

# Strengthening Rural States' Capacity to Prepare for and Respond to Emerging Infectious Diseases, 2013–2015

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Because clinicians may be the first to encounter cases of emerging infectious diseases, they need to be able to work together with public health departments to quickly identify and respond to infectious disease outbreaks. Infectious diseases are a constant threat in many parts of the United States, including rural areas. For example, from 2004 to 2016 reports of diseases from mosquito, tick, and flea bites—which are known to affect rural areas—have tripled in the United States.<sup>1</sup> During this period, 9 new pathogens spread by infected mosquitoes and ticks were discovered or introduced, and >640,000 cases of these diseases were reported in the United States. Although state and local health departments and vector control organizations are the nation's main defense against this threat, 84% of local vector control organizations lack at least 1 of 5 core vector control competencies.<sup>1</sup>

Rural states, defined here as states having a high percentage of their population living in rural areas according to the 2010 US Census,<sup>2</sup> face challenges in public health infrastructure<sup>3–5</sup> and staffing in small, local health departments. According to the National Association of County and City Health Officials,

62% of local health departments serve populations of fewer than 50,000. Eighty percent of local public health agencies employ fewer than 50 individuals and 37% fewer than 10.<sup>6</sup> Staffing challenges in small, local health departments may make it difficult for rural states to respond adequately to infectious disease outbreaks. Since 1995, the Epidemiology and Laboratory Capacity (ELC) cooperative agreement of the Centers for Disease Control and Prevention (CDC) has provided funding to 64 jurisdictions, including those serving rural areas, in all 50 states to enhance the capacity to detect, respond, prevent, and control infectious diseases. Clinicians may be unaware of public health efforts to prepare for and respond to infectious diseases. There is little published information for clinicians about the capacity of rural states to respond to infectious diseases. To provide clinicians with a snapshot of rural public health efforts to prepare for and respond to infectious diseases, we describe how, with support from the CDC and other sources, state and local public health agencies in 14 states with high percentages living in rural areas worked to strengthen their ability to respond to infectious diseases.

## Methods

Our primary data source came from the 64 state and local health department awardees funded for the ELC cooperative agreement in fiscal years 2013–2015. During this time frame, as part of the annual application process for ELC funding, we sent an electronic query to all awardees comprising four questions on health problems encountered, key activities, outcomes/accomplishments, and lessons learned. We collected data via a Microsoft Word (Microsoft, Redmond, WA) template completed by awardees and exported text responses into an Excel workbook. All grantees (N = 64) submitted a success story at least once during the 3 years, and 84% of grantees submitted at least one success story each of the 3 years. The average response rate during the 3 years was 94%.

Although the ELC played a role in supporting all of the activities identified, in some cases this support was combined with funds from various other, often unspecified funding sources achieved through collaboration and partnerships at the state and local levels. For example, an initiative of the Alaska Section of Laboratories and the Alaska Section of Epidemiology involving rabies testing received financial support from the Alaska Departments of Fish and Game and Environmental Conservation.

In a secondary qualitative analysis of these data, we reviewed fiscal year 2013–2015 reports for overall epidemiologic and laboratory capacity and public health activities unique to rural states. We selected the three states with the highest percent rural population (range 33.61%–61.34%) in the northeast, south, midwest, and west US Census regions, plus two additional states, for a total of 14 (Table) for this analysis. (The US Census Bureau identifies two types of urban areas: urbanized areas of ≥50,000 people, and urban clusters of at least 2500 and <50,000 people. “Rural” encompasses all population, housing, and territory not included within an urban area).<sup>2</sup> We analyzed for frequencies of responses and conducted a thematic analysis to identify major categories

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**Table. 14 US states with high percentages of people living in rural areas, 2010 US Census Bureau<sup>2</sup>**

Region	State	State's total population	Rural population	Rural population, %	Total area that is rural, %
Northeast	Maine	1,328,361	814,819	61.34	98.83
	New Hampshire	1,316,470	522,598	39.7	92.81
	Vermont	625,741	382,356	61.1	98.31
South	Arkansas	2,915,918	1,278,329	43.84	97.89
	Mississippi	2,967,297	1,503,073	50.65	97.64
	Oklahoma	3,751,351	1,266,322	33.76	98.10
	Tennessee	6,346,105	2,132,860	33.61	92.95
	West Virginia	1,852,994	950,184	51.28	97.34
Midwest	Iowa	3,046,355	1,096,099	35.98	98.29
	North Dakota	672,591	269,719	40.1	99.73
	South Dakota	814,180	352,933	43.35	99.70
West	Alaska	710,231	241,338	33.98	99.95
	Montana	989,415	436,401	44.11	99.80
	Wyoming	563,626	198,633	35.24	99.80

and themes. The categories were developed through repeated examination of respondent comments (ie, a data-driven process) in which similar portions of text were identified, separated from the document, and sorted so that major commonalities could be determined.<sup>7</sup>

Overall, we identified a total of 119 success stories from the 14 rural jurisdictions; 48 were from the south region, 26 were from the northeast region, 26 were from the west region, and 19 were from the midwest region. As an initial step, we determined three main categories in which to group the responses: (1) project impact, which included narratives on staffing, collaboration with state/local health department/local providers, training, and funding; (2) project type, which included narratives on outbreak response, health information systems, laboratory capacity, and other; and (3) disease related, which included narratives on foodborne disease, vaccine-preventable disease, hospital-associated infection, emerging infectious disease, vector-borne disease, zoonotic disease, and antibiotic resistance. These narratives were not mutually exclusive; stories could contain information related to several topics.

Because of the complexity of the subject matter, we divided the information into three separate subprojects, to be developed into three specialized papers. This first, overarching paper focused on applied epidemiologic and laboratory capacity and four disease-specific public health activities—foodborne disease, vaccine-preventable disease, vector-borne disease, zoonotic disease—with a focus on efforts distinctive to rural states. Two remaining topics, laboratory technology and hospital-associated infections/antibiotic resistance, are the focus of two other specialized articles.

## Results

### Overall Applied Epidemiologic and Laboratory Capacity

Rural states described some public health activities similar to urban, metropolitan health departments. Of the 119 success

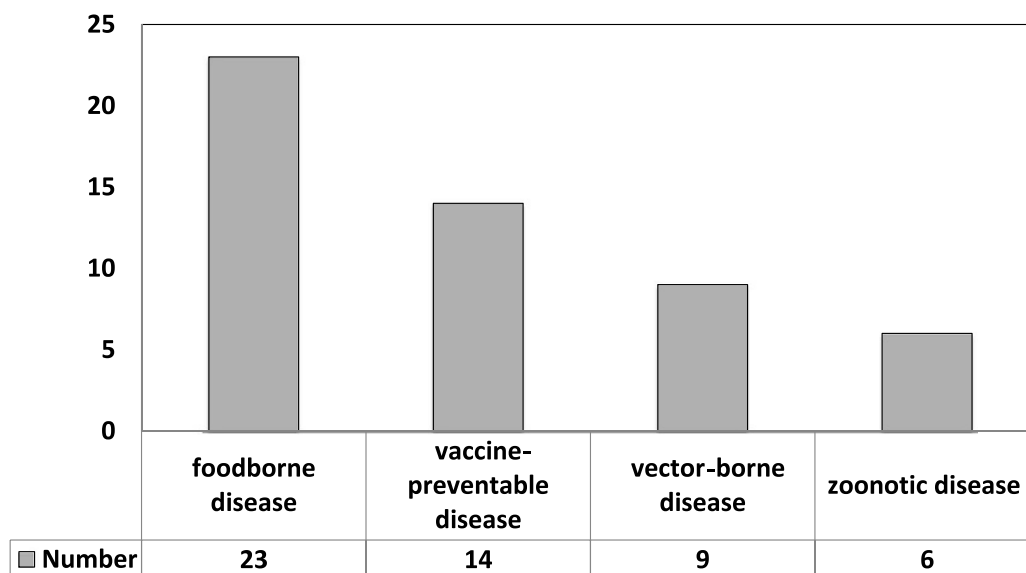
stories, 53 (44.5%) involved outbreak response. Twenty were from the south region, 15 were from the northeast, 9 were from the west, and 9 were from the midwest region. Of the 14 states, 13 (93%) noted the importance of complete and timely surveillance, and 11 (79%) mentioned the value of flexible epidemiologists (ie, ELC-supported epidemiology staff capable of working on a cross-section of infectious diseases).<sup>8</sup> These flexible epidemiologists assisted in outbreak investigations and responses and participated in outreach to providers and healthcare facilities.

Of the 119 success stories, 52 focused on disease-specific public health activities, and of these, 23 (44%) focused on foodborne disease, 14 (26%) involved vaccine-preventable disease, 9 (17%) concerned vector-borne disease, and 6 (12%) involved zoonotic disease (Fig.).

### Foodborne Disease

Of 23 success stories focusing on foodborne disease, 8 were from the west region, 7 were from the south, 4 were from the northeast, and 4 were from the midwest region. For example, during a multistate outbreak of *Salmonella poona*, Montana's public health laboratory identified a unique cluster through matching pulsed-field gel electrophoresis patterns and serotyping. These results were quickly communicated to the communicable disease epidemiology program, which initiated actions to protect the public. Montana's flexible epidemiologist worked with local health partners to perform case interviews, identifying fresh produce as a potential source. A public health environmental health sanitarian was enlisted to perform further investigation. Together they interviewed people infected with *S poona*, traced cucumber invoices, and collected grocery store samples to verify and remove the implicated source from stores. Montana public health staff noted:

Because of the low threshold for *Salmonella* surveillance, Montana was able to identify this unique cluster early and contribute



<sup>1</sup> The Census Bureau identifies two types of urban areas: Urbanized Areas of 50,000 or more people, and Urban Clusters of at least 2,500 and less than 50,000 people. "Rural" encompasses all population, housing, and territory not included within an urban area. [United States Census Bureau. 2010 Census Urban and Rural Classification and Urban Area Criteria.]

**Fig. Frequency of self-reported disease-specific public health activities in 14 rural states, funded by the Epidemiology and Laboratory Capacity (ELC) cooperative agreement, United States, 2013–2015.**

significant findings to the multistate investigation. CDC and state partners were able to announce the imported cucumbers as the culprit and imitate actions to protect the health of the public. The product was removed from shelves and the public was notified of the recall. (Montana Department of Health and Human Services)

### Vaccine-Preventable Disease

Yellowstone National Park has >3 million annual visitors.<sup>9</sup> Some visitors present to national park clinics with respiratory illness. Wyoming conducts influenza sentinel surveillance to identify potential outbreaks and novel influenza strains and monitor for possible novel strain introduction to the United States through park visitors.

Iowa experienced a prolonged mumps outbreak that began in July 2015 on the University of Iowa campus. Epidemiology staff conducted outbreak investigation training for local response partners and health information staff and improved electronic laboratory reporting in Iowa to permit more rapid notification of new cases. These training efforts allowed disease control measures to be implemented quickly, decreasing the risk of transmission. As a result of these efforts, the Iowa Department of Public Health worked with the university, local clinicians, and public health staff to vaccinate thousands of college students.

### Vector-Borne Disease

Vector-borne disease was the focus of 9 success stories: 6 were from the south region, 2 were from the northeast region, and 1 was from the midwest region, with 0 reported by the west region. Vector surveillance is essential in heavily forested areas. Epidemiologists developed, enhanced, and monitored mosquito surveillance in Arkansas, Mississippi, New Hampshire, and

West Virginia. For example, La Crosse encephalitis is transmitted to humans by the bite of an infected mosquito.<sup>10</sup> It is endemic in Appalachia. West Virginia has a high human incidence of this disease. West Virginia health officials reported:

The mosquito surveillance program was expanded to survey new counties, search for more mosquito species, utilize new mosquito collecting equipment, assist with local environmental assessments at human case sites, improve arboviral detection in mosquitoes, and update action plans. (West Virginia Department of Health and Human Resources)

In addition to La Crosse encephalitis, West Virginia’s Mosquito Surveillance Program provides timely data on West Nile, Eastern equine, and St Louis encephalitis.

Human cases of Lyme disease have increased in West Virginia since 2006, occurring beyond Lyme endemic counties in the eastern panhandle.<sup>11</sup> West Virginia health officials described how wildlife biologists collected external parasites including ticks from 30 white-tailed deer at 20 official game-checking stations. This generated new county-level data for *Ixodes scapularis* (blacklegged tick) in the northern and southern parts of the state. County-level *I scapularis* data correlate with the human tick-borne disease cases. Because many West Virginia counties border states with a high incidence of tick-borne disease, feedback on human and tick surveillance data was used to educate providers in counties of concern about risks to patients.

### Zoonotic Disease

For the purposes of this analysis, we considered zoonotic, foodborne, and vector-borne diseases to be mutually exclusive categories. The zoonotic disease category included both livestock

and wildlife. Zoonotic disease was the focus of 6 success stories: 2 each from the west, midwest, and south regions, with 0 reported by the northeast. Although fewer narratives on zoonotic disease were reported compared with other categories, a review of the text reveals these represented important topics. In Wyoming, epidemiologists offered specific guidance to those in the livestock industry. Most Wyoming *Campylobacter* infections are linked to dairy and beef cattle. The state has two populations at risk—raw milk and raw milk product consumers and those who own or work with cattle. Many families run small farms with 50 head of beef cows as a second income. “Human exposures can often be linked to specific activities with livestock; ie, castration after lambing or calving season,” Wyoming public health staff noted (The Wyoming Department of Health). “Based on this information, epidemiologists had opportunities to ask very targeted questions when interviewing the patients and provided guidance to farmers on cleaning clothing and equipment after handling livestock.”

North Dakota representatives recounted a case in which a pig tested positive for rabies. The pig was 1 of 21 feeder pigs housed in an outdoor pen. The day before the rabies-positive pig died, two other pigs became ill and died. Three days later, a fourth pig became ill, was euthanized, and tested positive for rabies. The remaining pigs were to be slaughtered and used as a meat supplement for deer sausage, jerky, and other food items. CDC rabies subject matter experts, working with the North Dakota Board of Animal Health, discussed options for the remaining pigs that would halt transmission while avoiding unnecessary financial hardship for the owners. Following consultation, the remaining 17 pigs were placed in an 8-month quarantine instead of being euthanized. The collaboration prevented further transmission and potentially saved lives. “We gained knowledge on exactly how animals potentially exposed to rabies that will be used for human consumption need to be followed-up and handled,” North Dakota public health staff observed (The North Dakota Department of Health).

The Alaska Section of Laboratories conducts rabies testing for actionable events such as human exposures. In partnership with and financial support from the Alaska Departments of Fish and Game and Environmental Conservation, the Alaska Section of Epidemiology engaged CDC rabies staff to conduct training on the use of the direct rapid immunohistochemistry test for the detection of rabies virus antigen. After the training, ELC provided some of the funding to support use of this test. During the past several years, wildlife biologists/veterinarians tested nearly 3000 animals, greatly increasing the numbers, species, and locations for rabies surveillance. Two rabies-positive wolves were identified, along with a rabies-positive wolverine, which was the first confirmed rabies-positive animal of its species in Alaska.

## Discussion

Rural states have been active in preparing for and responding to infectious diseases. In addition to the states mentioned here, all 50 states have some rural areas. For example, ticks carrying Lyme disease are an important problem in New York

and Massachusetts, which may not be considered rural states. It is useful for clinicians and public health staff alike to be aware of the unique challenges affecting rural areas in any states. These states and areas must address challenges in surveillance, epidemiology, and outbreak investigation similar to urban and metropolitan areas. In addition, they face diverse challenges, such as exposure to pathogens related to agriculture or livestock and other animals (pets, wildlife), heavily forested areas, and outdoor recreation. Conducting activities across large, sparsely populated areas can be difficult.

Progress has been made through initiatives such as One Health, a collaborative, multisectoral, and transdisciplinary approach—working at local, regional, national, and global levels—with the goal of achieving optimal health outcomes while recognizing the interconnection among people, animals, plants, and their shared environment. The One Health approach allows state and local public health, animal health, and environmental partners to build capacity and facilitate interagency, multisectoral, and multidisciplinary coordination and sharing of expertise to address shared health threats at the human-animal-environment interface. This approach leads to better prevention, detection, response, and recovery from emerging infectious and zoonotic disease outbreaks and related health threats.

Staffing was a challenge reported by all 14 rural jurisdictions. Of 119 success stories, 53 (44.5%) noted staffing issues. Of these, 28 (53%) were from the south region, 10 (19%) were from the west, 9 (17%) were from the northeast, and 6 (11%) were from the midwest region. Respondents noted that collaboration with the CDC, including ELC funding, was instrumental to their efforts. For example, respondents commented, “Iowa’s ability to respond to infectious disease threats hinges upon having the necessary epidemiologic and laboratory capacity,” and “Oklahoma’s ability to continue surveillance for influenza-associated hospitalizations and deaths relies on having sufficient epidemiology and laboratory personnel support” (Iowa Department of Public Health and the Oklahoma State Department of Health).

Although considerable progress has been made in rural states, more needs to be done. For example, when facing resource constraints, rural states and local health departments operating in rural areas within nonrural states collectively may consider identifying the minimum proficiency that is needed to be successful in these areas. For example, competence in veterinary, animal health, and agricultural issues, or at minimum a working relationship with local clinicians and veterinary and agricultural agencies may be needed to ensure a One Health approach at the front lines of public health and animal health.

This study had several limitations. First, success stories were obtained through ELC progress reports from awardees. They do not include a comprehensive listing of all of the activities occurring in these health departments. Findings are intended to provide a snapshot of infectious disease capacity reported by rural state health departments. Second, data were self-reported and may be subject to recall bias. Because all of the respondents are funded through ELC, grantee funding bias may have occurred,

suggesting a more positive overview of capacity-building activities and perspectives. Lastly, narratives were not mutually exclusive. Stories could contain information related to several topics. We have done our best to summarize hundreds of pages in a format that will be more accessible to readers, but we realize this carries the risk of oversimplification of complex topics.

## Conclusions

Clinicians and public health departments in many other rural settings in the United States face similar challenges to those reported here. Through this report, we hope to recognize the progress made and galvanize future efforts to address remaining challenges.

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