Department of Emerging Infectious Diseases.

USAMRU-K DEID
USAMRU-K-DEID formerly known as USAMRU-K GEIS is the Kenyan arm of the United States DoD Global Emerging Infectious Surveillance and Response System (DoD-GEIS) a core component of the Armed Forces Health Surveillance Center (AFHSC). Being part of the global DoD GEIS partnership, USAMRU-K DEID, promotes and facilitates national and international preparedness for emerging infections to protect the health of all DoD health care beneficiaries and the public at large. USAMRU-K DEID continues to promote, expand and execute its strategic goals of surveillance and detection; response and readiness; integration and innovation and cooperation and capacity building.
Dear Colleagues,

As you know, after three wonderful years as commander of the US Army Medical Research Unit – Kenya (USAMRU-K) I will be re-assigned in September to the Walter Reed Army Institute of Research (WRAIR) in Silver Spring, Maryland. I would like to take this opportunity to express how proud I am to have witnessed the tremendous growth and expansion of DEID programs and their integration into the overall research program of USAMRU-K. DEID has reached beyond the borders of Kenya, to Uganda, Tanzania and Cameroon, further expanding our health surveillance network in Sub-Saharan Africa to provide relevant and timely information to our armed forces while supporting the public health infrastructure of our host nations. Our growth and expansion is further proof of the hard work and dedication of everyone affiliated with the DEID program and USAMRU-K. I am certain that USAMRU-K as a whole, and the DEID program in particular, will continue to grow and expand under the leadership of COL Thomas Logan whom I have known personally and professional for many years. Rest assured, that I will continue to support you in my new capacity as the Executive Officer at the WRAIR. Dr. Stewart and I wish each and every one of you the very best in all your future endeavors in both professional and personal lives, and we will always cherish our experience in this beautiful country.

MESSAGE FROM THE OUTGOING USAMRU-K COMMANDER
SCOTT GORDON, PhD Colonel, Medical Service Corps

Dear colleagues and friends,

I want to take this opportunity to thank everyone associated with AFHSC-GEIS, the DEID, USAMRU-K, KEMRI, the CDC and the many partners for the wonderful accomplishments in the past 5 years, I am proud to have served as the DEID coordinator supported by wonderful people who have made my job interesting and enjoyable. I have enjoyed my tenure here and I appreciate having had the opportunity to work in a wonderful country and great colleagues. I will always be grateful for your support and professionalism you have provided me during my time in Kenya. Though I will miss all my colleagues in Kenya, Uganda, Tanzania and Cameroon, I am confident, this program will continue to grow under the new leadership at USAMRU-K and DEID.

MESSAGE FROM THE OUTGOING USAMRU-K DEID DIRECTOR
David Schnabel, MD, MPH Major, Medical Service Corps

It is indeed a pleasure to be part of a team of professional men and women who have made and continue to make great scientific contributions. USAMRU-Kenya - DEID has experienced tremendous growth in recent years and extended its reach beyond the borders of Kenya. I am confident that success will continue in the years to come. The dedication and enthusiasm I have witnessed in the short time I have been here has reinforced my resolve to make this institution the best that it can be. USAMRU-K DEID has made a huge contribution in strengthening the public health infrastructure of our host nations (Kenya, Uganda, Tanzania and Cameroon) by improving surveillance capacity and responding to public health emergencies. In an interconnected world, timely health surveillance plays a critical role not only for protection of our personnel but also for the populations of the host nations, the region and the world.

MESSAGE FROM THE INCOMING USAMRU-K COMMANDER
Thomas M. Logan, PhD Colonel, Medical Service Corps

I am honored to have the chance to serve as one of the DEID directors. DEID’s role and contribution to the public health infrastructure of Kenya and the East African sub-region is significant. Its role in outbreak investigation and capacity building remains its corner stone. Over the past 4 years under the leadership of Major Schnabel, DEID has expanded its great work into Cameroon, Uganda and Tanzania. Over the next 2 years I plan on developing the systems and streamlining operations at each location. Bringing the Acute Febrile Illness protocol to the remaining sites is a goal of mine. Another goal is to encourage and develop the young scientists within the DEID organization by establishing a work study program that will enable staff to complete their graduate level education and to encourage young Scientists to come up with proposals under the guidance of their lab heads. Nontraditional funding streams seem the only way for DEID to increase its work in the future. The concept of pathogen discovery is another area in which DEID is poised to play a critical role. It is key for all of our Scientists to have a good working knowledge of basic biostatistics in order to better take advantage of the wealth of data that we have. Steps will be taken to increase the amount of quality scientific publications. Mine is an open door policy and look forward to talking to anyone that stops by my office.

MESSAGE FROM THE INCOMING USAMRU-K DEID DIRECTOR
Eyako Kofi Wurapa MD, MTM&H LTC, Medical Service Corps

01. Mission and Vision
01. MISSION AND VISION

Breaking the swab.
GLOBAL GEIS BACKGROUND

GEIS was established in 1997 in response to Presidential Decision Directive NSTC-7. GEIS published a strategic plan in 1998 that outlined the goals, objectives, and activities of the new program. These two documents, NSTC-7 and the strategic plan, formed the cornerstone of the DoD-GEIS foundation.

With the appearance of the highly pathogenic H5N1 avian influenza in 2005, GEIS was directed to administer additional funds from a U.S. Congressional supplement for avian and pandemic influenza surveillance in January 2006. The DoD developed a plan that followed the U.S. National Strategy for Pandemic Influenza and with the supplemental funding, GEIS implemented long-term initiatives to increase influenza surveillance, laboratory support, and communication. GEIS, through its partner networks expanded laboratory diagnostic capability, enhanced influenza and BSL-3 laboratory capacity, improved surveillance coverage by increasing the sentinel sites and the number of countries under surveillance and established centralized communications. In a Deputy Secretary of Defense memorandum dated 26 February 2008, GEIS became a core component of the newly formed AFHSC. AFHSC GEIS, now known as the Division of Emerging Infectious Diseases, joined the Defense Medical Surveillance System (DMSS) and the DoD Serum Repository (DoDSR) as part of a larger and more diverse and capable organization in the DoD. The GEIS surveillance portfolio generates essential data that bolster the DoD and global public health efforts. Many surveillance systems have been expanded and additional programs instituted and the robust training efforts by DEID continue.

Priority Surveillance Pillars:
- Respiratory Infection (RI)
- Gastrointestinal Infection (GI)
- Febrile and Vector-borne Infection (FVBI)
- Antimicrobial Resistance (AR)
- Sexually Transmitted Infection (STI)

Mission: Successfully develop, implement, support, and evaluate an integrated global emerging infections surveillance and response system that supports the AFHSC and contributes to force health protection in U.S. Forces, the Military Health System (MHS), and the global public health community.

Vision: Be a scientifically credible and recognized worldwide surveillance system for emerging infections, fully integrating a global network of laboratory capabilities with a comprehensive DoD health surveillance system.

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With the appearance of the highly pathogenic H5N1 avian influenza in 2005, GEIS was directed to administer additional funds from a U.S. Congressional supplement for avian and pandemic influenza surveillance in January 2006.
USAMRU-K GEIS, now known as USAMRU-K DEID, was started in Kenya in 1998 and expanded to Uganda, Tanzania and Cameroon in subsequent years. Most influenza outbreaks in Sub-Saharan Africa go undetected, furthermore, there are only a few surveillance studies cited in the literature. Due in part to the lower priority accorded to Influenza compared to endemic diseases such as malaria and HIV/AIDS, there has been a large knowledge gap about the disease’s circulating strains. Data available from the Kenyan Ministry of Public Health and Sanitation indicates that respiratory illnesses are the second highest cause of outpatient morbidity in both the under and over fives populations (Fig. 1,2). However, before Influenza surveillance and detection initiatives like the one instituted through AFH-SC-GEIS funding, the country had no capacity to characterize the illness. This scenario is common for most other Sub-Saharan countries, which are plagued by lack of resources, inadequate lab facilities and a poorly funded public health system. USAMRU-K DEID is now making a difference in Influenza surveillance and detection capabilities. Apart from this, researchers at USAMRU-K DEID also play a vital role in helping to predict and prevent zoonotic diseases. According to the World Health Organization (WHO), zoonotic diseases make up more than 60% of all human infectious diseases and more than 70% of all emerging infectious diseases. Fast changes in food systems and production of livestock foods in developing countries is creating new niches and transmission pathways for pathogens, with unprecedented numbers of diseases emerging and re-emerging in recent decades. The growing threat of emerging diseases such as SARS, and re-emerging diseases such as Rift Valley Fever and avian influenza calls for more comprehensive animal-human disease research; the collaboration between animal health and public health services is necessary if these threats are to be minimized.

The USAMRU-K DEID’s robust surveillance network plays a critical role in outbreak prediction, mitigation and response.

Data available from the Kenyan Ministry of Public Health and Sanitation indicates that respiratory illnesses are the second highest cause of outpatient morbidity.

Source: HIMS; KMoH 2008 Annual Report
There is increasing recognition that, for a number of zoonotic diseases, the most effective way to protect the health of the public is to control disease in the animal host. USAMRU-K DEID is interested in aspects of zoonotic diseases that impact the world’s poorest communities, where animal husbandry is a way of life and a central means of livelihood. Through funding from AFHSC-GEIS, researchers at USAMRU-K DEID have therefore been carrying out surveillance at the livestock-human disease interface and supporting better integration of veterinary and public health surveillance programs. In particular, we appreciate that the occurrence of Influenza virus infections in animals could potentially give rise to human pandemic influenza strains. The program focuses on the several areas of research pertaining to the human/animal interface that could have a profound impact on protecting human health. Overall, our robust surveillance network (Fig. 2) plays a critical role in outbreak prediction, mitigation and response. Additionally, as the sense of safety enjoyed by peoples and governments throughout the world regarding public health gradually erodes due to the threat of bioterrorism, USAMRU-K DEID continues to play a leading role in ensuring biosecurity in our areas of operation by keeping biological agents and toxins out of the reach of unauthorized persons. USAMRU-K DEID has rigorous biosafety measures that ensure the proper containment principles; technologies and practices are implemented in our laboratories to prevent unintentional exposure to pathogens and toxins, or their accidental release. We continually improve the safety of our laboratories and provide enhanced security, continued staff training, secure freezer storage and incineration capacity. These biosafety measures nurture biosecurity by preventing the loss, theft, misuse, diversion or intentional release of pathogens or toxins. With this publication, we would like to highlight USAMRU-K DEID and its various activities to the peoples and governments of Kenya, Uganda, Tanzania, Cameroon, to the broader scientific community and finally to our funders.

**Surveillance projects for USAMRU-K DEID:**
- Influenza (Human, Avian and Swine)
- Arbovirology
- Viral Hemorrhagic Fever
- Acute Febrile Illnesses,
- Leishmaniasis,
- Enteric diseases
- Sexually Transmitted Diseases
- Rodent Borne Viruses
- Health demographics
- Malaria drug susceptibility

**USAMRU-K DEID’s robust surveillance network plays a critical role in outbreak prediction, mitigation and response; the program is making a big difference in influenza surveillance capabilities.**

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USAMRU-K DEID’s robust surveillance network plays a critical role in outbreak prevention, mitigation and response.
Influenza viruses continue to be very unpredictable, with the recent unexpected triple re-assortant 2009 pandemic Flu A H1N1. Its quick spread across the globe and the time it took for vaccines to be available is further proof that the world is unprepared and vulnerable for a serious and more virulent influenza pandemic. Nevertheless, the ability of the different countries to provide rapid diagnosis including many developing countries with limited resources has been impressive, this can be attributed to the previous H5N1 scare that enabled better preparedness among nations.

As influenza viruses continue to evolve and attain more virulence and cross species adaptability, it is important to undertake surveillance as an alert mechanism, to effect timely preventive and control mechanisms in case of the emergence of influenza viruses that may be of pandemic potential. Starting with Kenya, the USAMRU-K DEID influenza surveillance has now expanded to include, Uganda, Tanzania and Cameroon. These surveillance activities are part of the AFHSC-GEIS laboratory based influenza surveillance network around the world. It serves the overall DEID goals of the program namely to:

1. Detect local Influenza outbreaks,
2. Provide isolates for the WHO vaccine pool for vaccine component determination that protects not only the US forces in foreign missions but also the general public and to,
3. Detect any emerging strains that could have pandemic potential. This is not only important for the AFHSC-GEIS but also to the general public of the host nations, the region and the scientific community in general.

THE REGIONAL INFLUENZA SURVEILLANCE PROGRAMS

Influenza real time PCR analysis is done using an ABI 7500 thermal cycler © DEID Tanzania

As Influenza viruses continue to evolve and attain more virulence and cross species adaptability, surveillance is an important alert mechanism.
Prior to 2006, Kenya lacked the laboratories and public health infrastructure to conduct sustained Influenza surveillance/Influenza-like-illness (ILI). In 2006, DEID funded a program to start conducting influenza surveillance in Kenya. The objective of the program is to carry out sentinel surveillance for human influenza and ILI in Kenyan outpatient clinics. The program has grown through the years, and the AFHSC-GEIS funded National Influenza Center is now a major component in the Kenyan Public Health infrastructure, serving not only Kenya but also, the Republics of Seychelles and Somalia. In brief, nasopharyngeal swabs are collected from patients presenting with fever, cough or sore throat and the samples are transported weekly to the NIC for analysis. Currently the NIC is able to carry out molecular and serologic influenza diagnostics, isolation of viruses, characterization of their antigenic properties and even mapping of their genetic changes that are indicative of changes in virulence/antigenicity/drug resistance. However, the center plans to develop the capacity to carry out all aspects of influenza testing to include in vitro antiviral resistance testing to enable phenotypic drug characterization of these viruses. Furthermore, with the acquisition of a genetic analyzer in the summer of 2010, it is envisioned that we will not only sequence Influenza but also look at the other respiratory viruses being isolated in the laboratory. This capacity should also benefit other local DEID laboratories (such as, the VHF & Arbovirology lab, the avian influenza program, West Nile program, AFI program) as well as support our regional collaborators in Uganda, Tanzania and Cameroon, improving existing collaborations within and outside of the USAMRU-K DEID network. For the immediate present, current influenza surveillance activities will be sustained by continuous sample collection at the eight public hospitals and the two KDoD facilities. We will also set up a committee within the laboratory that will be tasked with writing manuscripts from the much data that has been generated by the program thus improving its current publication output. In the future, we hope the following activities will steer the program forward: An increased collaboration with the KDoD; Expanding the influenza agenda beyond surveillance and response activities, to include basic science research.
themes with proposals focusing not only on influenza but on other respiratory viruses. The goal is to set up a regional centre of excellence in respiratory virology in line with the AFHSC-GEIS mandate, vision and mission. The NIC also plans to establish partnerships and collaborations with local Universities especially the University of Nairobi. Such partnerships will facilitate the rotation of the US Military (Preventive Medicine Residents) at Kenyatta National Hospital (KNH) the largest teaching referral hospital in the region. We will also continue to; encourage and support all NIC employees who are currently studying to complete their respective courses and actively involve them as leaders in their areas of study while encouraging new enrollments and expand existing laboratory and office spaces. The proposed new building at the NIC is a perfect example of our plan to strengthen the existing collaboration between KEMRI, the PEPFAR funded KDoD program and the University of Washington.

**Partners**

- a. Kenya Medical Research Institute (KEMRI)
- b. Kenya Ministry of Public Health and Sanitation (KMoPHS)
- c. CDC-Kenya (Global Disease Detection Program)
- d. United States Air Force School of Aerospace Medicine (USAFSAM)
- e. Naval Health Research Centre (NHRC)
- f. Lovelace Respiratory Research Institute (LRRI)

**USAMRU-K DEID’s goal is to set up a regional center of excellence in respiratory virology.**

**Fig 3: Annual distribution of Influenza strains in Kenya**

**Fig 4: Predominant influenza strain in Kenya**

Pandemic H1N1 is the predominant strain in circulation in Kenya (Sep 09 - Mar 10)
Viruses of the Influenza A genus affect a variety of animals, especially birds and pigs. Mixing of these viruses does sometimes lead to the emergence of new influenza virus lineages that acquire the ability to infect and be transmitted among the human population. To date, 16 HA and 9 NA subtypes of Influenza A viruses have been identified, and all of these subtypes have been isolated from avian species. The domestic avian influenza study seeks to initiate surveillance of zoonotic influenza viruses in domestic poultry sold at live bird markets, and eventually in humans who handle these birds. The project began in 2009 as a collaboration between DEID and the Department of Veterinary Services (DVS) at the Ministry of Livestock and Development. Training on assays for assessing risk of exposure to zoonotic influenza viruses was initiated at the Center for Emerging Infectious Diseases; Iowa State University. Follow up visits from the Iowa University team to KEMRI and DVS laboratories reinforced assay methodology and cohort study implementation. This year, we started a pilot study with a sample size of 500 birds at the LBMs. Dr. David Ojigo of the DVS who often accompanied the field team explains “the roadside markets source poultry from all over the country so this LBM preliminary study will give us a snapshot of bird flu incidences in the whole country.” The field team would operate from a ‘mobile poultry clinic’, the traders helped them identify the different locations from where the birds were sourced. Blood samples, cloacal and oral pharyngeal viral swabs from healthy birds as well as those with signs and symptoms of influenza infection were collected and transported to the WRP laboratories in cool boxes for sorting and analysis. “The pilot study will establish baseline statistics for further focused research,” says Dr. Ojigo.

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“While a majority of the traders were open to having their birds sampled, the field team did not have it easy with all of them. “The resistance from traders came from fear that the sampling could arouse suspicion from buyers who might think the birds are sick which would drive sales down,” explains Mr. Charles Magiri, the study’s field coordinator. Ms. Veronica Nduku, a 54-year-old trader has been in the chicken business since 1977 today, she sells her chicken at stalls along the busy Jogoo Road. Veronica is one of the supportive traders, she says, “we had been selling birds for a long time and had never before heard about this disease, then suddenly, there were media announcements that the birds were sick and our sales plummeted.” Continues Veronica, “I welcomed this project because we can now understand bird flu better, additionally, when

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surveillance is going on, it is easier to detect other diseases that might arise faster as the surveillance structures will already be in place.” In the laboratory viral RNA template was prepared and later used in a Multiplex PCR for detection of gene targets for multiple influenza subtypes (H1, H2, H3, H5, H7, H9, N1 and N2). Amplicons will be sequenced and compared to existing wild type sequences. The traders who appreciate the benefit of the study say they are really happy that the government is also showing that they not only care for the big beef industry but for the small-scale poultry traders as well. A human-use protocol will be written during the 1st quarter, FY 2011 to allow identification of viruses at the bird-human inter-phase. Veronica says it will be really beneficial to sample the traders, “sometimes we have respiratory illnesses that we suspect could be related to our occupation,” she explains. The surveillance data emanating from this project will be valuable in establishing the role domestic chicken play in the continued evolution of influenza viruses and the best strategy for effective control. This is a critical area to the DEID program, and the world at large especially in the wake of the current H1N1 outbreak.

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iii. INFLUENZA VIRUSES SURVEILLANCES IN MIGRATORY BIRDS

The U.S. Army Medical Research Unit-Kenya, CDC-Kenya, the Kenya Medical Research Institute, the National Museums of Kenya, the Kenya Ministry of Livestock Development, and the U.S. Naval Medical Research Unit No 3, Egypt, began collecting and testing migratory bird samples in 2005. Birds are trapped using mist nets and cloacal and oropharyngeal swabs collected and stored in liquid nitrogen in the field. Samples are screened for Influenza A and H5 subtype by real time RT-PCR at laboratories either at CDC-Kenya, Nairobi or at NAMRU-3, Egypt. From October 2005 to June 2009 specimens from 3,618 birds representing 150 bird species were collected in 13 sites with the majority of the specimens being collected from sandpipers, plovers and ducks.

Findings:
Influenza A virus was detected in 1.7% (61/3618) of all the birds representing 23 different species. Of the 61 Influenza A virus positives 21(34%) were from resident birds, 21(34%) from paleartic migrants and 19 (32%) from intra African migrants. All the positives were detected during the migration period between October - April. No positives were detected outside the migration period. No highly pathogenic avian influenza viruses were detected during the study period. However, 1 low pathogenic avian influenza virus (LPAI) H12N2 and 4 LPAI H5 subtypes whose neuraminidase subtype could not be established was detected in 4 bird species representing both resident and migratory species sampled in 3 sites. The discovery of influenza viruses in both migratory and resident birds reinforces the probability of the potential transmission between migratory and resident birds. This effort has built local capacity for the expert collection and analysis of bird influenza and has given animal and public health experts baseline statistics of influenza virus activity in birds during the most recent, four seasons. This surveillance has the potential to function as an early warning system for Highly Pathogenic Avian Influenza.

“This surveillance has the potential to function as an early warning system for Highly Pathogenic Avian Influenza.”
Influenza surveillance in migratory birds

Flamingo nests, Lake Nakuru Kenya

Greater Commorant, Lake Nakuru Kenya

A bird sampling station at Lake Magadi Kenya.

Collecting a Cloacal swab from a dead maribou for avian influenza surveillance.
B. ACUTE FEBRILE ILLNESS (AFI) SURVEILLANCE

AFI is a valuable attempt to catalogue etiologies of fevers of unknown origin in the area of study and will increase our understanding of the diseases, where they are likely to occur, at what frequency, resulting in improved treatment, reporting and recognition of emerging and re-emerging diseases. In this study, better known as the Surveillance of Fevers of Unknown Origin (FUO), nasal swabs and whole blood from patients presenting with AFI are collected from health care facilities from sites all over the country. The samples are then sent to the USAMRU-K/KEMRI laboratory in Kisumu for inventory, analysis and storage. Each sample is stored in multiple aliquots to allow immediate evaluation for etiology and archiving for sharing with DoD laboratories and other scientific collaborators. At the Kenyan lab, nucleic acids are extracted and evaluated for Malaria, Dengue, Rickettsia, Leptospirosis, Salmonellosis, Measles and Upper Respiratory Tract viruses. Arbovirology cultures for yellow fever, alphaviruses, flaviviruses and flaviviruses and phleboviruses, Ebola, Lassa and Marburg are conducted at the KEMRI Arbovirus laboratory. The disease burden comprises Malaria, salmonellosis (Fig. 5) and upper respiratory tract viruses. Other etiologies include Brucella, Rickettsia and Dengue. The current recruitment strategy for AFI screens out patients with Malaria by RDT in order to capture true FUOs. This notwithstanding, malaria still turns out as a big problem at submicroscopic level. We now have indicators for some of the etiologies associated with AFI in the surveillance sites. The hospital physicians have been notified on identification of rickettsiosis, brucellosis and dengue in children with fever. The physicians are keen to include rickettsiosis in the differential diagnosis of fevers of unknown origin. Luckily, rickettsiosis and brucellosis responds to treatments with antibiotics. Importantly, there are many instances in which an etiology does not exist. We are collaborating with other DoD departments that have better technology for identifying infectious diseases, all with an aim of accounting for each of the FUO.

Nationally, while the burden of some infections like Malaria (Appendix 1) is understood to be substantial, the significance of others like brucellosis and rickettsial diseases has been unknown.

For AFI Surveillance, blood is drawn from Malaria RDT negative febrile patients.

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C. THE NATIONAL MALARIA DRUG RESISTANCE (MDR) SURVEILLANCE

As an epicenter of malaria drug resistance emergence in Africa, Kenya continues to experience significant malaria-related morbidity and mortality, especially in children under the age of 5. Currently, Plasmodium falciparum in Kenya is moderately multidrug resistant as determined by various genotypic and phenotypic analyses. The Malaria Drug Resistance (MDR) laboratory of the U.S. Army Medical Research Unit – Kenya (USAMRU-K), based in Kisumu, in collaboration with the Kenya Medical Research Institute (KEMRI) and Kenya Ministry of Health (KMOH), has monitored in vitro malaria drug sensitivity and molecular marker profiles across Kenya since 1995. Among the achievements of the MDR laboratory is that its surveillance data combined with data from other labs was used to inform the change of malaria first-line drug policy from Fansidar (a combination of sulfadoxine and pyrimethamine) to Coartem (a combination of artemether and lumefantrine) by the KMOH in 2006. The MDR lab was also the first lab in the region to adopt a new non-radioactive malaria SYBR Green I fluorescence-based assay technology for use in its drug sensitivity studies. This assay is highly sensitive, less expensive, simple and safe compared to other existing formats. The MDR laboratory is composed of two sections:

- The malaria culture and drug susceptibility testing (MCT) core
- The malaria molecular core

Briefly, the malaria MCT core performs routine culture of malaria laboratory strains and patient isolates, culture adaptation and cloning, sample archiving, and semi-automated drug sensitivity analysis and data reporting. Drug sensitivity analysis is routinely performed for both cultured patient samples (in vitro) and uncultured patient blood samples (immediate ex vivo) to determine sensitivity indexes to malaria drugs of regional public health, military, and pharma/bio-tech interest. Examples of tested antimalarials include artemisinin-derivatives, lumefantrine, mefloquine, doxycycline, and many others. The malaria molecular core performs routine mutational analysis of molecular markers associated with malaria drug resistance.

The techniques used include conventional and real-time PCR. Example markers examined include the multi-drug resistance gene (PfMDR1), which is involved in resistance to a multiple number of antimalarial drugs, the chloroquine transporter gene (PfCRT), and PiATPase6, among others. Together, the MDR lab processes up to 400 patient isolates per year collected mainly from District Hospitals in Kisumu, Kericho, and Kisii (Western Kenya) and Malindi (Coastal Kenya). The samples are acquired through a Walter Reed Army Institute of Research and KEMRI dual IRB-approved minimal risk human use investigational protocol. Data from the two core laboratories is correlated to corroborate resistance profiles over time. Furthermore, it provides valuable epidemiological data and medical intelligence on the efficacy of prophylactic and therapeutic artemisinin-derivatives and other antimalarial drugs in western and other parts of Kenya. The GEIS MDR program is lead by CPT Jacob D. Johnson, PhD, Medical Service Corp, US Army. The MDR MCT core lab is headed by Hoseah Akala, MS and the Molecular core lab is headed by Fredrick Eyase, MS.

The program is chiefly involved in surveillance of anti-malaria drug resistance across Kenya.

Molecular assays employ markers that determine mutations associated with drug resistance.

Kenya, an epicenter of Malaria drug resistance emergence in Africa continues to experience significant malaria-related morbidity and mortality.
Leishmaniasis is a disease caused by protozoan parasites that belong to the genus Leishmania and is transmitted by the bite of female phlebotomine sand flies (subfamily Phlebotominae). About 30 of the 500 known phlebotomine species that infect mammals have been found to transmit the disease and while most forms of the disease are transmissible to humans only from animals (zoonosis), some can be spread between humans. Some of the disease causing Leishmania include: the L. donovani complex with three species (L. donovani, L. infantum, and L. chagasi); the L. mexicana complex with four main species (L. mexicana, L. amazonensis, and L. venezuelensis); L. tropica; L. major; L. aethiopica; and the subgenus Viannia with four main species (L. (V.) braziliensis, L. (V.) guyanensis, L. (V.) panamensis, and L. (V.) peruviana). Leishmaniasis can have a wide range of clinical symptoms, which may be cutaneous, mucocutaneous or visceral. Cutaneous leishmaniasis is the most common form of leishmaniasis while visceral leishmaniasis is the most severe, affecting vital body organs such as the spleen, liver and bone marrow. Leishmaniasis threatens about 350 million people in 88 countries in the world. As many as 12 million people are currently believed to be infected, with about 1–2 million estimated new cases occurring every year.

Thus, information on population distribution and infection rates is crucial for targeted prevention and control measures. The HOA Leishmania project was initiated in 2008 by the U.S. Army Medical Research Unit – Kenya (USAMRU-K) Department of Entomology based in Kisumu. The objective of this project is to establish a surveillance system for detecting and monitoring endemic sand fly infection rates. This will lead to the development of risk assessment tools for contracting leishmaniasis. The first field collections were done in Garissa in September of the same year. Sand fly collections in Kenya are conducted in the areas around Isiolo, Garissa, Wajir, Gilgil, and West Pokot. Outside of Kenya, sampling is conducted in northern Tanzania around Mt. Kilimanjaro and areas around Turmi Ethiopia. Plans are currently underway.
to sample in the Pokot region among other areas of Uganda. Each operational site is sampled twice a year, giving a sample size of about 20,000 sand flies annually. Out of these, a representative sample of 10% have their heads and genitalia dissected for identification using their unique morphological characters. The thorax and abdominal segments are then used for PCR analysis. PCR is carried out on all the collected sand flies for parasite identification. A genus-specific conventional PCR assay is used to screen for infected sand flies and a real time PCR assay is used for species confirmation. Due to the large sample size, 10-15 sand flies are pooled for each reaction. Thus far we have identified 1214 *P. orientalis* from sites in Isiolo, Garissa and Wajir and 80 *P. martini* from Garissa and West Pokot sites. In total, 7666 sandflies in 351 pools were analyzed by PCR. Of these, 14 pools were presumed positive samples at the genus level, however, only 4 were specified as *L. major* and none tested positive for *L. donovani*. All positive *L. major* pools were collected in Eastern (Isiolo) and Costal (Lamu) provinces where CL is rarely reported, indicating that the distribution of CL in Kenya could be more widespread than previously documented. *Leishmania major* has been reported in Baringo; *L. tropica* in Laikipia, Samburu, Isiolo, Nakuru, and Nyandarua districts while *L. aethiopica* has been reported in the Mt. Elgon area.

Literature also indicates that *P. duboscqi* is the primary vector for *L. major* CL in Kenya but we have not collected this species yet, suggesting that *P. orientalis* or some Sergentomyia species could also potentially transmit CL. Large outbreaks of VL in Sudan are attributed to *P. orientalis* – transmitted *L. donovoni*. The presence these species in Isiolo, Wajir and Garissa suggests that the potential to contract VL may be more widespread in Kenya than previously thought. This risk may be increasing as the distribution of competent vector species push southeastward from the Sudan. In the future, we hope to develop a reliable *L. tropica* real time assay that may account for the unidentified conventional PCR-positive pools. We also hope to have an automated extraction system that will improve the speed at which we can process specimens. A protocol to gauge host preference of the female sand flies through blood meal analysis is also currently underway.

**Partners:**

a. The National Center for Medical Intelligence  
b. Sokoine University of Agriculture, Tanzania  
c. Makerere University, Uganda

The presence of *L. donovani* in Isiolo, Wajir and Garissa suggests that the potential to contract VL may be more widespread in Kenya than previously thought.
E. GONORRHEA DRUG SUSCEPTIBILITY SURVEILLANCE

Generally, sexually transmitted infections (STIs) associated with discharge like gonorrhea are a serious health problem in Kenya. However, available data on STIs caused by *Neisseria gonorrhoeae* in Kenya are limited though high prevalence of gonorrhea has been reported in special risk groups in both urban and rural populations. Patients presenting to Ministry of Health (MoH) clinics with complaints suggestive of STIs often go undiagnosed, and are treated empirically with broad spectrum antibiotics in line with the WHO recommendations for syndromic management of STIs. Treatment consists of fluoroquinolones such as Norfloxacin prescribed together with an antibiotic usually doxycycline or azithromycin. With the widespread increase in resistance to fluoroquinolones and a rapidly changing drug sensitivity profile of *N. gonorrhoeae* in other parts of the world, it is prudent for Kenya to undertake surveillance to monitor *N. gonorrhoeae* antimicrobial resistance as part of a comprehensive prevention strategy that should also adapt screening recommendations for individuals at high risk for infection, and assure prompt and effective treatment for infected persons and their sexual partners. The surveillance of antimicrobial susceptibility profiles of *Neisseria gonorrhoeae* isolates from patients seeking treatment in select military and civilian clinics in Kenya is a new project under the DEID STI program. The aim of the study is to establish and monitor antimicrobial susceptibility profiles of *N. gonorrhoeae* isolates from patients seeking treatment for sexually transmitted diseases in these facilities. Surveillance activities under this project will involve recruitment of patients presenting with STIs suggestive of gonorrhea, enrollment of patients who are rapid test positive for gonorrhea and isolation of *N. gonorrhoeae* for antimicrobial susceptibility testing. Isolates of *N. gonorrhoeae* obtained from patients will be used for antimicrobial susceptibility testing using the E-test method to determine the minimum inhibition concentrations of a selection of the antimicrobial agents recommended for treatment of gonorrhea. Antimicrobial susceptibility testing will be done at the USAMRU-K-DEID Centre for Microbiology Research Laboratory in KEMRI, Nairobi. It is hoped that data arising from this surveillance will shed light on the extent of gonococcal antimicrobial resistance in Kenya, and also provide a rational basis for recommended treatment regimens. This data will also play a crucial role in guiding therapy and combating drug resistance. The protocol for the study which has already been reviewed and approved by the WRAIR scientific committee and the Department for Human Subject Protection has recently been approved by the KEMRI/National Ethics Review Committee and is scheduled to initially start in two civilian sites in the month of January, 2011.

**Partners**

a. Ministry of Defence (KDoD)
b. University of Washington (UW)
The USAMRU-K Microbiology Hub (MHK) mission is to provide microbiology expertise and laboratory support for the detection and diagnosis of bacterial, parasitic, and viral causes of acute diarrhea in Kenya. Furthermore, the laboratory provides support for outbreak response preparation and active surveillance, microbial agent identification from sister laboratories, and clinical investigation studies conducted by the US Army HIV Program. The MHK is currently conducting two externally funded enterics studies. Stool samples are collected from nine different surveillance sites throughout Kenya and are processed and analyzed for pathogens such as pathogenic enteric bacteria *Shigella spp*, *Salmonella spp*, and *Campylobacter jejuni*, pathogenic parasites to include *Giardia lamblia* and *Entamoeba histolytica*, and enteric viruses to include rotaviruses and noroviruses. Since October 2009, the MHK has collected and processed over 700 stool samples as a result of these two studies of which over 200 pathogens have been identified and isolated.

In addition to conventional microbiology methodologies, the MHK conducts routine antibiotic susceptibility and resistance testing on all bacterial isolates using a MicroScan Walkaway 40 Plus. The MHK is the only laboratory in Kenya to house a MicroScan. This system allows for rapid identification of bacterial isolates and also its susceptibility to 23 antibiotics. Diagnostic microscopy is used to identify pathogenic protozoan parasites as well as intestinal parasites such as hookworm, Ascaris lumbricoides, and *Schistosoma mansoni*. With the addition of real time PCR, the diagnostic capabilities for the MHK have increased significantly in its surveillance for enteric viral pathogens. Using real time PCR allows the MHK to identify rotaviruses, noroviruses, and astroviruses. Real time PCR methodologies are currently being optimized for identification of certain strains of pathogenic *Escherichia coli* as well as intestinal helminths.

**MHK’s mission is to provide microbiology expertise and laboratory support for the detection and diagnosis of the causes of acute diarrhea in Kenya.**
Future studies on the horizon for the MHK are enterics surveillance studies involving military populations deployed to Kenya (British military personnel) and other regions of sub-Saharan Africa (US military personnel). The laboratory staff consists of an active duty US Army microbiologist and five medical microbiologists.

Partners:
a. The Centers for Disease Control and Prevention – Kisumu, Kenya,
b. The University of Washington,
c. The Walter Reed Army Institute of Research,
d. The Naval Medical Research Center,
e. The Kenya Medical Research Institute, and
f. The British Royal Centre for Defence Medicine.

G. THE KISUMU WEST HEALTH AND DEMOGRAPHIC SURVEILLANCE SYSTEM (KWHDSS)

The KWHDSS is a research project designed to generate health and demographic data which can be used in disease surveillance, outbreak monitoring and response, as well as improving public health infrastructure in Kisumu West District, Kenya. The project is based in Kisumu; Nyanza province, Kenya. Approximately 150,000 people reside in the geographic area of interest, where USAMRU-K has been conducting medical research trials in malaria, TB, and other severe acute respiratory illnesses (SARI) and acute febrile illnesses (AFI) for more than 4 decades. The KWHDSS is set up to better monitor demographic changes and disease prevalence within the target population by integrating data from household based and health facility-based surveys. The program was initiated in 2007 with the first mapping exercise commencing in December 2008. After a year of data collection, in June 2010 the project completed the first rollout phase (cartographic mapping). To date, a total of 357 villages have been mapped and surveyed from the target area. The next phase of the project will collect demographic and health data for each household. Based on the mapping data, it is estimated that close to 150,000 individuals will be surveyed over the next year. This will furnish the project and the community with a broad range of social, health and development indicators to monitor disease prevalence and assist with the development of public health strategies to interrupt disease transmission. Since its inception the KWHDSS has seen tremendous growth and progress; in a bid to improve efficiency in the field, the project purchased six new motorcycles for the field staff. Additionally, the project acquired 20 new Personal Digital Assistants (PDA) complete with external Global Positioning Systems (GPS) units. The handheld devices will be used in conducting subsequent household and geographic surveys in the study area. The project has also re-submitted amendments to the protocol so as to expand data collection and allow for additional related studies to collect both healthcare based and clinical specimens for the purpose of linking this data to the ongoing field studies. The program has 9 staff members comprising GIS and Data Specialists and six field workers in charge of field data collection. The growth of the project over the past year has also seen a number of students from local colleges and universities undertake their internship with the department. With the acquisition of motorbikes for field activities, the project supported motorcycle training and certification for all the six field staff. The field staff are now required to complete Bi-Annual training on motorcycle safety. In the future, KWHDSS program plans to collaborate with other scientific protocols to collect more precise data on the disease burden within the study area and assist the Kenya ministry of health (KMOH) in the placement of health resources.

Partners:
a. Centers for Disease Control and Prevention (CDC) Kenya
b. Kenya Ministries of Health- KMoH
c. The Kenya Medical Research Institute- KEMRI

The KWHDSS is set up to better monitor demographic changes and disease prevalence within the target population by integrating data from household based and health facility-based surveys.
SPECIAL FEATURE: Expanding Acute Febrile Illness (AFI) Surveillance to the Somali Basin
By Rose Nyawira

AFI is a major public health challenge in peripheral health care systems like in NEP as the etiologies may be clinically indistinguishable.
Dr. Dahaba Ali says she became a doctor, as she wanted to help her people; the predominantly ethnic Somalis inhabiting the 126,902 km² North Eastern Province (NEP). The region spans the entire length of the Somalia border (Map 3), with a 1999 population projection showing it to be home to approximately 1.3 million people. The 2009 census put the figure at 2.3 million. NEP falls in an arid zone that experiences prolonged droughts often followed by devastating floods. Apart from river Tana, most other rivers here are characterized by dry riverbeds. With little possibility for irrigation-based development, nomadism is the main economic activity. The pastoralists rely on well water; patchy pasturage necessitating periodical movement. This pastoralism is based around the Arabian camel, which is well adapted to hot, dry habitats. Dahaba, quite possibly the only female of the 26 medical doctors in the whole province is the medical superintendent at Iftin Sub-District Hospital, AFI’s first site in NEP where surveillance commenced in February 2010. NEP is plagued by high poverty and illiteracy rate. The province lags behind the rest of the country in development. Indeed, NEP has the least developed infrastructure in the country, “we did not get a good deal like in roads, there is no road from here (Garissa) to Nairobi, to Mandera it’s even worse” explains Dahaba, “staff posted between districts cannot manage to work efficiently as they have no means to get there.” This underdevelopment is also mirrored in NEP’s health delivery system. Kenya’s pyramidal public health sector delivers through a referral system, which requires patients to start at the base, the dispensaries, working their way up to the hospitals only on referral. Resource scarcity towards the base of the pyramid however greatly affects health care delivery; the focus on curative/hospital care invariably centered in urban areas denies distribution of resources to the more rural based health centers and dispensaries, accessible to Kenya’s 80% rural population, this is a major problem in NEP where most of the population is rural poor. The average facility/population coverage rate for hospitals, health centers and dispensaries in NEP is: 121,000, 230,000 and 19,000 respectively. While the vertical distribution of these facilities may be right for the referral framework, less than 42% people in this far-flung region have access to health care: Geographical inaccess stems from a mal-distribution of the facilities rather than the actual numbers (Fig. 7; Appendix. 2 > P. 61). NEP’s personnel distribution is also significantly below its population share (Fig. 8), which can be explained by personnel flight from the harsh environment and the prejudicial perception by the rest of the country that the area is a hostile no go zone. Meanwhile, NEP lacks skilled locals to take over the vacant posts. With poverty, education and health being interlinked, NEP has some of the poorest health indicators in the country. The province has the highest Total Fertility Rate, women without postnatal check up, underweight rates, lowest sanitation coverage and highest illiteracy amongst adults of both genders in the whole country (Fig. 9). Such underserved populations would be the greatest beneficiaries of disease surveillance programs like the USAMRU-K DEID AFI surveillance. AFI is a common cause of morbidity and mortality in developing countries and a common complaint in patients seeking medical attention in NEP. Infections continue to be its most important cause but these remain poorly characterized in many parts of the world largely due to limited diagnostic ability and the little active surveillance. “High fever infections are so common here but we have no idea why or what the causes
are,” explains Dahaba. The illness is a major public health challenge in peripheral health care systems as the etiologies may be clinically indistinguishable leading to misdiagnoses and under reporting. The available data is insufficient to assess the prevalence and relative importance of the infectious agents and disease burden, estimate priorities for health resources or refine policy on the empiric management of febrile patients. Nationally, while the burden of some infections (e.g., Malaria) is understood to be substantial, the significance of others (e.g., brucellosis and rickettsial diseases) remains unknown. Appendix 1 > P. 61 With no etiology-specific signs and symptoms, a lack of knowledge of the scope of local pathogens and unavailability of accurate diagnostic testing, patients in NEP are empirically treated for Malaria with the potential for increased morbidity and mortality. “It has been puzzling because when we look at these patients clinically they have all the signs and symptoms of Malaria but when we send them to the lab, the blood smears turn up negative,” explains Ahmed Noor an AFI recruiting clinical officer at Iftin Sub-district Hospital. Noor says they then just disregard the laboratory results, “per his judgment, the clinician will either prescribe anti-malarials or manage the pain and fever with paracetamol as he buys time for a hopefully better blood smear” he continues “in that case we ask the patient to come back in 3 or so days, however, if the smear turns out negative again but the patient still has a persisting fever we still wind up dispensing anti-malarials anyway.” Sentinel hospital-based studies performed over defined periods of time have provided useful clinical and public health information in countries that lack resources for long-term routine diagnostic testing. This approach has been used in Sub-Saharan Africa and Southeast Asia to determine the relative importance and antimicrobial susceptibility patterns of common pathogens, and to provide clinical predictors in well-defined patient populations. Additionally, application of these methods has resulted in the identification of emerging or previously unrecognized pathogens among these populations. Similarly, the AFI surveillance will systematically assess the etiologies of infections in patients presenting with fever to several hospitals and health centers in NEP. The targeted panel of pathogens for investigation is arboviruses, tick-borne bacteria, and several zoonoses. High animal exposure, wide consumption of unpasteurized dairy products and rare animal vaccination or insecticide spraying are all factors that favor the spread of infectious diseases and the occurrence of simultaneous or multiple zoonoses. Additionally, the common Somali shelter, the aqal, a dome-shaped, collapsible hut made from poles covered by hides and woven fiber mats, while being flexible enough for the nomads to carry on a camel’s back, is too exposed allowing easy entry of diverse disease vectors. NEP’s disease patterns are further complicated by a refugee population the United Nations High Commission for Refugees (UNHCR) puts at 400,000 and a further monthly influx of sometimes as high as 5,000 refugees. This is bound to have an impact on the region as the

**Fig 9: Kenyan Health Indicators 2008**

**N.E.P has some of the poorest health indicators compared to the other provinces in Kenya.**


A Somali woman outside her kitchen in NEP: The province is plagued by high poverty and illiteracy rates which negatively impact health.

Underserved populations like in NEP should be the greatest beneficiaries of disease surveillance like USAMRU-K DEID’s AFI program.
vaccine coverage in Somalia is compromised by the war; indeed, the World Health Organization (WHO) has previously reported Polio outbreaks in the refugee camps. “There are so many diseases coming from the other side”, says Noor, “before the surveillance we had no hope of knowing what sort of diseases to expect, but with DEID coming in they have simplified our work.” The provision of accurate epidemiologic data for common pathogens will be of practical importance to clinicians as the presence of infections for which specific antimicrobial therapies are available might be identified. Where microbiologic facilities cannot be permanently established, validated clinical predictors may help guide therapeutic interventions. This has both Dahaba and Noor excited, “with the DEID results streaming in, it will make patient management informed” she says, while Noor adds, “patient mismanagement will be a thing of the past.” Dahaba explains additional benefits to clinicians “the fact that you are giving us results from other AFI sites in the country is great for us because if we are transferred elsewhere we will know what diseases to expect” she continues “DEID is also training our lab staff on diagnosis and they have now become resource persons to the other technicians around the hospital.” The surveillance information will also enable targeted public health measures as resources can be directed towards prevention of the diseases with the heaviest burden and in case of outbreaks and epidemics. However, though Dahaba can easily see the advantages of the project, it was not received with jubilation by the wary and suspicious residents. “Most of our people are illiterate and it takes time to convince them, they need more enlightenment on the project but slowly you will gain their trust,” she explained. She however had a message of encouragement saying, “the initial suspicion that was there is slowly ebbing due to the feedback we are getting from DEID and the evident improvement of our lab staff performance since the project began.” Though the road has not always been smooth for AFI Somalia, the project has grown from strength to strength. This July saw the initiation of the 2nd site- the Police-line Health Center with a total of 8 field staff at both sites. This has boosted sample numbers and more residents are buying into the idea. 2011 will see AFI Somalia expand to the larger NEP with additional sites in Ijaara and Wajir districts.

It has been puzzling because when we look at the patients; clinically, they have all the signs and symptoms of Malaria but their blood smears turn up Malaria Negative.”

With the USAMRU-K DEID results streaming in, patient management will now be informed.”
Rodents cause and transmit at least 60 human diseases directly (through their meat or bites) and indirectly (through their excreta and their blood-sucking insects like fleas). Rodent-associated diseases include leptospirosis, relapsing fever, hantavirus infections, murine typhus fever and relapsing fever.
The DEID RBV project was started in 2008 with the aim of carrying out surveillance activities of rodent borne viruses such as the hanta and the arena viruses. Hantavirus produces chronic persistent infection in the host rodent. Transmission of these viruses across a species barrier results in human infections with the virus type correlating closely with disease severity. Hantaviruses have the potential to cause two different types of diseases in humans: hemorrhagic fever with renal syndrome (HFRS) and Hantavirus pulmonary syndrome (HPS). After about 30 years of its first modern description in the Russia Federation, HFRS came to the attention of the world when approximately 3,200 cases were reported from 1951 to 1954 among American soldiers deployed in the Republic of Korea. Hantavirus causes a significant number of human illnesses, making it a global public health threat. Approximately 150,000 to 200,000 patients with HFRS are hospitalized each year throughout the world. On average, approximately 200 cases of HPS per year are reported in the Americas, and although the number of cases is much smaller in number than that of HFRS, its average case fatality is about 40%. The species Lymphocytic choriomeningitis virus (LCMV) of the genus Arenavirus also includes the species responsible for Lassa fever. 

**HFRS came to the attention of the world when approximately 3,200 cases were reported from 1951 to 1954 among American soldiers deployed in the Republic of Korea.**
Evidence of Hantavirus infection in Africa has been limited. Serological evidence of human exposure to Hantavirus infection has however been reported in several countries including Egypt, Sudan, Central African Republic, Chad and Burkina Faso (Map 4). Recently, the first Hantavirus, the Sangassou virus, was isolated from a wild rodent in Guinea. It is thus reasonable to assume that select Hantaviruses may exist in East Africa. Through AFHSC-GEIS funding, the department of Entomology at USAMRU-K embarked on a study to test wild rodents for possible Hantaviruses. Over the last three years, the study has opened up six sites across the country in collaboration with NMK. We have managed to collect samples twice in at least 4 of the sites and collected different species of rodents and shrews. The rodents are captured live using Sherman traps and a selected percentage euthanized for tissue (Lung, Liver, Kidney, Heart and Spleen) harvesting. Reverse Transcriptase Polymerase Chain Reaction (rt-PCR) technique is used to amplify Hantavirus genome segments (L and S segments of nucleocapsid protein) and positive samples are sequenced for characterization. To date the study has managed to meet most of its set objectives. A total of 331 rodents have been trapped across the country representing 16 species distributed longitudinally from the western to the coastal part of the country. This has helped to map out the areas with the species of interest. Further, a total of 187 samples from diverse species have been tested with rt-PCR and at least six samples are indicating a possibility of Hantavirus infection in Kenyan rodents. This study has revealed valuable preliminary data on the possible occurrence of Hantaviruses in Kenya and possible target species. Confirmatory testing is still ongoing with an aim of validating these findings. The preliminary findings of this study were presented at the Health Africa Development Cooperation (HADCO) conference in Tampere, Finland in May 2010. During this time, molecular training for pathogen detection was also conducted at two Finnish Universities, TAMK University of Technology (Tampere) and HAMK University of applied sciences (Hameenlina). Though the focus of the RBV project has been on Hantaviruses, the recent detection of an arenavirus in neighboring Tanzania has necessitated a modification to the RBV protocol that will see the project expand to include tests for other rodent borne viruses including arenaviruses and pox viruses. We will also enact a new protocol where we will be collecting rodent ectoparasites (ticks, fleas and mites) and endoparasites (ascarids,) and evaluate their possible implication in zoonotic disease transmission. The project is now being steered by Capt. Joshua Bast.

Map 4: African countries with serological evidence of Hantavirus infections.

This study has revealed the possible occurrence of Hantaviruses in Kenya and the target rodent species.

Partners
a. The National Wildlife Research Center of the United States Department of Agriculture (USDA),
b. The National Museums of Kenya (NMK)
c. The University of Northern Colorado
USAMRU-K DEID perpetuates its capacity building mandate through constant trainings.

USAMRU-K DEID supports local MoPHS staff through a standardized skill based training at the MDCoE to improve Malaria diagnosis in clinical settings.

Members of the entomology and arbovirology laboratories undergoing tick taxonomy training.
The safety, QA/QC and Regulatory Affairs Departments at DEID work synergistically to ensure that quality standards, biosecurity, study subject protection are ensured by the various projects and surveillance programs.
A. REGULATORY AFFAIRS

The Regulatory Affairs Department based in Kisumu was formed in 2006 in an effort to streamline research administrative operations in clinical trials. The department has a primary role of ensuring the safety of the subjects enrolled in studies at the Walter Reed Project. Our second responsibility is in ensuring high quality data from studies at USAMRU-K, data should be complete, correct and reproducible. The RA team of 20 comprises; clinical research coordinators 2 of whom are certified by the Association of Clinical Research Professionals, internal quality control (IQC) personnel, records personnel, a project manager, an archivist and an administrative assistant all under the director regulatory affairs. The study coordinator and project managers are key in ensuring that operational objectives are effectively achieved at the departmental level and they also lead the team in executing protocols. They are supported by IQC personnel, fellow Clinical Research Coordinators (CRCs) and the study team in ensuring adherence to Good Clinical Practice (GCP) requirements, Local Regulations, Army regulations, unit-wide Standard Operating Procedures (SOPs) and Study Specific Procedures (SSPs). Currently the department supports at least 45 protocols with varying requirements with 7 out of these being DEID funded studies. The overall distribution of the protocols is as follows:

- 10 protocols at IRBs (3 Greater than Minimal Risk (GTMR), 6 Minimal Risk (MR), 1 Research not Involving Human Subjects
- 5 Ongoing Research protocols that do not involve human subjects
- 10 Human Subjects Research protocols actively enrolling (Active interaction with subjects)
- 20 protocols are open/ongoing with no active subject interaction.

The department has a Centralized Communication system. We are the link between the study team and other stakeholders in research, including the approving authorities and protocol sponsors. All communication from the approval committees is channeled through the department along with all review submissions. The department also coordinates both in-house and external training. We ensure that study personnel are qualified by training and experience before they are allowed to participate in research studies. In essence, the department ensures that research staff are equipped with all the necessary training before engaging in any research activities. This year, the department set up and maintained essential study documents/ Regulatory files for all studies as a GCP requirement. This service will be extended to all projects or studies under the Regulatory Affairs support. It is anticipated that all files will be set up before the end of the year 2010. Regulatory Affairs Support for other programs including the DEID program, PEPFAR, and MDCOE will include regular review of the study files for completeness, site visits to monitor for compliance and facilitation of training as opportunities arise. The department will also continue to support all programs that need help in reporting study activities to include Deviations, annual reports and other protocol lifecycle activities. There is need to put structures in place to guide the conduct of research and there is also need for training. A trained team is most likely a compliant team.

B. SAFETY

Bio-safety is a critical component of the USAMRU-K DEID activities. Personnel at USAMRU-K DEID work in laboratories handling dangerous known and unknown pathogens. With that in mind, USAMRU-K - DEID safety department instituted a stringent training program. The training is done in seven major sections divided into 28 modules. The modules are occupationally specific, and every employee is required to receive training when hired with refresher training courses offered annually. The USAMRU-K DEID safety officer provides training to employees on a minimum of three modules every year.

The mandatory entry training includes Blood borne pathogens and infection control, Laboratory safety and Biosecurity, Risk assessment, Communication and management, Chemical inventory and hygiene, Waste management and disposal, Fire safety and evacuation and Select agents awareness. There’s further hands-

Our systematic pathogen archiving system and a restricted access system prevents loss, theft, misuse, diversion or the unintended release of pathogens or toxins.

We ensure that study personnel are qualified by training and experience before they are allowed to participate in research studies.
pathogen archiving system systematically inventories all the different agents in our various laboratories. This inventory, together with our restricted access system for preventing unauthorized entry into our laboratories, ensures that the Principal Investigators can easily prevent; the loss, theft, misuse, diversion or the unintended release of pathogens or toxins. DEID Biosafety/Biosecurity is corroborated by bi-annual inspections that focus on 9 (nine) areas (Biosafety training and management records, Occupational Health, Fire safety management records, Electricity safety, Sharps safety and control measures, Chemicals safety, Waste management and disposal, General house keeping and Biosecurity). Overall, DEID reinforces its biosafety and biosecurity by offering training to ensure the suitability of personnel who may have access to agents. Refresher courses are organized annually or whenever a new agent that requires different handling is introduced. The DEID safety department is headed by a thoroughly trained safety officer, assisted by personnel from four different laboratories; Malaria, VHF, Human influenza and Enterics. The program is also further supported by the QA/QC and the Regulatory Affairs departments.

Training offered by this department ensures that all staff handling dangerous pathogens and hazardous reagents know all the risk containment protocols.
The QA/QC program provides guidance and support to DEID and other related studies in order to enhance the quality of their output. Efficiency in research activities revolves around an elaborate and effective Quality Assurance and Quality Control System. The DEID QA/QC program has set standards and has been working towards improving the standards in all the main laboratories and the satellite laboratories while ensuring standards compliance. To attain and measure the level of compliance we undertake continuous trainings, routine inspections and SOPs review just to mention a few. Quality assurance quality control is a continuous process that starts with setting systems to fit the desired quality standards with continuous improvement. Regulatory document control has been a major challenge in the past years due to the lack of a proper archiving system for the DEID regulatory records (regulatory files and protocol(s) related patients’ records). But this is no longer a challenge, since April 2010 all the DEID regulatory records were moved into an archive. The program is headed by the DEID QA/QC officer who is assisted by QA/QC officer(s) in each of the DEID departments.

D. KENYA STUDENTS INTERNSHIP PROGRAM

A critical part of our capacity building mandate, the DEID attachment program was initiated in 2002. The program provides laboratory placement, practicum, internship and other forms of professional, industrial or vocational experience. The program is designed to provide undergraduates, diploma students and volunteers with educational training and research experiences to strengthen their knowledge and skills and deepen their commitment to pursue careers in medical research. Most importantly it is a way for USAMRU-K DEID to promote the transfer of scientific knowledge and technology to host country nationals. While on placement, students are also trained on occupational health & safety, quality assurance and control and privacy legislation requirements. Student progress is systematically monitored. Since December 2006 a total of 75 interns have passed through the program. The majority of our trainees successfully completed their rotations and are now gainfully employed or in postgraduate studies. The quality of the program can be attested by the high number of applications, which averages 180 annually. Our ultimate vision is to open the program to DEID partner countries and eventually turn it into a Tropical Medicine training program for students worldwide.
06. LABORATORIES

Taxonomists identifying mosquito species
In response to the 2009 pandemic influenza A H1N1 outbreak, the Kenya Ministry of Public Health and Sanitation began implementing its influenza pandemic preparedness plans in mid May. USAMRU-K DEID officials were consulted on preparedness, diagnostic, and public outreach planning and implementation throughout this time period. On June 29 2009, the first case of pandemic influenza A H1N1 was jointly confirmed in Kenya by the CDC-Kenya and the USAMRU-K DEID influenza program. Together with ministry officials, the WHO, and CDC-Kenya personnel, the DEID Coordinator at USAMRU-K, and the program virologist were co-opted in the planning teams that drew up case definitions, hospital response, communications, laboratory testing algorithms and other preparedness and response issues. In support of these endeavors, other DEID program employees at USAMRU-K were also co-opted in the sensitization and medical education training teams that traveled the country to train 756 healthcare providers on all matters relating to the new pandemic 2009 influenza A H1N1 outbreak. In tandem with its mandate as a regional laboratory, the National Influenza Centre (NIC) under significant management by DEID USAMRU-K, also served as the reference and diagnostic laboratory for pandemic influenza diagnosis for the republics of Seychelles and Somalia. Within three months of its introduction into Kenya, pandemic influenza A (H1N1) virus spread to many parts of the country. In the first three months of the pandemic outbreak, 1439 samples were sent to the NIC from diverse parts of the country for diagnostic testing for the presence of the novel 2009 pandemic influenza A H1N1. Out of these, 233 samples (16%) tested positive for the novel 2009 pandemic influenza A H1N1 strain. Ninety nine (99) samples from suspected pandemic influenza A H1N1 cases were sent from the Republic of Seychelles to the Kenyan NIC between May and 10th October 2009. Close to one half (46%) of these specimens tested positive for influenza.
THE ARBOVIROLOGY/VIRAL HEMORRHAGIC FEVER (VHF) LABORATORY

The laboratory housed in the Centre for Virus Research, the Kenya Medical Research Institute (KEMRI) is headed by Dr. Rosemary Sang (MSc. Medical Virology, PhD Medical Entomology) and managed by Lillian Musila (BSc. Microbiology, PhD Molecular Parasitology). The laboratory has the capacity to perform: ELISAs, virus cultures in various cell lines, animal inoculations, plaque assays, immuno-fluorescence assays, conventional and real-time PCR, vector competence tests, arthropod vector sampling and identification, mosquito rearing and outbreak response. The laboratory is mandated to provide support for public health action and response in respect to arbovirus and hemorrhagic fever virus emergencies. We conduct surveillance to monitor arbovirus infections and/or transmission in diverse human and vector populations at sites in Kenya. These are selected on the basis of past documented outbreaks and incidence of disease and other vulnerability factors towards understanding their epidemiology and developing diagnostics and control strategies. In addition, we participate in outbreak investigation and response supporting activities both in Kenya and the East African region. We perform vector competency studies to evaluate the vector efficiency of mosquito species found harboring arboviruses. We act on request from the Kenyan Ministry of Public Health and Sanitation and the WHO being a member of the WHO Global Outbreak Alert and Response Network (GOARN) mandated to investigate or respond to outbreaks of arboviruses. The laboratory supports research programs focusing on arbovirus epidemiology, diagnostics and disease control. The ongoing activities in the laboratory are supported largely by USAMRU – K. The lab participates in the DEID-funded Acute Febrile Project to detect...
The laboratory supports research programs focusing on arbovirus epidemiology, diagnostics and disease control.
USAMRU-K DEID has continued to build Kenya’s infrastructure for disease surveillance and response through various strategic collaborations.
DEID continues to be closely involved in several national cooperation and capacity building initiatives. All DEID surveillance activities are carried out at public, government facilities and select KDoD facilities. Collaboration, cooperation and capacity building with the Kenyan Ministry of Health and the KDoD are therefore crucial in moving these activities forward. DEID capacity building activities at the Ministry of Health has involved the refurbishment of rooms in the various health facilities where we operate, provision of generators for power back ups, equipment and medicine donations. More importantly, DEID is involved in the training of the Kenyan Ministry of Health staff from the various surveillance sites in Malaria Diagnosis. DEID fully sponsors the Ministry’s Lab Technologists and Technicians to the USAMRU-K/KEMRI Malaria Diagnostics Centre of Excellence (MD-CoE). The MD-CoE was established by USAMRU-K in 2003 to conduct malaria microscopy training. The center was set up out of the realization that though light microscopy remains the gold standard for malaria diagnosis in both clinical and research settings it is however, an imperfect gold standard. The technique has inherent diagnostic errors such as false negatives and false positives, inaccurate species identification and parasite quantification. These errors are attributed to lack of highly skilled malaria microscopists. To improve their competency and strengthen microscopic diagnosis of malaria, these local MoPHS staff undergo a standardized skill based training and assessment program at the center with the aim of improving malaria diagnosis in clinical settings through quality training. Part of the course outline includes; the Clinical presentation of malaria and practical sessions on; Parasite detection and quantification, Species differentiation, Stains and buffer preparation, Malaria blood film preparation and staining, Equipment care and maintenance, Rapid diagnostics tests for malaria, Quality control and quality assurance. After the training the staff are assessed both by written and practical tests with a certificate awarded on course completion. The trained staff become resource persons in their respective health facilities where they pass on the learnt skills. The certificate awarded by the MD-CoE is also hoped to help the staff with their career progression. DEID is also involved in numerous capacity building activities at the Kenyan Ministry of Livestock Development through various programs like the Avian flu surveillance; the Influenza Virus Surveillance program in Migratory Birds and the Arbovirology Laboratory. DEID has sponsored - staff from this Ministry for specialized training in the United States and also in the local DEID laboratories. It is hoped that in time, the capacity built by DEID at the Ministry of Livestock will help the Ministry carry out independent Avian Flu detection/diagnosis. Last but not least, DEID sponsors its local staff through Masters and PhD programs while the GIES student attachment program offers local students a chance to intern or volunteer in the various DEID programs and departments nurturing the next generation of scientists. The student attachment program, which is mainly centered in Nairobi, is bound to expand to the other regions of DEID operations like Kisumu and Kericho.

Collaboration, cooperation and capacity building with the Kenyan Ministry of Health and the KDoD are crucial in moving DEID’s activities forward.
Local Collaborations

gram,” says Ekuttan, “the pandemic at the time we had no surveillance program. However, though the DEID-KDoD is a more recent development, Kenya and the United States have had a long standing military to military cooperation in many different spheres for well over 30 years now including:

- Military training-
- Combat for land sea and air
- Medical services- joint medical evaluation exercises
- Public Health projects; - The PEPFAR- HIV Preventive program
- Malaria prevention

Disease surveillance within the army is important because soldiers present a special population; the vast areas where they operate constantly expose them to physical stress and a lot of unknown diseases: The army’s areas of operation are by design in the arid and semi arid areas, these areas are sparsely populated so that the heavy machinery present a minimal disturbance to people and animals. However, due to budget constraints and competing disease interests, the Kenyan Ministry of Health is unable to put up surveillance in areas with such sparse populations. The army has taken up this responsibility because every eco-geographical zone has its own distinct pathogen profile says Col. Ekuttan, “due to the aridity in these regions, you find that ordinarily rare conditions like Trachoma are very common here.” We study the distribution of these and other common diseases in these regions to understand the burden of disease presented to the soldiers and the local population. Col. Ekuttan elaborates the advantage of army surveillance in such areas, “when we gain knowledge on the preventive measures to effect this, it is beneficial to the civilians in these habitats as these measures are not exclusive to the soldiers but target the region as a whole.” Though reports indicate that respiratory infections and in particular influenza are the most prevalent illnesses in Kenya’s forces Col. Ekuttan explains that, “generally Kenyans undermine the flu problem as it is often confused with the common cold.” He says though that this perception improved somewhat when the H1N1 pandemic flu hit globally, “at KDoD, we had 4 documented cases of H1N1 but at the time we had no surveillance program,” says Ekuttan, “the pandemic was a blessing in disguise as it helped us set the program up faster.” To KDoD’s advantage, at that time, USAMRU-K DEID through the NIC already had an operational countrywide flu surveillance protocol. This protocol was then amended to include the armed forces. Extending the influenza surveillance to the KDoD sites was also made easier because of the existing relationship between USAMRU-K and the KDoD through the PEPFAR HIV program. Of the three public health collaborations with the US Army, the DEID Influenza project which started less than a year ago, comes second only to the HIV prevention program in terms of scope and impact. At the moment, the program covers 2 sites the Kahawa Barracks launched in February 2010 and the Lanet Barracks Nakuru launched in June 2010. “Since the program is still young, we don’t yet know the flu disease burden in the forces for now,” explains Col. Ekuttan, “however the surveillance has enabled the KDoD staff to make diagnosis for flu at these 2 sites.” A total of 5 surveillance sites are anticipated at the KDoD as follows:

**Operational sites:**

i. The Lanet Barracks in Nakuru
ii. Kahawa Barracks in Nairobi

**Sites awaiting a protocol amendment:**

iii. Nanyuki Barracks
iv. Mombasa Barracks
v. Eldoret Barracks

“Such military-military collaborations are beneficial to the US- Army which operates throughout the world. This way, they are able to know what sort of diseases to anticipate in their deployed soldiers making clinical management efficient and effective,” explains Dr. Wallace Bulimo, head virologist at the NIC. Despite this advantage to the United States, Col Ekuttan says, “this collaboration is a win-win proposition for both countries.” He explains, “the US Army has given us drug donations to treat Trachoma, and they have also built capacity for flu diagnosis and surveillance at the KDoD.” In this collaboration, while KDoD avail the site and personnel for diagnosis and sample collection, DEID offers all the other necessary infrastructure including; logistics for sample transportation to the NIC, refrigeration for the reagents and samples and the laboratory analysis of the samples which is carried out at the NIC. DEID has to date trained 15 KDoD clinical officers and laboratory technologists in the 2 operational sites and this number is expected to rise as the other 3 sites become operational. Of the cooperation Col. Ekuttan says, “we envision this as a long term collaboration and though we already have preventive programs going on in Malaria we hope that USAMRU-K DEID can incorporate a new forces malaria research component.” The Colonel explained that at the moment, they have an ongoing mosquito repellent research project since soldiers in the field might not have the time to mount mosquito nets, “however, we would also like to collaborate in malarial clinical management,” he noted. Col. Ekuttan says that he hopes the scope of the collaboration can expand to cover more diseases of the KDoD’s concern like the aforementioned Trachoma, Rift Valley Fever and Leishmaniasis. “We also hope to collaborate on bio-terrorism prevention programs as we have no idea what agents an enemy might use on us- so in that sense we are not at all ready,” he concluded.
USAMRU-K DEID has continued to have a close working relationship with the Ministry of Public Health and Sanitation (MoPHS) under whose auspices we operate. The two collaborate on various fronts. We talked to Dr. Phillip M. Muthoka, the Influenza focal person in the Division of Disease Surveillance and Response at the Ministry to tell us more about this relationship. He explained the partnership as follows: “In any community, wherever you go, you need the good will of the government to be able to operate,” continued Muthoka, “USAMRU-K DEID is working from Government health institutions; they have been given a listening ear by the Kenyan Government without whose blessings this would be impossible.” Dr. Muthoka explains how the cooperation between the two began, “we felt that we had a problem, and USAMRU-K DEID had the expertise to fix it and so we allowed them to participate in activities that are beneficial to our citizenry.” Specifically, Muthoka has been involved in the DEID Influenza surveillance program for the last 4 years now. USAMRU-K DEID has continued to build the country’s infrastructure for surveillance and response activities for instance through its funding of the National Influenza Center and establishing surveillance sites within several Government health facilities with more capacity building going to staff training. Dr. Muthoka heads Kenya’s Influenza Unit, which was set up by the Ministry after the WHO sounded an alarm on a possible flu pandemic in 2003-4. “The Ministry then saw the need to put in place preparedness activities the most important of which was the national surveillance program,” he explains. He says that this was particularly crucial because at the time, the country had no data on influenza at all. “So we came together with a number of partners including DEID and set up the influenza surveillance system,” he says. According to Muthoka the Kenyan Government is happy with this collaboration. “This has been a high impact collaboration, though it was set up just 3-4 years ago, it is already bearing fruit,” he says, “we now know the circulating strains of influenza in the country and we have therefore demonstrated that Influenza is inherent in Africa and not an exotic problem as was earlier perceived; people have now started to realize that influenza is a threat.”He says that this strain identification was important in the response to the last H1N1 Influenza outbreak in the country. “If we had not known the circulating strains here by building the relevant capacity to detect the pandemic strain, we would have been handicapped during this outbreak,” he explains. He says that without collaborations like the one the Government has with USAMRU-K DEID, it is not always easy building such capacities, “though Influenza is a problem which no one seems to understand in most African countries,” he says, “it’s not always easy to expend resources to this because of competing problems like the big three: HIV, Malaria and Tuberculosis.” He says that thanks to DEID, they are now starting to understand the flu patterns in Kenya. “DEID has been very supportive in setting up the surveillance sites in high volume district hospitals across the whole country,” says Muthoka, “just to mention a few; Kisii, Kericho, Alupe, Isiolo, Malindi, Port Reis and Mbagathi here in Nairobi and the recent additions of the military hospitals.” He also added “the Influenza Center which we in this country take pride in has been set up and is being put to good use through DEID support.” He said that the DEID facilitated local outbreak if we need some extra hands; we are grateful for support.” In his opinion, the Muthoka feels that this collaboration will have a lasting influence in Kenya, “the training received by the host country nationals will be asset that will stay here forever.”

“In any community, wherever you go, you need the good will of the government to be able to operate.”

Ms. Fatma Mohamed a lab technologist at Iftin Subdistrict hospital; DEID fully sponsors local MOPHS staff through a comprehensive course in Malaria microscopy
Over the years, DEID has expanded its scope beyond Kenya to Uganda, Tanzania and Cameroon with support from the Henry Jackson among other partners.
**UGANDA**

**A. MAKERERE UNIVERSITY WALTER REED PROJECT (MUWRP)**

MUWRP is USAMRU-K DEID’s partner in Uganda in the regional Influenza Surveillance Program. Initiated by two surveillance sites in 2006, MUWRP is currently conducting influenza surveillance in 11 hospital-based sentinel sites and it has now become an integral part of the Ugandan Public Health structure. Through AFHSC-GEIS funding, MUWRP renovated and equipped two BSL 2 laboratories at the Makerere University School of Veterinary Medicine and the Uganda Virus Research Institute in 2008 and 2009 respectively.

MUWRP was involved in the 2009 pandemic H1N1 outbreaks response. Uganda reported its first index laboratory confirmed case of the pandemic flu strain on July 1st 2009, and the number of these cases has since risen to over 200. As part of the Public Health community, MUWRP officials were consulted on preparedness, diagnostic, and public outreach planning and implementation throughout this time period.

MUWRP continues to jointly support investigations at Live Bird Markets (LBM) and in Swine with the National Influenza Centre for Human and Non-Human Routine Surveillance. MUWRP also identified waterfowl sites for surveillance with samples being collected from waterfowl roosting sites during migration periods. A maximum of 25 samples are collected from each of these sites weekly and tested with real-time PCR for influenza viruses.

Our activity has tremendously improved the turn-around time for timely response by all partners. Efforts are being made to further improve the use of environmental sampling for the waterfowl surveillance. Sample types collected include environmental samples (fecal excreta) from waterfowl, cloacal, and oropharyngeal swabs and blood sera from domestic fowls, and blood sera and nasal swabs from pigs/swine. MUWRP is also in the process of starting influenza transmission investigations at the human-animal interface in LBM following IRB approval.

“Through AFHSC-GEIS funding, MUWRP renovated and equipped two BSL 2 laboratories at the Makerere University School of Veterinary Medicine and the Uganda Virus Research Institute in 2008 and 2009 respectively.”

[Image of COL Scott Gordon, Commander USAMRU-K and the Hon. James Kakooza Minister of Primary Health Care; Uganda, MURWP laboratory Dedication August 2009 - Entebbe, Uganda.]
The GVF laboratory in Yaoundé is an AFHSC-GEIS funded BSL 2 laboratory inaugurated and operational since 2009. Thanks mainly to AFHSC-GEIS support and in collaboration with the UoB LEID, GVF undertakes Influenza Surveillance in the French Speaking regions of Cameroon, by partnering and working closely with the MoH and the NIC. GVF has become an important part of the Cameroonian public health infrastructure. GVF has been undertaking public health surveillance and research activities in Cameroon since 2000. It has implemented more than 15 protocols from which about 40 publications have emerged. GVF operates in collaboration with the Ministry of Public Health and Ministry of Scientific Research and Innovation, both of which have signed MOUs with GVF. GVF also works in collaboration with the Ministry of Defense, Ministry of Forestry and Wildlife and Ministry of Livestock, Fisheries and Animal Husbandry and MOUs with those are being finalized. In 2003, GVF expanded its activities throughout the Central African Sub region with the objective of supporting the armies of 8 countries in the sub region in their HIV-AIDS prevention programs. This network is now being capitalized upon to tackle influenza and other emerging infectious diseases. GVF and partners funded and helped organize a sub regional conference of Central African military health services in Yaoundé in July 2010 with military and public health officials from Cameroon, Congo, DRC, Chad, CAR, Gabon, Sao Tome and Principe and Equatorial Guinea. Capacity building has been one of the goals of GVF in Central Africa. Niete in the South Region (clinical BSL 2 facility) and a laboratory for emerging Infectious diseases has been developed and equipped at the Military Health Research Centre in Yaoundé, Cameroon where GVF has its regional headquarters. The laboratory is a BSL2 lab with human and animal sample processing, testing and

A. GLOBAL VIRAL FORECASTING (GVF)

Some of the current projects of GVF include:
- Surveillance for cross-species transmission and establishment of novel human retroviruses.
- Ecological networks and microbial emergence: looking at microbial fauna of birds, bats, primates, rodents and other animals.
- HIV Surveillance and Prevention: including HIV screening in Central African military, rubber plantation workers and other rural residents.
- Healthy Hunting Education: GVF undertakes prevention activities with high-risk communities such as people exposed to wild animals through hunting and butchering.

Thanks mainly to AFHSC-GEIS support and in collaboration with the UoB LEID, GVF undertakes Influenza Surveillance in the French Speaking regions of Cameroon.

In Cameroon, bushmeat is an important source of food. © GVF Cameroon

A GVF employee sorting samples © GVF Cameroon
Dedication ceremony, GVF Laboratory November 2009; Yaoundé Cameroon.

Capt. Kevin Russell, Director GEIS; Deputy Director, AFHSC signing the visitors log at the GVF laboratory inauguration.

GVF Laboratory tour at the dedication ceremony; November 2009, Yaoundé, Cameroon.
B. THE LABORATORY FOR EMERGING INFECTIOUS DISEASES (LEID)
UNIVERSITY OF BUEA, CAMEROON

Funded by AFHSC-GEIS and inaugurated in November 2009, the Laboratory for Emerging Infectious Diseases (LEID) at the University of Buea is located in the South West Region of Cameroon. This BSL-2+ facility conducts surveillance for influenza and influenza-like illnesses with the capacity to detect other emerging infectious diseases. The facility includes a dedicated laboratory space for sample reception, a QA-QC area, molecular/main laboratory a PCR/Dark room, clean cell/tissue culture room, a virus isolation lab and electrophoresis area in addition to an office space and a conference room. In line with the AFHSC-GEIS mission, the activities of LEID and its influenza surveillance program provide surveillance for early detection of global disease threats and making it possible to efficiently respond to these threats. The LEID team has educational backgrounds in the biological sciences at the B.Sc., M.Sc., and Ph.D levels. Collectively, researchers have education and experience in biology; epidemiology; tissue culture; molecular biology, basic genetics and biostatistics analytic tools and development of SOPs. In its relatively short existence, the LEID has become an integral part of the Cameroonian public health infrastructure by working with and closely collaborating with the NIC, the Ministry of health and other important stakeholders.

The activities of LEID and its influenza surveillance program provide surveillance for early detection of global disease threats.
Dedication ceremony, Laboratory for Emerging Infectious Diseases (LEID) University of Buea November 2009, Buea, Cameroon

Inauguration ceremony for the Laboratory for Emerging Infectious Diseases (LEID) University of Buea November 2009, Buea, Cameroon

The Laboratory for Emerging Infectious Diseases (LEID) University of Buea Cameroon.
TANZANIA

A. TANZANIA PEOPLE’S DEFENSE FORCE (TPDF)-DEID PROGRAM

Global influenza surveillance to detect influenza viral shifts must be reliably undertaken to protect the public’s health: Surveillance data enables health services to anticipate outbreaks early and respond in a timely manner. Before the US Department of Defense Global Emerging Infections System (DoD–GEIS) started the influenza surveillance and response capabilities in Tanzania, the country, like most others in Sub-Saharan Africa, lacked laboratories and the public health infrastructure to consistently conduct reliable, sustained influenza surveillance. The Walter Reed Army Institute of Research (WRAIR) had before this initiative assisted the Tanzanian Military, the Tanzania People’s Defense Force (TPDF) in its battle to fight HIV/AIDS since 2004 by implementing prevention efforts and care and treatment with Anti-Retrovirals through the PEPFAR program. Therefore, the DoD–DEID influenza program which officially became operational in 2009 was built from an already existing fruitful collaboration between TPDF and WRAIR. Laboratory equipment worth $200,000 was purchased to start up the Tanzanian NIC, which also got supplemental technical staff. Surveillance sites were initiated at eight TPDF hospitals, which serve TPDF personnel as well as the surrounding communities. In the surveillance, nasopharyngeal samples are taken from individuals two months and older who present to the participating outpatient TPDF clinics with acute upper respiratory symptoms. Cases are identified at the TPDF hospitals by trained TPDF clinicians. Samples are stored in liquid nitrogen and delivered to the National Influenza Center once a week.

With the assistance of DoD–GEIS and the CDC, Tanzania’s new NIC has become a robust member of the WHO’s Global Influenza Surveillance Network and an important national asset in the response to the threat of Pandemic Influenza. In early 2009 during the H1N1 pandemic though the program was at its conception stage, it was nevertheless able to support the Tanzania public health system in preparedness and response to the pandemic H1N1 virus. The response efforts were coordinated by the Tanzania Ministry of Health and Social Welfare (MoHSW); the DEID project manager and the Principal Investigator were co-opted to participate in the Health sector technical/expert committee for preparedness and response for pandemic influenza in the country. They became members of a national multi-sectoral expert group where each participating institution contributed efforts according to their resources and expertise. The team met weekly to advise the MOHSW on various measures to respond to the pandemic. In this period, DEID augmented the diagnostic capacity for influenza at the National Influenza Centre where all samples were being tested by:

- Providing extra human resource to the lab which was overwhelmed by the many samples to be tested. The DEID PI Dr. Gerald Misinzo and co-PI, LT Daudi Kadigi, offered technical support to the NIC technical and laboratory staff. This assistance continued through December 2009.
- Provided laboratory supplies worth ~$27,000 a significant portion of the ~$100,000 of the initial DEID laboratory consumables, these were donated to the NIC to support the testing for the H1N1 pandemic samples. The Tanzanian DEID influenza program has had many advantages including: an improved cooperation between the Tanzania People’s Defense Forces Medical Services and the TMOHSW, which will increase Tanzania’s capacity to respond to future public health emergencies; Capacity building of TPDF laboratory personnel, the staff

The NIC Building in Tanzania.
undertake a six month training rotations at the NIC under DoD–GEIS expertise and this will further develop the scientific capacity of the TPDF. Finally, the development of TPDF laboratory assets at Lugalo Infectious Disease Laboratory and field epidemiology training will increase the TPDF’s capacity to respond to public health emergencies.

The Tanzania DEID Influenza program was built from an already existing fruitful relationship between TPDF and WRAIR.

THE HENRY JACKSON FOUNDATION FOR THE ADVANCEMENT OF MILITARY MEDICINE

The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., (HJF) is a private, not-for-profit organization authorized by Congress to support research at the Uniformed Services University of the Health Sciences and throughout military medicine. Since 1983, the Foundation has served as a vital link between the military medical community and federal and private partners. As a dynamic organization committed to meeting the diverse needs of the military medical community, HJF’s research support and administration capabilities allow military medical researchers and clinicians to maintain their scientific focus and to accomplish their goals in a quick and cost-effective manner. The Foundation’s more than 2,200 employees are deployed to more than 100 locations in 12 countries. Nearly 90 percent of HJF employees work side by side with military medical researchers in the field. In addition to research administration, HJF provides grant and contract management, program management, clinical trials support, education and meeting support, and technology transfer services.

HJF’s research support and administration capabilities allow military medical researchers and clinicians to maintain their scientific focus.
09. Q&A WITH USAMRU-K DEID’ LONGEST SERVING STAFFER Mr. CHARLES MAGIRI

Charles Magiri coordinating avian influenza surveillance at an LBM
Q: How long you have been part of DEID and KEMRI?
A: I joined KEMRI in 1981 as a Medical Laboratory Technologist and was seconded to WRP to work on a trypanosomiasis surveillance study in the early 80s under the late Dr. Bruce T. Wellde. I have continued to work for both KEMRI and WRP to date.

Q: What do you enjoy most about your work?
A: I enjoy interacting with people; my job allows me to interact with patients and the communities while in the field. I have also gained broad work experience and it is gratifying to work and share this experience with the young scientists that come on board. Five staff members in my lab today are now research officers; it is very fulfilling to be a part of their development. Last but not least, there is a great team spirit at USAMRU-K- DEID for whom I now work.

Q: Could you expound a little on the different projects you have worked on at USAMRU-K?
A: I have worked on many projects given the duration I have worked here, however my top three projects would be:

i. Between 2000-2001, I was involved in a USAMRU-K HIV study under Dr. Carl Mason that sought to identify the circulating HIV serotypes in truck drivers operating along the Trans-African Highway. We studied HIV positive blood that had been rejected for transfusion from blood banks in 6 facilities along the highway in Mombasa, Nakuru, Kericho, Kisumu, and Kisii, the Kenyatta National Hospital represented Nairobi. We were able to characterize several HIV serotypes in this HIV high-risk group whom we identified by the occupation entry on the blood samples. These serotypes were used to design targeted ARV treatment and for identification of vaccine targets.

ii. Between 2008- 2009, I worked on a DEID protocol with Dr. John Wairimu on the surveillance of zoonotic Rickettsia infections in domestic animals in different slaughterhouses in Kenya. Not only did the study manage to recruit 95% of its calculated sample size, we also managed to identify Rickettsiosis hot spots around the country. This study was fascinating as it was novel in the country; in the past we had lost some tourists who were visiting these areas due to disease misdiagnosis while one tourist was diagnosed with a Rickettsia infection in Japan. The fact that we were able to prove the existence of Rickettsia in these places will in future make patient management timelier.

iii. Finally, from 2006, I was a PI of an immunology project that was partially USAMRU-K funded targeting Leishmaniasis, which is also my MSc project. I investigated the coinfection of Leishmania donovani and Plasmodium berghei in BALB/c Mice and the effect of the Leishmania parasite secretions on Plasmodium falciparum. I was interested in this investigation because of the curious observation that patients suffering from Visceral Leishmaniasis do not contract Malaria unless the VL clears. I have been able to show that the Leishmania parasites secrete products that interfere with the cell adhesion of the Malaria parasites which affects their cell entry and infection. I am currently working on several manuscripts for this work.

Q: How many protocols have you written that have gone on to the implementation stage?
A: Thanks to DEID I have now written three protocols, before it was unheard of for laboratory technicians to write up studies.

Q: What do you feel has been your greatest achievement at DEID?
A: This has been in the research on Leishmaniasis clinical management, which was especially high impact because Leishmaniasis is a neglected disease. I am glad to have made a contribution through USAMRU-K and DEID funding. Some of the highlights in this area were:

i. Being part of a team that came up with a treatment regimen for visceral Leishmaniasis at KEMRI, as a result, today we rarely lose a patient to the disease due to proper patient management and ii. I also supervised the team that came up with guidelines for the diagnosis of VL in Kenya a document that is already in use.

Q: What was your thought on this year’s DEID annual retreat by the way?
A: It was great but I wish it could be expanded so that everyone affiliated with USAMRU-K DEID can be part of the event.

Charles Magiri is a married, proud father of five.
Participants at the 4th Annual USAMRU-K DEID retreat at Watamu, Malindi.
The DEID Program has held annual meetings since 2002. These were initially meant to train staff on Epidemiology, Safety, Quality Assurance/Control and other areas in line with the DEID mission and active research protocols. In June 2002, DEID, under the leadership of Dr. Rodney Coldren held an outbreak investigation course at the Panafric Hotel, Nairobi facilitated by trainers from the USUHS (Uniformed Services University of Health Sciences, USA). In attendance were key personnel involved in DEID studies and KEMRI scientists. The next meeting was held in 2004 at the Silver Springs Hotel, Nairobi with 31 participants from the VHF (Viral Hemorrhagic Fever), Enterics (Centre for Microbiology Research – CMR) Laboratories, field surveillance staff. In 2005, 17 GEIS participants congregated in Kisumu for Malaria microscopy training facilitated by the Malaria Diagnostics and Control Center of Excellence, USAMRU-K. Beginning 2007, under the leadership of Dr. Schnabel, four annual conferences have been conducted with the modest goal of bringing all laboratory and field personnel together in one location to exchange ideas. The conferences are also a great event for building a strong, cohesive team through team building activities outside of the work environment. This event has also become an ideal venue to conduct our yearly safety training with a major achievement in the 2010 conference being IATA training certification for all attendees. As with any beginning, the 1st retreat was a modest event of less than 50 participants. In 2010, the event had more than 110 participants including, Kenyan DEID staff and DEID partners from Cameroon, Uganda, Tanzania. In addition, senior officers from the HJF were also in attendance.

Under the leadership of Dr. Schnabel, four annual conferences have been conducted with the modest goal of bringing all laboratory and field personnel together in one location to exchange ideas.
“The DEID retreat was very different from our CMES (Continuous Medical Educational Seminars); it was designed to incorporate field activities and discussion groups making it very interactive, it was a very wholesome experience!”

Dr. Eyako Kofi Wurapa
Director, DEID- Kenya

“Loved the retreat, a great opportunity to get to know the extended DEID Family and share scientific work with each other”

Hassan Abdi; Lab Technologist
AFI, Iftin Sub District
Hospital NEP

“This is a great initiative organized in a wonderful setting. Not sure a participant could talk to everyone present but the organization was appropriate and provided excellent opportunities for meeting and learning from most of them.”

Cyrille Djoko, GVF Cameroon

“I had the opportunity to get to know the people I’m working with better and from a different angle and put faces to names I often only know by email. It’s a great opportunity to share knowledge and experiences and a definite must.”

Griet Kenis: HJFMRI
Cameroon Program Manager

“Before the AFI surveillance was introduced, we assumed all febrile patients had Malaria; after the retreat, we now know that there are many emerging diseases some of which are difficult to diagnose in our basic laboratories so the retreat was a great learning experience.”

Ahmed Noor: AFI Clinical Officer;
Iftin Sub District Hospital NEP
USAMRU-K DEID: Some of the challenges faced to make a difference in public health
11. PUBLICATIONS


12. COLLABORATORS AND PARTNERS’ WEBSITES

i. www.afhsc.mil
ii. www.afhsc.mil/geis
iii. www.kemri.org
iv. www.wrair.mil
v. www.usamrukenya.org
vi. www.muwrp.org
vii. www.gvfi.org
viii. www.usafsam.mil
ix. www.hfj.org
x. www.leid.org
xi. www.usafsam.mil
xii. www.ubuea.net
xiv. www.cdc.gov

9. PRESENTATIONS BY DEID TEAM IN 2010

A. INTERNATIONAL CONFERENCES

1. Joel Lutomiah presented a talk entitled “Distribution and Diversity of Important Mosquito Vectors of Known Arboviruses in Selected Regions of Kenya as an Indicator of Arbovirus Disease Risk” 2010 International Conference on Emerging Infectious Diseases (ICEID) in Atlanta, Georgia, USA, July 11 - 14, 2010

2. Dr Rosemary Sang presented a poster entitled “Surveillance Reveals Circulation of Crimean Congo Hemorrhagic Fever virus among Hyalomma Tick Species in Northern Kenya” 2010 International Conference on Emerging Infectious Diseases (ICEID) in Atlanta, Georgia, USA, July 11 - 14, 2010

3. Seeking Answers to High Failure Rate of Malaria RDTs at the “Parasite to Prevention: Advances in understanding Malaria, Edinburg 20-22 October 2010” by John Waitumbi, Nancy Nyakoke, Linda Muringo, Ismail Mahat, Moses Otiende

4. Spatial Analysis of Pediatric Malaria at the “American Society of Tropical Medicine and Hygiene, Atlanta 2-7 November 2010” by Peter Sifuna, Caroliney Tunguony and John Waitumbi

5. The Africa Flu alliance conference held in Marrakech Morocco June 3rd - 4th 2010.


7. Peter Sifuna presented: Values of cartographic mapping in setting up a HDDS: A KWHDDS Experience at the INDEPTH ((The International Network for the Demographic Evaluation of Populations and Their Health in Developing Countries) 10th AGM, 27th-30th September, Accra, Ghana. INDEPTH is an international organization that coordinates all health and demographic surveillance systems worldwide. It currently consists of 35 health and demographic surveillance system (HDDS) sites in 18 countries in Africa, Asia and Oceania http://www.indepth-network.org/.

B. LOCAL PRESENTATIONS AT THE 4TH ANNUAL DEID RETREAT IN MALINDI JULY 2010


4. Djoko C. F. GVFI/DEID EID Laboratory. GVFI Activities in Cameroon.


18. Wangui J., DEID QA/QC officer. DEID QA/QC Program.


C. AT THE CENTER FOR VIRUS RESEARCH

1. Joycelyn Njuguna presented a talk on “Freezerworks” the new freezer inventory system, March 18th 2010

2. Esther Odanga a student of the Kenya Polytechnic completed a project on the use of plaque assays for the detection and quantification of various arboviruses and presented her work on March 26th

3. Wasonga presented her proposal for her PhD entitled “Development of replenishable ELISA reagents for the detection of Chikungunya”

4. David Omondi presented his master’s project work which involves determining host preferences of mosquitoes which are RVF vectors August 12th.

10. PROGRAM SPECIFIC TRAININGS FOR DEID MEMBERS IN 2010

VHF LABORATORY:

i. Members of staff participated in a safety training sponsored by the centers for disease control (CDC) and Walter Reed as trainers (Sam Limbaso and Victor Ofuala) and participants (Betty Chelagat on 26- 28th June 2010.

ii. Two members of the DEID partner laboratories in Cameroon, Joseph Namanga Monoda, (Laboratory for Emerging Infectious diseases-LEID) and Webnda Nkwenchi (Global Viral forecasting initiative -GVF) were trained in the VHF laboratory on conventional PCR and ELISA methods for the detection of Yellow fever(YF) from July 5- 9th 2010 to build capacity for YF outbreak response following outbreaks in Cameroon in the past months.

iii. Dr Sang, Victor Ofuala and Albina Makio attended the 1st AFRICAN BIOLOGICAL SAFETY ASSOCIATION biological safety pre-conference courses and conference March 8-12th 2010 at the KEMRI Training Center. Some of the topics covered were Emergency responses, Occupational health and safety, Respiratory protection and PPE, Quality systems and leadership in Biorisk management and the Road to laboratory certification.

HOA PROGRAM:

i. Elizabeth Kioko, Gladys Kerich and Nicholas Odemba went to Egypt NAMRU 3 vector biology labs for sand fly training. The trip was very successful and we achieved the following: -

• Improve sand fly identification skills for the species of this region and acquire skills on sand fly specimen preservation- making permanent slide mounts

• Learn more on the molecular aspects of testing leishmania in sand flies

• Insecticide resistance testing in sand flies

• Possible collaboration for the possibility of making a more current Sandfly Identification key for Kenya

SAFETY PROGRAM:

i. In February 2010, Mr. Bonaventure Juma, of the DEID safety department attended a training in Australia on high-level containment systems in Biosafety Levels 3 and 4 where he was certified on working in these two levels and biorisk management.

ii. In June 2010, Mr. Juma also went to Johannesburg South Africa to train on Biosecurity, Occupational Health and certification as Trainer of trainers in Packaging and shipping of dangerous goods.

KWDHSS PROJECT TRAINING:

i. Mr. Peter Sifuna and Ms. Mary Oyugi attended a PDA programming training organized by the center for disease control (CDC) in Kisumu, 4-5 February 2010

ii. Mr. Peter Sifuna KWDHSS, attended a Geographic Information System (GIS) Capacity building course, 10-12 March, 2010 in Nairobi and

iii. Mr. Peter Sifuna attended an advanced research methodology training sponsored by the university of Washington (UW) on, 16-20 August 2010 at the University of Nairobi.
ACRONYMS AND ABBREVIATIONS

1. AFHSC Armed Forces Health Surveillance Center
2. AFI Acute Febrile Illness
3. AI-PI Avian Influenza – Pandemic Influenza
4. CCHFV Crimean Congo Hemorrhagic Fever Virus
5. CDC Center for Disease Control and Prevention
6. DEID Department of Emerging Infectious Diseases
7. DoD Department of Defense
8. kDoD Kenyan Department of Defense
9. LEID Laboratory for Emerging Infectious Diseases
10. AR Antimicrobial Resistance
11. CL Cutaneous Leishmaniasis
12. CME Continuous Medical Education
13. CNHR Consortium for National Health Research
14. CPE Cytopathic Effect
15. CRCs Clinical Research Coordinators
16. CRT Chloroquine Transporter
17. DEID Department of Emerging Infectious Diseases.
18. DHFR Dihydrofolate Reductase
19. DMSS Defense Medical Surveillance System
20. DoDSR Department of Defense Serum Repository
21. DPHS Dihydropteroate synthetase
22. DVS Department of Veterinary Services
23. EID Emerging Infectious Diseases
24. ELISA Enzyme-linked-immunosorbent serologic assay
25. FVBI Febrile and Vector-borne Infection
26. GCP Good Clinical Practice
27. GDP Global Disease Detection Program
28. GEIS Global Emerging Infectious Diseases Systems
29. GI Gastrointestinal Infection
30. GOARN Global Outbreak Alert and Response Network
31. GPS Global Positioning System
32. GTMR Greater Than Minimal Risk
33. GVF Global Viral Forecasting
34. HADCO Health Africa Development Cooperation Organization
35. HDSS Health Demographics Surveillance System
36. HFRS Hemorrhagic Fever with Renal Syndrome
37. HIMS Health Information Management System
38. HIV Human Immunodeficiency Virus
39. HF The Henry Jackson Foundation
40. HOA Horn of Africa
41. HPS Hantavirus Pulmonary Syndrome
42. IATA International Air Transport Association
43. ICAO International Civil Aviation Organization
44. ICEID International Conference on Emerging Infectious Diseases
45. ICIP International Centre of Insect Physiology and Ecology
46. ILI Influenza Like Illness
47. ILRI International Livestock Research Institute
48. INDEPTH The International Network for the Demographic Evaluation of Populations and Their Health in Developing Countries
49. IQC Internal Quality Control
50. IRB Internal Review Board
51. JKMU Jomo Kenyatta University of Agriculture and Technology
52. KEMRI Kenya Medical Research Institute
53. KMoPHS Kenya Ministry of Public Health and Sanitation
54. KNH Kenyatta National Hospital - Nairobi
55. KWHDS KISumu West Health and Demographic Surveillance System
56. KWS Kenya Wildlife Service
57. LBK Live Bird Market
58. LCMV Lymphatic Choriomeningitis Virus
59. LEID Laboratory for Emerging Infectious Diseases
60. LPAI Low Pathogenic Avian Influenza Virus
61. LRRRI Lovelace Respiratory Research Institute
62. MDCOE Malaria Diagnostics Center of Excellence
63. MDR Multi Drug Resistance
64. MHK Microbiology Hub Kenya
65. MHS Military Health System
66. MoH Ministry of Health
67. MoPH Ministry of Public Health
68. MoPHS Ministry of Public Health and Sanitation
69. MoU Memorandum of Understanding
70. MR Minimal Risk
71. MTA Material Transfer Agreement
72. MUWRP Makerere University Walter Reed Project
73. NAMRU-3 Naval Medical Research Unit - 3
74. NEP North Eastern Province – Kenya
75. NHRC Naval Health Research Center
76. NIAID National Institute of Allergy and Infectious Diseases.
77. NIC National Influenza Center
78. NMK National Museums of Kenya
79. NMRC Naval Medical Research Center
80. PCR Polymerase Chain Reaction
81. PDA Personal Digital Assistant
82. PEPFAR President’s Emergency Plan for AIDS Relief
83. PPE Personal Protective Equipment
84. QA Quality Assurance
85. QC Quality Control
86. RA Regulatory Affairs
87. RBV Rodent Borne Virus
88. RCDM Royal Center for Defense Medicine
89. RRI Respiratory Infection
90. RT-PCR Reverse Transcriptase-Polymerase Chain Reaction
91. SOP Standard Operating Procedure
92. SSP Study Specific Procedure
93. STI Sexually Transmitted Infection
94. TPDF Tanzania People’s Defense Force
95. UoB University of Buea
96. UoN University of Nairobi
97. USAFSAM US Air Force School of Aerospace Medicine
98. USAMRIID United States Army Medical Research
department
99. USAMRU-K US Army Medical Research Unit-Kenya
100. USDA United States Department of Agriculture
101. UTMB University of Texas Medical Branch
102. UVRI Uganda Virus Research Institute
103. UVRI Uganda Virus Research Institute
104. VHF Viral Hemorrhagic Fever
105. VL Visceral Leishmaniasis
106. WHO World Health Organization
107. WRAIR Walter Reed Army Institute of Research
108. WRP Walter Reed Project
109. YF Yellow Fever
Appendix 1: Kenya National Cause of Outpatient Morbidity 2001-2009

In Kenya, Malaria remains the leading cause of outpatient morbidity. Most of the malaria cases are diagnosed clinically and hence the Inaccuracy in its diagnosis. The second leading cause of outpatient morbidity is respiratory system diseases.

Source HIMS, KMoH 2009 Annual Report

Appendix 2: National Health facilities Distribution

NEP has the least number of facilities among all Kenyan provinces, however, geographical inaccess to the few facilities available stems from a facility mal-distribution rather than actual numbers. Special feature > P. 22

Source HIMS, KMoH 2009 Annual Report
1st DEID Retreat
Venue: Mnarani, Kilifi
Date: 22nd- 28th July 2007
Participants: 51

2nd DEID Retreat
Venue: Bogoria Spa Resort
Date: 20th- 27th July 2008
Participants: 82

3rd DEID Retreat
Venue: Voi Wildlife Lodge
Date: 5th - 11th July 2009
Participants: 98
4th DEID Retreat Venue: Turtle Bay Watamu
Date: 25th - 31st July 2010 Participants: > 100

DEID PROFILE CREDITS

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