinical Relevance: Future researchers should assess the association between these variables and lower extremity overuse injuries. The multivariate model developed in this study helps to provide the clinician with a topographical map of the foot which may be useful in designing orthoses that account for both the shape and plantar pressure parameters of the foot.

Supports: Neuromusculoskeletal Injury Prevention & Rehabilitation Research Program

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