Preventing and Responding To Dengue Transmission On the Border

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Introduction

Dengue transmission is rapidly growing in incidence and geographic range.[1] Geographic areas at the boundary of transmission, such as the U.S.-Mexico border region, are the most vulnerable to emergence and increased transmission, and both sides of the border have been impacted. While transmission on the U.S. side has been somewhat limited, Texas has had recurring outbreaks.[2] Dengue transmission in the Mexican border states of Sonora, Chihuahua, Coahuila, and Tamaulipas has been occurring seasonally for over a decade. Only Baja California has not reported regular dengue transmission. Yet these states are not homogenous. For example, despite established vector populations in Nogales, Sonora, no transmission has been reported. Likewise, across the border in Arizona, no autochthonous transmission has been reported despite established vector populations for nearly two decades.[3]

The emergence of dengue requires not only the presence of a competent vector, a susceptible population, and introduction of the virus, but also an environment that fa-

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Aedes aegypti mosquitos spread dengue fever.

cilitates the interaction of all three. A comprehensive strategy leveraging resources on both sides of the border should be developed to understand and monitor the current state of transmission potential and the factors that, if changed, could lead to the emergence of the disease or high levels of transmission. We discuss and make recommendations for potential strategies below.

Engagement of Stakeholders

Dengue, like most infectious diseases, is impacted by environmental, social, and political infrastructures. The most important element in controlling dengue is political commitment to shrinking disease transmission through a multi-focal approach to reducing human-vector contact.[4] The most obvious partners include local and national public health agencies, vector control agencies, the medical community, and diagnostic laboratories. Yet efforts should be made to include the following stakeholders, who may have considerable influence over the potential for dengue transmission:

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1. Private and public sanitation: *Ae. aegypti* infestation and dengue transmission are tied to municipal and household waste management.[5] Programs that engage waste management alongside the community have successfully reduced pupal indices in other dengue endemic areas.[6]
2. Private and public water suppliers: Water supply and household water storage have been repeatedly linked to *Ae. aegypti* indices and dengue incidence.[7] Engaging smaller, private suppliers of water, including truck distribution, in addition to the governmental sector would allow broader coverage of public health messaging and appropriate water harvesting/storage technology.
3. Media and communications: Media coverage of dengue often occurs when the problem already exists and the disease is on the rise. Coordination between public health and the media could facilitate more regular reporting of cases by neighborhood. Risk perception is correlated with risk-reduction practices, and knowledge that dengue has been reported within the neighborhood could motivate action.[8] One way to engage communities at a local level is through neighborhood organizations that could train block captains who would be responsible for engaging households on their block to monitor for *Ae. aegypti*. This has been done in some parts of Mexico as part of the Patio Limpio ("Clean Patio") campaign.
4. Municipal administrators: Administrators must deal with a wide variety of community concerns but should be engaged in the stakeholder process since they are instrumental in decisions regarding budget allocations, which can influence funding for control and prevention and essential services.
5. Economic Development Boards (EDB)/Boards of Commerce: Dengue transmission has a significant economic impact on households and communities.[9] EDBs should be engaged in the process to determine developmental projects that could reduce transmission and encourage economic growth.

6. Schools: Secondary schools can be involved to educate young adolescents to act as health messengers to their extended family and to engage in community improvement projects.[10] Furthermore, museums, particularly children's museums, could be engaged in developing interactive tools that allow children and their parents to participate in understanding the lifecycle of *Ae aegypti*.

Cross-border Relationships

Knowledge about dengue should be a bi-directional exchange in all efforts including 1) surveillance of dengue; 2) surveillance of the vector populations; 3) best practices for control; 4) best practices for lab testing; and 5) best practices for treatment. The Border Infectious Disease Surveillance System (BIDSS) was established in 1997 and has been working to address several of these areas including enhanced surveillance in the border region for febrile exanthems, of which dengue is one.[11] Laboratory capacity is another target area for BIDSS.

While governmental collaborations are growing at the national and state levels, local-level collaborations and more academic partnerships should be forged to address dengue control and prevention. Binational academic collaborations, including the Arizona Prevention Research Center,[12] have effectively addressed chronic diseases in the U.S.-Mexico border region. Their approaches are rigorously designed and evaluated community-led health promotion activities. To further efforts to prevent and control dengue and other infectious diseases in the U.S.-Mexico border region, a broad-scale approach such as this one is warranted.

Innovative Surveillance and Vector Control Strategies

Before prevention and control activities can be performed efficiently, the geographic and temporal distribution of risk should be established. Traditional surveillance relies on symptomatic cases seeking care and clinicians ordering tests and reporting results, leading to delays in control implementation. Two primary approaches are being developed to address this issue with vector-borne diseases; syndromic surveillance systems that simply report people with specific symptoms (for example, BIDS and Dengue Trends)[13] and surveillance that tracks vector dynamics to predict proximate dengue risk. Monitoring vector populations provides a window of time between rising vector populations and dengue transmission that can be exploited to implement control. However, dengue incidence does not always correlate perfectly with vector densities, and surveillance systems must operate in tandem. Systems such as DengueWeb incorporate multiple data streams to create predictive risk maps that are tailored to a geographic area.[14] Efforts should be made to test these systems in the border area at the margins of transmission to determine if they are able to pick up low levels of transmission and predict areas most vulnerable to emergence.

Innovative measures to reduce vector densities below levels that can sustain an epidemic are a step toward the reduction of disease transmission. Efforts are currently underway to develop lethal ovitraps as one mechanism for reduction of female adults. These inexpensive yet effective traps used in concert with other household vector-reduction strategies, such as covering water containers and reducing human-vector contact through implementation of insecticide treated curtains, may effectively reduce the number of females capable of transmitting disease.[15]

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Evaluation of Program Activities and Success

Dengue prevention and control activities are often not rigorously evaluated for their impact and must be continuously monitored for change.[16] The community mobilization campaign Patio Limpio ("Clean Patio") has had initial success in Mexico, but sustainability has been difficult to achieve.[17] Programs that show initial success, such as Patio Limpio, need to be frequently monitored and evaluated to determine when efficacy begins to decline and what underlying factors are impeding their success. Evaluations should engage all individuals involved in the intervention process including community stakeholders, community mobilizers, and community members themselves. Monitoring strategies should include both quantitative and qualitative indicators of acceptability of the program, engagement of partners, frequency of protocol

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implementation, profiles of community members not being reached, quality of data collection, and alternative strategies and solutions. Overall program evaluation should examine direct disease indicators. Often endpoints for dengue prevention and control strategies revolve around decreasing vector indices; however, given that dengue incidence and vector density are not synonymous, efforts should also include monitoring of dengue cases in intervention households.

Public health interventions do not occur in isolation, and identification of ongoing programs/interventions that may have unintended consequences for dengue transmission is exceedingly important. One related effort is maintaining water security. This issue is particularly relevant to the arid U.S.-Mexico border region since water scarcity is ranked as critical in the area and is slated to increase as the climate changes.[18] One proposed strategy to adapt to water shortages in arid areas is water harvesting and storage. As public water supplies become even more constricted, governments may implement water rationing and restrictions. Containers for storing water have been productive *Ae. aegypti* breeding sites in various regions and social contexts (for example, when stored for household consumption, gardening, etc.).[19] A recent study in Australia directly linked increased water harvesting and storage as a response to governmental water restrictions to increases in dengue.[20] As indicated in the stakeholder section of this article, including public and private water suppliers as voices for dengue control and prevention could prevent some of these unintended consequences from occurring. With proper communication, messaging about conservation of water could include public health information that outlines the appropriate way to store water. Coordination between agencies could also lead to distribution of appropriate containers, screens or lids, larvivorous fish, or BTI mosquito dunks that could reduce the risk tied to water storage.

Even if programs are effective and do not incur unforeseen consequences, they may not be sustained. Sustainability should be achieved by identifying key individuals in stable government positions that are not subject to turnover with governmental changes in power. If high turnover does impact the continuity of control and prevention efforts, politically neutral or diverse stakeholder groups should be leveraged to educate incoming officials on the importance of dengue control. Rigorous follow-up and evaluation of prevention and control strategies should facilitate adoption of existing strategies by incoming officials.

Conclusion

A multi-sectorial binational approach that addresses social, political, and environmental determinants of dengue transmission will be the most successful strategy for preventing and controlling transmission. Engagement of partners prior to emergence may be difficult since motivation for action generally occurs after the events; however, a core group of actively engaged individuals could lead preliminary efforts to put things in place and maintain contacts with key players who in effect would be "activated" during a response. Strong communication and information exchange will be needed to fully realize the potential of these types of efforts. VM

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