Global Disease Detection—Achievements in Applied Public Health Research, Capacity Building, and Public Health Diplomacy, 2001–2016

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The Centers for Disease Control and Prevention has established 10 Global Disease Detection (GDD) Program regional centers around the world that serve as centers of excellence for public health research on emerging and reemerging infectious diseases. The core activities of the GDD Program focus on applied public health research, surveillance, laboratory, public health informatics, and technical capacity building. During 2015–2016, program staff conducted 205 discrete projects on a range of topics, including acute respiratory illnesses, health systems strengthening, infectious diseases at the human–animal interface, and emerging infectious diseases. Projects incorporated multiple core activities, with technical capacity building being most prevalent. Collaborating with host countries to implement such projects promotes public health diplomacy. The GDD Program continues to work with countries to strengthen core capacities so that emerging diseases can be detected and stopped faster and closer to the source, thereby enhancing global health security.

Infectious disease outbreaks present a serious health threat that requires early detection and effective preventive action to avoid regional or even global spread. Such actions enhance global health security by protecting the health of persons in the affected regions and in the United States. Recent epidemics, including severe acute respiratory syndrome (SARS) during 2002–2003, pandemic influenza A(H1N1) in 2009, Ebola virus disease in 2014, and Zika virus infection during 2015–2016, underscore this risk and highlight the critical need for building core global public health capacity for detection and response.

In 2001, the Centers for Disease Control and Prevention (CDC) established the International Emerging Infections Program (IEIP) to conduct applied public health surveillance and research aimed at preventing infectious disease outbreaks with pandemic potential. IEIP placed CDC staff in key overseas locations to work with national public health institutes and their partners to establish sentinel surveillance and conduct applied research on emerging infectious diseases. The program was modeled after the US-based Emerging Infections Program, a network of state health departments and their partners that conduct surveillance of certain infections and thereby provide a foundation for various epidemiologic studies to explore risk factors, spectrum of disease, and prevention strategies (1). IEIP had a similar objective but on a global platform; namely, to conduct applied public health research in strategic global locations to prevent, detect, and control emerging and re-emerging pathogens.

CDC established the Global Disease Detection (GDD) Program in 2004 by using existing research programs within IEIP as the scientific backbone of its GDD regional centers; this effort was made in response to data gaps identified during the SARS epidemic. The GDD Program mission was to ensure that infectious diseases were detected and stopped at the source before crossing international borders (2). The GDD Program, like IEIP, set up a network of CDC technical experts stationed in GDD regional centers located in multiple countries across the World Health Organization (WHO) regions. GDD regional centers were initially set up in countries with IEIP presence (Thailand, Kenya, Guatemala, Egypt, China, and Kazakhstan). Subsequently, new GDD regional centers were established in Bangladesh, India, South Africa, and Georgia (3). These centers serve as regional resources for neighboring countries and are a framework for improving public health and global health security through close collaboration with local partners. To date, the 10 GDD regional centers have supported ≈90 countries around the world, including the United States (Figure). The GDD regional centers have assisted US domestic public health institutions in response to...
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infectious diseases that affected international visitors while in the United States and US citizens while abroad.

The GDD Program promotes intersectoral public health responses and applied epidemiologic research that include ministries of health and agriculture, academic institutions, other US government programs, and international and nongovernmental organizations. These established and trusted relationships with national governments enable more effective prevention and detection of emerging infectious diseases. The GDD regional centers also provide an in-country infrastructure that enables CDC to respond rapidly to public health threats. A critical strength of the GDD Program is the long-term assignment (i.e., 2–6 years) of epidemiologists, laboratorians, statisticians, and other diverse technical staff at GDD regional centers in host countries. The GDD technical staff work alongside locally hired technical staff to foster close collaboration and bilateral knowledge transfer with host country partners. These strategically placed GDD technical staff can have localized information for early detection of unusual infectious disease events. During public health emergencies, where time lost often equals lives lost, the ability to leverage trusted international public health scientific partnerships is essential for life-saving action. GDD field staff are often a first line of response during an epidemic. During the 2014–2016 West Africa Ebola outbreak, ≈30 GDD field-assigned staff, including US and local personnel, deployed from GDD regional centers to assist with establishing diagnostic, contact tracing, and data analysis capacity. GDD field staff’s experience in international settings was critical to the response and facilitated quick integration into ongoing response and prevention efforts. GDD’s sustained capacity-building efforts enabled these forward-deployed assets to respond quickly not only in their own regions but also across the globe.

Activities and Accomplishments
The core activities of the GDD Program focus on applied public health research, surveillance, laboratory, public health informatics, and technical capacity building. Applied public health research refers to activities that generate data to answer a research question; test a hypothesis; evaluate a program or programmatic element (e.g., a public health practice, a surveillance system, data quality); or provide information for evidence-based decision making. Surveillance refers to activities that collect health-related data in a systematic manner over time to inform public health action. Laboratory refers to activities that collect specimens for laboratory analyses. Informatics refers to any activity that collects and aggregates data (paper-based or electronic) that could be used for further analysis. Capacity building refers to activities that increase the skills, infrastructure, or resources of individuals or partnering organizations. Current GDD Program projects incorporate multiple core activities, with technical capacity building, laboratory, and public health research being most common (Table 1). These activities are essential for the identification of new health threats, monitoring and tracking of health threats over time, and for conducting applied research and pathogen discovery. At times, regional centers
might conduct studies of noninfectious causes of illnesses because it is not always clear whether the etiologic agent is a pathogen, a toxin, or some other cause at the beginning of an outbreak (4,5). The GDD Program also provides a robust framework for public health diplomacy and the development and implementation of coordinated multisite activities and studies (6).

**GDD by the Numbers**

In 2015, the GDD Program performed a portfolio review of activities in the 10 GDD regional centers for fiscal years 2015 and 2016 (October 1, 2014–September 30, 2016). The unit of analysis was a GDD Program–funded project. Multiyear projects were counted once. Projects were not weighted by the size or scope of a project; thus, a small research study was equivalent to a large, multiyear, population-based-surveillance project. We excluded projects that listed HIV (n = 2) or noncommunicable disease (n = 1) as their primary focus. We classified projects into core activity areas: technical capacity building, surveillance, applied public health research, national public health institutes, and research in special epidemiologic studies. Capacity-building projects (n = 125) were most common (Table 1). We also classified technical projects into topical areas based on the key focus of the project. Topical areas were collated and categorized by major groupings (Table 2). The variability in the range of topical areas was attributable to a combination of factors, including the epidemiology of the disease (nationally and globally); available funding; the technical capacity at the local level; and the changing priorities of the United States and local partners (e.g., ministries of health, national public health institutes, and research institutes). Of 205 projects with a defined topical area, 24% (n = 50) were focused on acute respiratory illness (Table 2), which is expected given that respiratory disease surveillance has been a core function since the inception of the program. Health system strengthening (n = 36), One Health (n = 30), and emerging infectious disease (n = 22) were the next most common topical areas. The increasing prevalence of these new topical areas indicates an expansion of the breadth of projects being conducted by GDD regional centers.

**GDD Core Activities**

**Applied Public Health Research**

The GDD Program has a broad portfolio of applied public health research and special epidemiologic studies, ranging from ensuring infection control practices for Nipah virus in Bangladesh to evaluating antimicrobial drug–resistant invasive salmonellosis in Thailand (Table 3). Conducting applied public health research and epidemiologic studies in international settings can address important knowledge gaps in infectious disease issues. Many of these issues would be difficult to examine in the United States, primarily because of low prevalence of many infectious diseases. International public health research studies contribute to the scientific knowledge base and help answer questions that can influence US public health policy. Examples range from gathering data for the issuance of travel notices to conducting vaccine studies needed to guide domestic vaccination guidelines (7,8).

GDD regional centers work closely with the international partners, often a ministry of health or national public health institute, to identify common areas of research

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Table 1. Number of projects conducted by Global Disease Detection Program regional centers, by activity type and year center was founded, fiscal years 2015 and 2016*  

| Year center founded | Country/region             | No. projects | PHR | S | L | PHI | CB |
|---------------------|----------------------------|--------------|-----|---|---|-----|----|
| 2004†               | Thailand                   | 20           | 8   | 13| 11| 13  | 7  |
| 2004                | Kenya                      | 36           | 12  | 10| 9  | 9   | 19 |
| 2006                | China                      | 14           | 10  | 5 | 8  | 10  | 8  |
| 2006                | Egypt                      | 11           | 3   | 2 | 3  | 3   | 11 |
| 2006                | Guatemala and Central America| 22          | 15  | 11| 14| 15  | 10 |
| 2008                | Kazakhstan and Central Asia| 13           | 3   | 2 | 4  | 2   | 13 |
| 2009                | India                      | 13           | 4   | 4 | 5  | 3   | 13 |
| 2010                | South Africa               | 28           | 9   | 5 | 12 | 5   | 20 |
| 2011‡               | Bangladesh                 | 31           | 22  | 14| 17 | 1   | 11 |
| 2012                | Georgia and South Caucasus | 17           | 6   | 9 | 12 | 11  | 13 |

Total no. projects 205 92 75 95 72 125  

*October 1, 2014–September 30, 2016. Activities do not sum across the rows because activity types are not mutually exclusive. CB, technical capacity building; IEIP, International Emerging Infections Program; L, laboratory; PHI, public health informatics; PHR, applied public health research; S, surveillance.  
†IEIP-Thailand founded in 2001.  
‡IEIP-Bangladesh founded in 2008.
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Table 2. Number of projects conducted by Global Disease Detection Program regional centers, by topical area and activity type assessed, fiscal years 2015 and 2016*

| Topical area                        | Definition                                                                 | No. projects | Activity type* |
|------------------------------------|---------------------------------------------------------------------------|--------------|----------------|
| Acute respiratory illness          | Syndromic surveillance focusing on respiratory pathogens (e.g., influenza, severe acute respiratory infections, pneumonia) | 50           | PHR S L PHI    |
| Health system strengthening        | Incorporating any components of training, guidelines and protocol development, or capacity building to enhance the national disease surveillance system, workforce development, epidemiologic research, or information systems | 36           | 7 2 7 6 34    |
| One Health                         | The intersection of animal and human health, zoonotic diseases, or program development around zoonoses | 30           | 13 14 15 10 16|
| Emerging infectious disease        | Emerging or reemerging infectious disease within the regional center (e.g., hepatitis in Egypt and Georgia, polio in Kenya, neglected tropical diseases in Guatemala) | 22           | 8 12 13 10 12|
| Emergency preparedness and response| Emergency preparedness and response efforts focusing on risk communication, pathogen detection, and outbreak investigation | 19           | 2 1 0 2 19    |
| Vectorborne infections             | Vectorborne infections (e.g., malaria, dengue, Japanese encephalitis, Crimean-Congo hemorrhagic fever) | 12           | 5 7 4 5       |
| Hospital-associated infections     | Healthcare infection and control                                          | 9            | 5 4 4 1 4     |
| Tuberculosis                       | Tuberculosis infection, case findings, control, and treatment             | 9            | 7 1 5 4 3     |
| Enteric disease                    | Diarrheal diseases or infection                                           | 8            | 3 6 6 6 6     |
| Antimicrobial resistance           | Antimicrobial drug–resistant pathogens                                    | 6            | 1 1 2 1 5     |
| Acute febrile illness              | Syndromic surveillance focusing on acute febrile or neurologic illness    | 4            | 4 4 4 2       |
| Total no. projects                 |                                                                           | 205          | 92 75 95 72 125|

*October 1, 2014–September 30, 2016. Activities do not sum across the rows because activity types are not mutually exclusive. CB, technical capacity building; L, laboratory; PHI, public health informatics; PHR, applied public health research; S, surveillance.

interests and national priorities. The data generated from these collaborations have been used by host governments to quantify the public health issue and, ultimately, to guide and inform public health policy. Implementing high-quality research studies also serves as a hands-on training mechanism for international partners. Projects are conducted in collaboration with the in-country hosts, from developing the concept, writing the research protocol, implementing the study, analyzing and interpreting the data, and publishing the results. A tangible way that highlights the results of these collaborations is dissemination of findings in the scientific literature. Since the inception of the GDD Program, GDD staff have authored or coauthored ≈875 peer-reviewed scientific articles (9).

Surveillance

GDD regional centers partner with host countries to develop and strengthen surveillance for key illnesses and to limit spread of disease to the point of origin. Projects integrate laboratory, clinical, and epidemiologic information that can guide public health interventions and other control measures. GDD centers achieve this objective through several types of surveillance strategies, such as syndromic, laboratory-based, population-based, and sentinel systems (10–15). Population-based surveillance provide a framework for applied public health research that can help to characterize the burden, risk factors, and transmission characteristics of new or emerging infectious diseases and to assess the effectiveness of prevention strategies (3). Sentinel surveillance in a few key sites/facilities for specific or syndromic infectious diseases can help to identify emerging or reemerging pathogens (16).

Outbreaks of SARS and avian influenza A(H5N1) highlighted the need to have systems in place for detecting emerging pathogens (3). Thus, establishing population-based infectious disease surveillance for pneumonia and acute respiratory infections was a primary goal of the GDD Program (3). The resulting surveillance activities also provide a platform for other GDD core activities. Moreover, the GDD respiratory surveillance research projects have helped quantify burden of illness for pneumonia and influenza-associated acute respiratory illness, especially among children, and a high incidence of several respiratory pathogens, including respiratory syncytial virus, parainfluenza, and adenoviruses (6,11,12,17–23).
As GDD regional centers have matured, existing surveillance platforms have increasingly been adapted to include emerging pathogens, special noncommunicable disease studies, and projects focused on the animal–human interface (i.e., zoonotic diseases) (24–28). In 2014, the GDD regional centers began efforts to link common acute febrile illness (AFI) syndromic surveillance strategies across 5 regional sites (Egypt, Guatemala, India, Kenya, and Thailand) to gain a global perspective on AFI. Conducting AFI surveillance at GDD regional centers is of public health importance because AFI represents a common clinical syndrome for multiple diseases of outbreak potential or emerging zoonotic infections and provides an opportunity to evaluate novel diagnostics. Unlike respiratory illness syndromes such as severe acute respiratory illness and influenza-like illness, no international consensus case definition exists for AFI surveillance, although recommendations for improving methods have been

| Country     | Title of presentation                                                                 | Activity type |
|-------------|---------------------------------------------------------------------------------------|---------------|
| Bangladesh  | Ensuring infection control is feasible and acceptable: identifying high-intensity interventions for Nipah-like illness and low-intensity interventions for routine use in Bangladesh | S L PHR CB    |
|             | Making the case for rotavirus vaccination in Bangladesh: surveillance impacting public health interventions | X X X        |
|             | Spatial heterogeneity for dengue risk in Bangladesh: significance for other arthropodborne infections such as Zika | X X X        |
| China       | Verification of patients reported as central line–associated bloodstream infections (CLABSI) in a healthcare-associated infections surveillance system evaluation in Beijing | X X          |
|             | Risk factors for *Vibrio parahaemolyticus* infection in a southern coastal region in China | X X          |
| Egypt       | National surveillance of healthcare-associated infections and antimicrobial resistance in Egypt | X X X X      |
|             | Overview of GDD Egypt’s population-based syndromic surveillance—Damanhur, Egypt, 2009–2016 | X X X X      |
|             | *Rickettsia typhi* as an unrecognized cause of acute undifferentiated febrile illness—Damanhur, Egypt, 2010–2014 | X X          |
| Georgia     | Bloodborne disease prevalence in the blood supply, Georgia, 2012–2014 | X X          |
|             | Hepatitis C elimination in Georgia: a one-of-a-kind program providing a golden opportunity to strengthen public health systems | X X          |
| Guatemala   | Influenza-like illness and influenza vaccination during pregnancy in Quetzaltenango, Guatemala | X X X X      |
|             | Participatory development of a congenital Chagas disease screening strategy after the vector control attack phase in Guatemala | X X X        |
| India       | Acute encephalitis syndrome in Assam, India: importance of Japanese encephalitis in the adult population, 2014–2015 | X X X X      |
|             | Redrawing the boundaries of Kyasanur Forest Disease (KFD) in India: early results of GHSA-supported acute febrile illness surveillance | X X X        |
| Kazakhstan  | Strengthening the capacity of the Republic of Uzbekistan to combat antimicrobial resistance | X X          |
|             | Implementation of the CCHF surveillance enhancement activities in Kazakhstan, 2012–2015 | X X X        |
| Kenya       | Epidemiology of brucellosis and MERS-CoV in linked human and animal populations in Kenya | X X X X      |
|             | Indirect effects of 10-valent pneumococcal conjugate vaccine (PCV10) against adult pneumococcal pneumonia in rural western Kenya | X X X X      |
| South Africa| Application of a simple differential diagnostic tool for solving febrile, neurologic and haemoragic fever cases in Southern Africa | X X          |
|             | Decline in syphilis seroprevalence among females of reproductive age in Northern Cape Province, South Africa, 2003–2012: utility of laboratory-based information | X X          |
| Thailand    | Spotted fever group, typhus group rickettsioses and Sennetsu neorickettsiosis in rural Thailand | X X X X      |
|             | Enhanced surveillance for severe pneumonia, Thailand 2010–2014 | X X X X      |
|             | Epidemiology and antimicrobial resistance of invasive salmonellosis, rural Thailand, 2006–2014 | X X X X      |

Table 3. Selected ongoing projects presented at the Global Disease Detection Program annual science meeting, by country and activity type assessed, June 2016, Atlanta, Georgia, USA*

| Country     | Title of presentation                                                                 | Activity type |
|-------------|---------------------------------------------------------------------------------------|---------------|
| Bangladesh  | Ensuring infection control is feasible and acceptable: identifying high-intensity interventions for Nipah-like illness and low-intensity interventions for routine use in Bangladesh | S L PHR CB    |
| China       | Verification of patients reported as central line–associated bloodstream infections (CLABSI) in a healthcare-associated infections surveillance system evaluation in Beijing | X X          |
|            | Risk factors for *Vibrio parahaemolyticus* infection in a southern coastal region in China | X X          |
| Egypt       | National surveillance of healthcare-associated infections and antimicrobial resistance in Egypt | X X X X      |
|             | Overview of GDD Egypt’s population-based syndromic surveillance—Damanhur, Egypt, 2009–2016 | X X X X      |
|             | *Rickettsia typhi* as an unrecognized cause of acute undifferentiated febrile illness—Damanhur, Egypt, 2010–2014 | X X          |
| Georgia     | Bloodborne disease prevalence in the blood supply, Georgia, 2012–2014 | X X          |
|             | Hepatitis C elimination in Georgia: a one-of-a-kind program providing a golden opportunity to strengthen public health systems | X X          |
| Guatemala   | Influenza-like illness and influenza vaccination during pregnancy in Quetzaltenango, Guatemala | X X X X      |
|             | Participatory development of a congenital Chagas disease screening strategy after the vector control attack phase in Guatemala | X X X        |
| India       | Acute encephalitis syndrome in Assam, India: importance of Japanese encephalitis in the adult population, 2014–2015 | X X X X      |
|             | Redrawing the boundaries of Kyasanur Forest Disease (KFD) in India: early results of GHSA-supported acute febrile illness surveillance | X X X        |
| Kazakhstan  | Strengthening the capacity of the Republic of Uzbekistan to combat antimicrobial resistance | X X          |
|             | Implementation of the CCHF surveillance enhancement activities in Kazakhstan, 2012–2015 | X X X        |
| Kenya       | Epidemiology of brucellosis and MERS-CoV in linked human and animal populations in Kenya | X X X X      |
|             | Indirect effects of 10-valent pneumococcal conjugate vaccine (PCV10) against adult pneumococcal pneumonia in rural western Kenya | X X X X      |
| South Africa| Application of a simple differential diagnostic tool for solving febrile, neurologic and haemoragic fever cases in Southern Africa | X X          |
|             | Decline in syphilis seroprevalence among females of reproductive age in Northern Cape Province, South Africa, 2003–2012: utility of laboratory-based information | X X          |
| Thailand    | Spotted fever group, typhus group rickettsioses and Sennetsu neorickettsiosis in rural Thailand | X X X X      |
|             | Enhanced surveillance for severe pneumonia, Thailand 2010–2014 | X X X X      |
|             | Epidemiology and antimicrobial resistance of invasive salmonellosis, rural Thailand, 2006–2014 | X X X X      |

| No. presentations by activity type | 18 | 6 | 15 | 23 | 2 |

*CB, technical capacity building; CCHF, Crimean-Congo hemorrhagic fever; GDD, Global Disease Detection; GHSA, Global Health Security Agenda; L, laboratory; MERS-CoV, Middle Eastern respiratory syndrome coronavirus; PHI, public health informatics; PHR, applied public health research; S, surveillance.
In the detection and identification of 12 novel strains and pathogens that were new to the world and 62 novel strains or pathogens that were new to the region where they were discovered (9). GDD laboratorians have helped implement capacity to conduct >380 new diagnostic tests in 59 countries, improving disease detection capability and contributing to faster response times within the region.

Public Health Informatics
Informatics is the application of public health information systems to capture, manage, analyze, and use information to improve public health practice (32). Examples of the key activities include the use of electronic databases, either as the source of data or as a method to collate data, for expediting the time between data collection and use. At GDD regional centers, public health informatics is a cross-cutting activity for disease surveillance, laboratory studies, and applied epidemiologic research to ensure that data are collected and managed in a systematic and reliable manner. Most GDD data-collecting projects currently under way have an informatics component (Table 3).

Capacity Building
Strengthening the local public health capacity and workforce are key for improving the detection and response to infectious diseases globally. The transfer of epidemiology, laboratory, and emergency preparedness skills to local public health professionals is necessary for sustainability, both nationally and across regions. Capacity building is another cross-cutting activity at the GDD regional centers and ranges from establishing or strengthening existing surveillance, laboratory, emergency preparedness, and health systems to conducting high-quality epidemiologic research studies to address knowledge gaps. This capacity is achieved through on-the-job training of local partners, providing technical expertise, conducting high-quality research studies, and collaborating on analysis of information to inform evidence-based decision making.

Public Health Diplomacy
Scientific exchange can play a strong role in building bonds across countries. Because health is an area of concern for all nations, international projects that address a common threat, such as infectious diseases that easily cross borders, can open avenues of communication and ease tensions between the United States and other nations (33). GDD China serves as an example of how 2 strong national public health institutes (1 in China and 1 in the United States) can collaborate and benefit. During the West Africa Ebola outbreak in 2014, China CDC had the resources and willingness to respond but not necessarily the US CDC experience or technical expertise with Ebola outbreaks and response. Since 2006, Chinese laboratorians have worked alongside US colleagues to build greater diagnostic testing capacity throughout China. Because of this preexisting relationship, the 2 countries were able to forge a new type of collaboration in Sierra Leone; scientists from both countries worked together to offer critical training and resources to Sierra Leone to help stop the spread of the largest Ebola outbreak in history (34). By building strong partnerships and scientific systems, GDD
protects the United States and countries around the world from threats to health, safety, and security.

Lessons Learned and the Future
The GDD Program promotes the prompt detection and mitigation of disease threats globally. GDD works with multiple countries (Figure) to conduct applied public health research and develop and enhance public health capacity to rapidly detect, accurately identify, and promptly contain emerging and reemerging infectious diseases. The activities of the GDD Program are critical to help countries improve their disease surveillance networks and enhance laboratory capabilities for detection of emerging pathogens. The program also has greatly expanded epidemiology workforce networks to meet their commitment to global health security and the International Health Regulations 2005.

The activities of the GDD Program have developed needed technical capacity, advanced science, and provided critical information for policy change. Activities of the GDD regional centers have allowed a greater understanding of what infections or conditions are of concern in the countries and regions in which they work. They have increased awareness of the emergence of antimicrobial resistance and the growing threat of infections that can be acquired in healthcare settings (35,36). Strengthening disease surveillance, applied public health research, and laboratory capacity have allowed for a better understanding of pathogens associated with illnesses that present with acute fever. The activities established serve as a base or launch pad for the rapid and timely implementation of surveillance for emerging infections like Zika virus and applied epidemiologic research studies to better understand which populations are being affected and to enumerate potential factors associated with infection and spread of illness.

As new laboratory techniques for the detection of pathogens are developed, the GDD regional centers have served as a platform to examine the performance of these new tests in multiple settings and promote the adoption of the new techniques in multiple countries. Because of ongoing surveillance and routine collection of epidemiologic information, GDD regional centers and the countries they work with have the tools needed to best characterize pathogens that are circulating and explore potential reservoirs and sources associated with these infections. Increased informatics capacity is concurrently enabling the active linkage of information and interfacing of data housed in multiple data systems within the countries and regions.

GDD regional centers make critical contributions to global disease detection by improving infectious disease detection capacity through integration of applied public health research and laboratory capacity building, which in turn will generate quality data that can inform high-level policy. The GDD Program has matured and transformed over the past 10 years and continues to evolve. Further advancing the technical capacity that has already been developed is allowing the GDD Program to focus on needed research and generation of data to develop and evaluate interventions and inform policies needed to reduce burden of multiple conditions worldwide. Examples of research activities needed include studies to understand the actual burden of conditions at play, assessments of the impact of multiple conditions on local and global populations, quantification of the societal and economic costs of illnesses, and evaluation of control measures.

Threats posed by emerging pandemics and other infectious diseases will remain a challenge to global health security, endangering economies and decreasing political stability. GDD will continue to work with countries to strengthen core capacities and conduct applied public health research so that emerging and reemerging diseases and conditions can be detected and stopped faster and closer to the source, thereby enhancing global health security.

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- Transmission of *Babesia microti* Parasites by Solid Organ Transplantation
- Immune Responses to Invasive Group B Streptococcal Disease in Adults
- Ambulatory Pediatric Surveillance of Hand, Foot and Mouth Disease As Signal of an Outbreak of Coxsackievirus A6 Infections, France, 2014–2015
- Increased Hospitalization for Neuropathies as Indicators of Zika Virus Infection, according to Health Information System Data, Brazil
- Global *Escherichia coli* Sequence Type 131 Clade with blaCTX-M-27 Gene
- Multidrug-Resistant *Corynebacterium striatum* Associated with Increased Use of Parenteral Antimicrobial Drugs

- Risk Factors for Middle East Respiratory Syndrome Coronavirus Infection among Healthcare Personnel
- Epidemiology of La Crosse Virus Emergence, Appalachian Region, United States
- Reassortant Eurasian Avian-Like Influenza A(H1N1) Virus from a Severely Ill Child, Hunan Province, China, 2015
- Serotype IV Sequence Type 468 Group B *Streptococcus* Neonatal Invasive Disease, Minnesota, USA
- Capsular Switching and Other Large-Scale Recombination Events in Invasive Sequence Type 1 Group B *Streptococcus*
- Changing Pattern of *Chlamydia trachomatis* Strains in Lymphogranuloma Venereum Outbreak, France, 2010–2015
- Imported Chikungunya Virus Strains, Taiwan, 2006–2014

- ESBL-Producing and Macrolide-Resistant *Shigella sonnei* Infections among Men Who Have Sex with Men, England, 2015
- Early Growth and Neurologic Outcomes of Infants with Probable Congenital Zika Virus Syndrome
- Severe Fever with Thrombocytopenia Syndrome Complicated by Co-infection with Spotted Fever Group Rickettsiae, China
- Guinea Worm (Dracunculus medinensis) Infection in a Wild-Caught Frog, Chad
- Dog-Mediated Human Rabies Death, Haiti, 2016
- *Staphylococcus aureus* Colonization and Long-Term Risk for Death, United States
- Group B *Streptococcus* Serotype III Sequence Type 283 Bacteremia Associated with Consumption of Raw Fish, Singapore
- Group B *Streptococcus* Sequence Type 283 Disease Linked to Consumption of Raw Fish, Singapore
- Novel Levofloxacin-Resistant Multidrug-Resistant *Streptococcus pneumoniae* Serotype 11A Isolate, South Korea
- Neutralizing Antibodies to Severe Fever with Thrombocytopenia Syndrome Virus 4 Years after Hospitalization, China