International Center for Enterprise Preparedness (INTERCEP)

Tick and Mosquito Borne Diseases and Infections

Web Forum

On Monday, June 25, 2018, INTERCEP held a web forum on the spread of tick- and mosquito-borne diseases and infections. Dr. Maria Diuk-Wasser, Associate Professor, Department of Ecology, Evolution and Environmental Biology at Columbia University and Principal Investigator at the Northeast Regional Center for Excellence in Vector Borne Diseases at Columbia University, and Byron Backenson, New York State Department of Health, Bureau of Communicable Disease Control, provided insights and discussed current trends in these diseases, data collection methods, a new app to assess exposure risk, as well as mitigation measures to reduce the risk to these public health concerns.

Introduction

Maria Diuk-Wasser led a discussion about recent trends in tick-borne diseases in the United States, the factors that affect exposure to these diseases and a new app developed to collect data to inform risk mitigation strategies.

Vector borne diseases are growing in both number of cases and number of diseases. According to the Centers for Disease Control and Prevention (CDC), the number of annual cases related to diseases transmitted by mosquitoes, ticks, and fleas tripled from 2004 to 2016 in the United States. Moreover, over this period nine new pathogens transmitted by mosquitoes and ticks have been introduced.

Lyme disease is a well-known tick-borne disease. Figure 1 shows CDC data on the number of annual cases of Lyme disease for the period 1996-2016. In 2016 there were over 35,000 cases confirmed and probable cases reported. The actual number of cases is probably much higher since many cases go unreported and sometimes people are not aware they have Lyme disease.

The number of areas where ticks are reported has also increased significantly. Figure 2 shows the geographical distribution of Lyme diseases cases in the United States for 2016. In the south there are ticks but there are fewer cases there. The ticks do not look for hosts high in vegetation. Ticks will only bite when they are in a certain position. Host seeking.

There are three different kinds of ticks that represent a health risk to humans (blacklegged, lone star and American dog ticks) and they behave differently. For example, lone stars are known as “hunter” ticks and they are more aggressive and fast-moving than other species such as the blacklegged tick, which is an “ambush” tick. Blacklegged ticks are also known as deer ticks and they can transmit seven pathogens to humans. Table 1 shows the pathogens that these ticks can transmit.

Lyme disease (Borrelia burgdorferi) incidence is affected by natural ecosystems and human factors. Some of these factors include land use fragmentation and the composition of hosts in a community.
Deer are an essential host for ticks. Adult ticks use deer almost exclusively. But at other stages in their lives they use other species such as mice, chipmunks and dogs. The edge between shrubs and grass is an important component of risk.

Figure 1. Reported Cases of Lyme Disease by Year, United States, 1996-2016

Image source: Centers for Disease Control and Prevention (CDC). Available at: https://www.cdc.gov/lyme/stats/graphs.html

Tick App

Researchers from Columbia University and the University of Wisconsin – Madison have developed a free app for smartphones called Tick App to collect information from users in areas where they are at risk for exposure to tick bites. As part of this effort researchers hope to use the data collected to develop risk mitigation strategies to reduce diseases transmitted by ticks.

The Tick App allows researchers to integrate where, when and how people are being infected with Lyme disease. It includes a daily tick survey to allow users to report if they found a tick, what they were doing when they found it and where they were located. Users can identify the species of tick or send a picture for identification.
Table 1. Pathogens Transmitted by Ticks

<table>
<thead>
<tr>
<th>Tick species</th>
<th>Pathogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lone star tick (Amblyomma americanum)</td>
<td>Spotted fever group Rickettsia</td>
</tr>
<tr>
<td></td>
<td>Ehrlichia chaffeensis</td>
</tr>
<tr>
<td></td>
<td>Ehrlichia ewingii</td>
</tr>
<tr>
<td></td>
<td>Francisella tularensis</td>
</tr>
<tr>
<td></td>
<td>Heartland virus</td>
</tr>
<tr>
<td></td>
<td>Borrelia lonestari</td>
</tr>
<tr>
<td>Deer tick (Ixodes scapularis)</td>
<td>Borrelia burgdorferi</td>
</tr>
<tr>
<td></td>
<td>Borrelia miyamontoi</td>
</tr>
<tr>
<td></td>
<td>Borrelia mayonii</td>
</tr>
<tr>
<td></td>
<td>Babesia microti</td>
</tr>
<tr>
<td></td>
<td>Anaplasma phagocytophilum</td>
</tr>
<tr>
<td></td>
<td>Deer tick virus</td>
</tr>
<tr>
<td></td>
<td>Ehrlichia muris eauclairens</td>
</tr>
<tr>
<td>American dog tick (Dermacentor variabilis)</td>
<td>Rickettsia rickettsii (RMSF)</td>
</tr>
<tr>
<td></td>
<td>Francisella tularensis</td>
</tr>
</tbody>
</table>

Figure 2. Geographical Distribution of Reported Cases of Lyme Disease in the United States, 2016

Image source: Centers for Disease Control and Prevention (CDC). Available at: https://www.cdc.gov/lyme/stats/maps.html
The Tick App also includes educational information about how prevent getting a tick and how to remove them.

Tick-borne diseases have been increasing in New York City (NYC). Figure 3 shows the trends in several tick-borne diseases for the period 1996-2015. The researchers using the Tick App are focusing on Staten Island and some parts of the Bronx since these areas represent a significant risk. The researchers are also trapping mice and other host species to understand the ecology of these areas. Researchers are also promoting the use of the app by going house by house and telling people about it.

Figure 3. Tick-borne Disease in New York City, 1996-2015

Source: New York City Department of Health and Mental Hygiene.
Tick-borne Diseases in New York State: Data Collection and Mitigation Strategies

Bryon Backenson discussed some of the programs conducted by the New York State Department of Health to collect the data to track threats, understand what is happening and conduct research in this area. The overall goal is to detect pathogens and prevent their spread. This includes human surveillance (number of cases of tick-borne diseases), vector surveillance (density of ticks) and host surveillance (populations of deer, mice, birds, etc.). Density of ticks.

Identifying the species present in an area is important since different species of mosquitoes and ticks represent different public health risks.

Data streams about cases of vector-borne diseases are mainly obtained through requirements on notifiable diseases that physicians have to report in New York State. Unfortunately physicians don’t always report diseases such as Lyme disease, and there is underreporting. There is also lab reporting. New York State automatically gets positive test results for diseases such as anaplasmosis or babesiosis.

The data collected through surveillance is analyzed, interpreted and shared to educate the public and public health providers. In the case of emerging diseases or the appearance of diseases in a new area there may be physicians that have not seen a case of one of these vector-borne diseases, and the New York State Department of Health has to let them know about the kinds of things they should look for.

Surveillance data is also critical to understand the impact of remediation and risk mitigation strategies.

Figures 4 and 5 show the distribution of cases of Lyme disease and anaplasmosis in New York State.

Figure 4. Lyme Disease Incidence Rates in New York State, 2013-2017.

Source: New York State Department of Health.
Figure 5. Anaplasmosis Incidence Rates in New York State, 2013-2017.

Source: New York State Department of Health.

Vaccines and Mitigation Strategies

A vaccine for Lyme disease was developed in 1998. It worked well and after three doses it offered about 80% protection. Unfortunately some people said they were getting Lyme disease from the vaccine and the publicity around that resulted in the vaccine being pulled from the market. There is another vaccine currently being developed but it probably won’t be available for another five years.

In the case of several vector-borne diseases vaccines are not developed because there isn’t enough a market to justify the expense required to develop a vaccine. For example, the number of cases of Zika virus have collapsed in the last couple of years so cost/benefit ratio of developing a vaccine for Zika means it will probably not happen.

Travel and people arriving from other parts of the world, along with better detection of pathogens, means is likely that new vector-borne diseases will continue to emerge in New York.

Climate change can also play a role in the spread of vector-borne diseases. Ticks have longer periods of activity because of warmer winters and they are spreading further north and to historically colder areas. In addition, land use changes and less hunting means deer populations are growing.
Actionable Strategies by Individuals and Organizations

Some of the strategies discussed as part of the web forum to reduce the risk of exposure to vector-borne diseases include:

- Wearing long pants when going outside in areas known to have vectors such as mosquitoes and ticks
- Spraying with insecticides that permeate into the clothes
- Showering immediately after coming in from outside
- Checking for ticks after going outside
- Spraying gardens, however that can also negatively impact other beneficial insect populations
- When hiking it’s best to stay on trails and avoid brushing against edge vegetation
- If a rash or flu-like symptoms are present in an individual located in a high tick area the person should consider a tick-borne disease as a possibility
- Lyme disease, babesiosis and anaplasmosis can all be transmitted in NYC – they can be treated very well with antibiotics but medical practitioners need to be aware about this in order to prescribe the right treatment
- In properties it is important to avoid ponds and spaces that foster breeding mosquitoes
- Organizations that have outdoor workers should consider using information provided by the New York State Department of Health and others to prevent vector-borne diseases
- It is important to disseminate information about the different species of ticks and the different health risks associated with them
- With the development of green spaces in urban areas it is important to understand the risks associated with disease vectors and to implement strategies to reduce them

Additional Resources:

- The Tick App: https://thetickapp.org/
- Northeast Regional Center for Excellence in Vector-Borne Diseases: http://neregionalvectorcenter.com/
- New York State Department of Health - Lyme Disease and Other Diseases Carried by Ticks: https://www.health.ny.gov/diseases/communicable/lyme/
- New York State Department of Health – Mosquitoes and Disease: https://www.health.ny.gov/diseases/west_nile_virus/