Testing environmental interventions to prevent Lyme and other tick-borne diseases in our communities

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www.tickproject.org
THREE TICK-BORNE DISEASES

Lyme disease

Anaplasmosis

Babesiosis

Cases

Multiply by 10
LYME DISEASE 2001

Data from CDC

1 dot placed randomly within county of residence for each reported case
LYME DISEASE 2013

Data from CDC

1 dot placed randomly within county of residence for each confirmed case
LYME DISEASE IN THE 21ST CENTURY

- Rapidly increasing in incidence and range
- No vaccines available
- Diagnosis and treatment problematic
- Estimated cost: $712M to $1.3B/year
- Effective tick management poorly developed
  - Small scale, poor replication, poor control
Effects on ticks and cases of TBDs

2-year, 3-state, 2727-household, double-blind, randomized, placebo-controlled study.

One annual springtime Bifenthrin spray.

Effects on ticks and cases of TBDs
63% reduction in questing nymphal blacklegged ticks

But......
Table 2. Proportion of Participating Households Reporting Tick Encounters or Physician-Diagnosed Tick-borne Disease, by Treatment Group, Study Year, and Study Site

<table>
<thead>
<tr>
<th>Outcome, Year(s), Site</th>
<th>Acaricide</th>
<th>Placebo</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ticks crawling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>185/762 (24.3)</td>
<td>209/769 (27.2)</td>
<td>.19</td>
</tr>
<tr>
<td>2012</td>
<td>139/541 (25.7)</td>
<td>150/518 (29.0)</td>
<td>.23</td>
</tr>
<tr>
<td>Overall</td>
<td>324/1303 (24.9)</td>
<td>359/1287 (27.9)</td>
<td>.08</td>
</tr>
<tr>
<td>CT</td>
<td>133/474 (28.1)</td>
<td>157/491 (32.0)</td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td>68/319 (21.3)</td>
<td>60/289 (20.8)</td>
<td></td>
</tr>
<tr>
<td>NY</td>
<td>123/510 (24.1)</td>
<td>142/507 (28.0)</td>
<td></td>
</tr>
<tr>
<td>Ticks attached</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>127/762 (16.7)</td>
<td>145/769 (18.9)</td>
<td>.26</td>
</tr>
<tr>
<td>2012</td>
<td>86/541 (15.9)</td>
<td>84/518 (16.2)</td>
<td>.89</td>
</tr>
<tr>
<td>Overall</td>
<td>213/1303 (16.3)</td>
<td>229/1287 (17.8)</td>
<td>.33</td>
</tr>
<tr>
<td>CT</td>
<td>78/474 (16.5)</td>
<td>103/491 (21.0)</td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td>35/319 (11.0)</td>
<td>30/289 (10.4)</td>
<td></td>
</tr>
<tr>
<td>NY</td>
<td>100/510 (19.6)</td>
<td>96/507 (18.9)</td>
<td></td>
</tr>
<tr>
<td>Self-reported illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>27/739 (3.7)</td>
<td>25/755 (3.3)</td>
<td>.72</td>
</tr>
<tr>
<td>2012</td>
<td>14/534 (2.6)</td>
<td>14/513 (2.7)</td>
<td>.91</td>
</tr>
<tr>
<td>Overall</td>
<td>41/1273 (3.2)</td>
<td>39/1268 (3.0)</td>
<td>.78</td>
</tr>
<tr>
<td>Verified illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>13/739 (1.8)</td>
<td>14/755 (1.9)</td>
<td>.89</td>
</tr>
<tr>
<td>2012</td>
<td>6/534 (1.1)</td>
<td>6/513 (1.2)</td>
<td>.94</td>
</tr>
<tr>
<td>Overall</td>
<td>19/1273 (1.5)</td>
<td>20/1268 (1.6)</td>
<td>.90</td>
</tr>
</tbody>
</table>
• 63% reduction in tick abundance is too modest?
• Two years is too short?
• Treating individual yards is too restricted?
63% reduction in tick abundance is too modest? ➤ Two tick-killing methods
Two years is too short? ➤ Five years
Treating individual yards is too restricted? ➤ Neighborhood scale
• 63% reduction in tick abundance is too modest? ► **Two tick-killing methods**
• Two years is too short? ► **Five years**
• Treating individual yards is too restricted? ► **Neighborhood scale**

**WHERE DO PEOPLE ENCOUNTER TICKS?**
Spatial risk factors for TBDs or tick bites

1,273 articles identified by database search

1,149 excluded after title and abstract screen

124 full-text articles assessed for eligibility

105 excluded
- 40 incidence studies
- 29 no spatial data
- 22 no disease or bite data
- 5 not *Ixodes scapularis*
- 5 spatial and disease data not associated
- 3 no controls

19 included in quantitative synthesis
≤500 m  >500 m
Replacing sensitive Information
Replacing sensitive Information
GOAL

Develop and test a safe, effective, and affordable means of preventing tick-borne disease at the scale of whole neighborhoods
TWO INTERVENTIONS

Metarhizium brunneum (=M. anisopliae)
TWO INTERVENTIONS

*Metarhizium brunneum (=M. anisopliae)*
TWO INTERVENTIONS

*Metarhizium brunneum* (=*M. anisopliae*)
Before-after-control-impact experiment: effects of Met52 on non-target arthropods

Metarhizium brunneum (=M. anisopliae)

TWO INTERVENTIONS

H₂O (control)

Forest

Lawn

8 m

Forest

Lawn

Met52

THE TICK PROJECT
TWO INTERVENTIONS

Metarhizium brunneum (=M. anisopliae)

Arthropod order

Fischhoff et al. PLOS ONE 2017
TWO INTERVENTIONS

TCS Bait boxes

Mean = 5.6, mode = 4
TWO INTERVENTIONS

TCS Bait boxes

Mice, chipmunks, and shrews are the main source of tick infection
TWO INTERVENTIONS

Met52 kills ticks in the environment

TCS Bait boxes kill ticks on “reservoir hosts” responsible for feeding and infecting many ticks
Replacing sensitive Information
STUDY DESIGN

Neighborhoods
**STUDY DESIGN**

Interventions, imposed on neighborhoods (~100 homes)

<table>
<thead>
<tr>
<th></th>
<th>Bait boxes</th>
<th>Inactive bait boxes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fungus</strong></td>
<td>6 replicates</td>
<td>6 replicates</td>
</tr>
<tr>
<td><strong>Inactive fungus</strong></td>
<td>6 replicates</td>
<td><strong>6 replicates</strong></td>
</tr>
</tbody>
</table>

Real controls

randomized, placebo-controlled, double-blind
STUDY DESIGN

Response variables

Reporting by participants on: diagnosed cases of tick-borne disease and on encounters with ticks by themselves and their pets.

Surveillance by healthcare providers: we contact providers to follow up self-reported cases of tick-borne disease.

Tick collection and mammal-trapping by our team: we estimate tick abundance and infection prevalence with four tick-borne pathogens.
PROGRESS TO DATE: 2016

Percentage of households enrolled

Neighborhood

THE TICK PROJECT
Response to biweekly surveys on tick encounters and tick-borne disease.
PROGRESS TO DATE: 2017

• 956 participating households
• ~2300 participating people
• 12,876 surveys completed
• 502 properties sampled for ticks
• 264 properties sampled for small mammals
• Interventions began in all 24 neighborhoods
 EXPECTATIONS

- Two interventions will be more powerful than one
- Longer duration (spray twice, boxes all season, four years of treatments) more effective
- TCS bait boxes will reduce infection prevalence as well as abundance of ticks
- Treatment of neighborhoods more effective than single yards
LOGISTICS

- Five year project, 2016 through 2021
- 2017 was the first year of interventions
- 2018 first year of full effects
- Funding from the Steven & Alexandra Cohen Foundation
- Additional funding from numerous smaller donations
FOR MORE INFORMATION

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