Operational Entomology in the Department of Defense (DoD): Implications on Clinical Practice

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- LCDR Kavanaugh earned the United States Navy Health Services Scholarship Collegiate Program in 2006 and attended the University of North Texas. He achieved a Master's of Science and was commissioned as a Medical Entomologist at the rank of Lieutenant Junior Grade.

- After commissioning in 2008, he was selected to go to the Navy Entomology Center of Excellence (NECE) and deployed to Afghanistan with the 2nd Marine Expeditionary Brigade’s first wave into the Helmand Province during Operation Khanjar. He then became the Assistant Officer in Charge (AOIC) of the Preventive Medicine Unit and one of a 12-member medical team that forward deployed to assist in building Camp Dwyer. During his deployment, he led a range of preventive medicine tasks, theater wide entomological support by providing vector surveillance and control and assisted the Shock Trauma Platoon with patient movement. Upon his return to CONUS, he deployed on Continuing Promise 2010 aboard the USS IWO JIMA (LHD7) as the AOIC of the Preventive Medicine Directorate, working with the Ministries of Health in South and Central American countries in best preventive medicine strategies.

- LCDR Kavanaugh reported to Navy Environmental Preventive Medicine Unit FIVE where he was the Director for the Forward Deployable Preventive Medicine Unit in 2010. He ensured teams’ readiness for deployment in worldwide operations as the Division Officer (DIVO) for Education and Training. He implemented the Catalog of Navy Training Courses (CANTRAC) and just-in-time training for deploying units.

- In 2013, LCDR Kavanaugh was selected for Duty Under Instruction for the World Health Organization Collaborative Center at the Entomology Branch of the Centers for Disease Control and Prevention (CDC), at which time he was awarded a Deployed Warfighter Protection Program grant of $116k. He also developed the first prototype non-destructive permethrin test kit for military uniforms in response to a request from MARCOSYSCOM. While at the CDC, he became the Deputy DoD Liaison Officer to the CDC, during the Dugway Proving Grounds anthrax investigation. He also led the surveillance and insecticide resistance testing in Puerto Rico in response to the Zika outbreak, in preparation for future emergency response with the CDC and Puerto Rican Health Department.

- LCDR Kavanaugh is currently stationed at the Armed Forces Pest Management Board where he is the Chief, Strategy and Information Division.
Disclosures

• LCDR Kavanagh has no relevant financial or non-financial relationships to disclose relating to the content of this activity.

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Overview

• Role of DoD Entomology

• Entomology and Public Health

• Operational Entomology
Learning Objectives

1. Analyze the role of entomology in DoD public health programs
2. Identify the components of the DoD Arthropod Repellent System
3. Outline emerging issues in vector-borne disease
The Role of DoD Entomology

CDR Steven E. Rankin, MSC, USN; AFPMB Historical Records
Prior to WWII many more deaths were caused by disease than by combat.

MAJ Walter Reed and Carlos Finlay discovered that yellow fever was vectored by mosquitoes.

Surgeon General William Gorgas established the Sanitary Corps in 1917.

Historical Perspective

https://www.medicalmuseum.mil/index.cfm?p=about.directors.reed

(Ginn, 1997.)
Historical Perspective

- Entomologists were first commissioned into the Sanitary Corps after WWI.

- **1944**: General George C. Marshall established **Army Committee for Insect and Rodent Control** to coordinate pest control efforts.

- **1979**: Renamed **Armed Forces Pest Management Board (AFPMB)** - Directorate in the **Office of the Under Secretary of Defense for Acquisition and Sustainment**, OUSD(A&S)

(Ginn, 1997.)

Our Mission

• Ensure environmentally sound & effective pest management programs are in place to prevent pests and disease vectors from adversely affecting DoD operations

• Ensure deployed forces have effective capabilities to prevent vector-borne diseases and optimize readiness of deployed forces

https://www.defense.gov/observe/photo-gallery/igphoto/2002244372/
Retrieved 26 May 2020
Our Customers

Retrieved on 21 May 2020
https://www.defense.gov/observe/photo-gallery/igphoto/2002301977/

Retrieved 21 May 2020
https://www.defense.gov/observe/photo-gallery/igphoto/2002254798/
Home and Abroad

Retrieved 21 May 2020

AFPMB
Entomology Capability Areas

Vector Surveillance

Vector ID

Pathogen Detection

Bite Prevention & Personal Protective Measures

Vector Control

Mapping, modeling & risk assessment
DoD Entomology Products

Personal Protective Equipment

Medical Planning & Decision Support Tools

Technical Guides (TG)

Pest Surveillance, Identification, & Control Tools

Policy

Photos from AFPMB, APHC, and USDA

https://www.acq.osd.mil/eie/afpmmb/
Entomology and Public Health

Jim Gathany-CDC The Public Health Image Library phil.cdc.gov/phil Retrieved 28 May 2020
Pathogens Vectored by Arthropods

• A massive amount of human suffering and economic loss is caused by arthropod-borne diseases

https://www.gatesnotes.com/Health/Most-Lethal-Animal-Mosquito-Week
Retrieved 26 May 2020
Diseases from Vectored Pathogens

- **Parasites**
  - Malaria
  - Leishmaniasis
  - Filariasis
  - Babesiosis
  - African and American trypanosomiasis

- **Bacteria**
  - Lyme
  - Plague
  - Spotted fever group (SFG) Rickettsiosis
  - Anaplasmosis
  - Epidemic typhus

- **Viruses**
  - Dengue fever
  - Yellow fever
  - Powassan
  - Sand fly fever
  - Ross River
  - West Nile Virus (WNV)
  - Eastern Equine Encephalitis (EEE)

Mechanical Transmission of Pathogens

• Insects can pick up pathogens on surfaces
• Those pathogens can make us sick if the insect then crawls or lands on us or our food

LTJG Tim Ciarlo, NEPMU 5 AFPMB
Pathogens Mechanically Transmitted

- Salmonella
- Shigella
- Entamoeba
- Giardia
- Toxoplasma gondii
- Francisella tularensis

Other Health Concerns

• Parasitism
  – Scabies
  – Myiasis
  – Lice
  – Bed bugs

• Envenomation
  – Arachnids
  – Hymenoptera
  – Hairy caterpillars

• Allergies
  – Hymenoptera
  – Cockroach infestations

• Phobias
  – Extreme fear of arthropods
  – Delusory parasitosis

Vaccines and Therapeutics

• Vaccines:
  – Yellow Fever
  – Lyme (withdrawn from market)

• Therapeutics:
  – Malaria prophylactics
  – Anti-parasitics (Ivermectin)

• The vast majority have no specific treatment or vaccine

Operational Pest Management

DoD Insect Repellent System

- Topical repellent
- Repellent treated uniform
- Proper wear of uniform
- Bed net
- Malaria chemoprophylaxis
- Coming soon: Spatial repellents

https://phc.amedd.army.mil/topics/envirohealth/epm/Pages/DoD-Insect-Repellent-System.aspx
Uniform Treatment

• Factory treatment
  – Permethrin
  – Etofenprox
• 2-gallon Hand Can
• Individual Dynamic Absorption Kit
• Aerosol can
  – Civilian clothing can be treated too!

Retrieved 26 May 2020
Integrated Pest Management

• Comprehensive program to reduce the impact of pests below a certain level of acceptability
• Required by DoD policy
• Types of control
  – Mechanical
  – Physical
  – Biological
  – Regulatory
  – Cultural
  – Chemical

Under Secretary of Defense for Acquisition and Sustainment. (2019, December 26).
Vector Surveillance and Control

Collection
Attraction, Collection, Processing, Identification, Counting, Recording, Reporting

Vector Population Reduction
Vector Control using insecticides and application technologies specific to vector species

Bite Prevention (Personal Protection)
Insecticide-treated bednets, fabrics, uniforms, topical and area repellents

Vector Mapping, Modeling, Predictive Risk Assessment

Vector Identification
Develop & Publish New Identification Keys (WWW/CD/Lucid/Apps)

Pathogen Detection
Sample Prep, Platform assays: Dipsticks, RTPCR, MAGPix, LAMP
DoD Public Health Activities

- Army Public Health Command Main - APG
- Army Public Health Command Europe - Landstuhl
- Army Public Health Command Pacific - Camp Humphreys
- Army Public Health Command Pacific - Camp Zama
- USAF Theater Preventive Medicine - Kadana AB
- US AF School of Aerospace Medicine - Wright-Patterson AFB
- Navy and Marine Corps Public Health Center - Portsmouth
- Army Public Health Command West - JBLM
- Army Public Health Command South - Fort Sam Houston
Mission: The mission of Entomological Sciences Division is to advance the readiness and health of Army personnel and communities by monitoring legacy, current, and emerging environmental public health threats; provide vector-borne disease prevention/surveillance, consultative expertise, and programmatic support to optimize the Army's Public Health Enterprise.

APHC Resources:
- Deployment pest management guidance
- DoD Pesticide Hotline
- Training aids and public health educational materials
- Disease fact sheets
- Identification and analysis of surveillance samples
- Surveillance data analytics
Free clinical support for DoD beneficiaries, DoD health care providers and their tick-bite patients

Tick identification provided

Testing available for agents of

- Lyme disease
- Human granulocytic anaplasmosis
- Babesiosis
- Human monocytic ehrlichiosis
- Ewingii ehrlichiosis
- Panola mountain ehrlichiosis
- Tidewater spotted fever
- Rocky Mountain spotted fever
- Powassan/deer tick virus

3000+ ticks tested annually
The DoD Human Tick Test Kit Program:

- DoD clinics and individuals submit ticks removed from DoD personnel to the Tick Test Kit by mail using kits they request.
- The Tick-Borne Disease (TBD) Lab identifies the tick to species, and tests it for the appropriate suite of pathogens using polymerase chain reaction (PCR) assays.
- Results are reported back to the clinic and tick-bite victim.
- The results from the Tick Test Kit can be used to guide medical treatment decisions for the tick-bite victim.
- The Tick Test Kit produces valuable long-term passive surveillance data on tick distributions and risk of tick-borne diseases at each submitting installation.
Public Health (PH) Airmen do tick drags or use CO$_2$ tick traps.
- Other collected ticks are also sent.
- Ticks that attached to a human are sent to the Army.
- Ticks are shipped dry to USAFSAM and identified to species.
Navy and Marine Corps Public Health Center (NMCPHC)

Mission: NMCPHC is the Navy and Marine Corps' center for public health services. NMCPHC provides leadership and expertise to ensure mission readiness through disease prevention and health promotion in support of the National Defense Strategy.

Field Activities:
- Navy Environmental Preventive Medicine Units (2, 5, 6 and 7)
- Navy Entomology Center of Excellence
Emerging Issues in Operational Entomology

Emerging Issues

• Insecticide Resistance

• Invasive vectors and emerging diseases
  – Climate change
  – Globalization
  – Shifts in habitat use
Tick-borne Disease in the US

Total Reported Cases of Tickborne Disease, 2004-2018
Centers for Disease Control and Prevention

Tickborne Disease Surveillance Data Summary. (2019, November 4).
Tick-borne Disease in the US

Seven new TBD in the past 20 years

- Lyme disease (B. burgdorferi)
- Borrelia miyamotoi
- Borrelia mayonii (also Lyme)
- Tick-borne relapsing fever
- Rickettsia parkeri rickettsiosis
- Rocky Mountain Spotted Fever (RMSF)
- 364D rickettsiosis
- Tularemia
- Anaplasmosis

- Babesiosis
- Erlichia ewingii
- Erlichia muris
- Powassan virus
- Heartland virus
- Colorado tick fever
- Bourbon virus
- Southern tick-associated rash illness (STARI)

Non-pathogenic concerns:

- Alpha-gal meat allergy
- Tick-bite paralysis

Lyme and Other Tickborne Diseases Increasing. (2019, April 22).
Alpha-gal Allergy. (2019, March 28).
Diseases Transmitted by Ticks. (2020, April 2).
Invasive Ticks

• Asian Longhorned Tick (ALT) (*Haemaphysalis longicornis*)
• Parthenogenic
• Severe Fever with Thrombocytopenia Syndrome (SFTS), RMSF
• Exsanguination

https://www.cdc.gov/ticks/longhorned-tick/index.html
Retrieved 28 May 2020

Insecticide Resistance (IR)

• A population of vectors can evolve the ability to overcome pesticide exposure
• Variable across time and space
• Variable mechanisms (genetic, metabolic, behavioral)

Why is IR an Issue?

• DoD only has two classes of insecticides.
• Without the tools to eliminate vectors we have to use other methods to protect personnel. These usually rely on personal compliance (repellents, bed nets, uniform usage)
Example: Aedes Pyrethroid Resistance

IR Mapper. (2016).
How Are We Combatting IR?

- Deployed Warfighter Protection Program has competitive funding to develop novel insecticides to combat IR issues.
- New tools being evaluated that do real time testing so personnel can make force health protection recommendations in hours vs. days.
Key Takeaways

• Entomology and pest management are integral components of an effective public health program

• Personal protective measures and pest management are the only means of prevention and control of most vector-borne diseases

• Insecticide resistance and tick-borne diseases are important emerging issues in operational entomology
References


  https://phc.amedd.army.mil/organization/ehse/Pages/EntomologicalSciences.aspx


  https://www.cdc.gov/ticks/alpha-gal/index.html

Centers for Disease Control and Prevention. (2020, April 2). Diseases Transmitted by Ticks.

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1. Go to URL: https://www.dhaj7-cepo.com/content/clinical-communities-speaker-series-health-innovations-and-promising-practices-jul-2020

2. Click on the REGISTER/TAKE COURSE tab.
   a. If you have previously used the CEPO CMS, click login.
   b. If you have not previously used the CEPO CMS click register to create a new account.

3. Follow the onscreen prompts to complete the post-activity assessments:
   a. Read the Accreditation Statement
   b. Complete the Evaluation
   c. Take the Posttest

4. After completing the posttest at 80% or above, your certificate will be available for print or download.

5. You can return to the site at any time in the future to print your certificate and transcripts at https://www.dhaj7-cepo.com/

6. If you require further support, please contact us at dha.ncr.j7.mbx.cepo-cms-support@mail.mil