Evaluation of the West Nile Virus Risk Assessment Tool for the Region of Peel, 2011-2016

Manjinder Bamotra[1]; Wendy Pons[2]; Ian Young[1]
[1]School of Occupational and Public Health, Ryerson University, [2]Peel Public Health, Region of Peel

Background

- Since 1999, about 44,000 cases of West Nile Virus (WNV) disease were reported in the USA, of which more than 1900 people died (CDC, 2016)
- West Nile encephalitis or meningitis is most severe form of WNV disease which could be developed in 1 out of 150 infected people; mostly in people with weakened immune systems (Peel Public Health, 2015)
- In the Ontario Public Health Standards, 2008 all boards of health should collect surveillance data on vector borne diseases (VBD) and O Reg. 199/03 has mandated all the municipalities to do WNV surveillance
- **Rationale of study:** To fulfill these legislative mandates Peel Public Health (PPH) developed a WNV-Risk Assessment Tool (RAT) to estimate the level of elevated risk from WNV to human health. The WNV-RAT results are used to educate general public and potential adulticiding of mosquitoes
- **Objectives of study**
  - ✓ Describe the trends for WNV in mosquito and human cases in the Region of Peel, Ontario, Canada
  - ✓ Investigate the ability of WNV-RAT to predict positive human cases and positive mosquito traps in the Region of Peel, Ontario, Canada

Methods and Materials

- Area of study is Region of Peel (Brampton, Caledon and Mississauga)
- Each year the PPH conducts adult mosquito surveillance using CDC light traps (Figure 1) and collects weekly data at 31 sites from June to the end of September
- The WNV-RAT is based on 7 different surveillance factors (Table 1)
- PPH assigns a weekly weighted score to each surveillance factor
- The WNV-RAT is used to predict the likelihood of risk of human infections and decisions on education and adulticiding in the coming week
- Data for study includes surveillance factors scores of WNV-RAT, number of positive traps for WNV, number of mosquitoes identified in traps and human cases of WNV
- PPH provided secondary datasets from 2011 to 2016, which were tabulated and analysed using mean, median and 'Fisher's exact test'

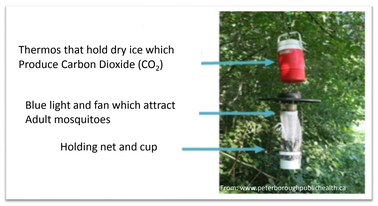


Figure 1. CDC Light Traps: For adult mosquitoes

Figure 2. Female mosquito sucking human blood

Results

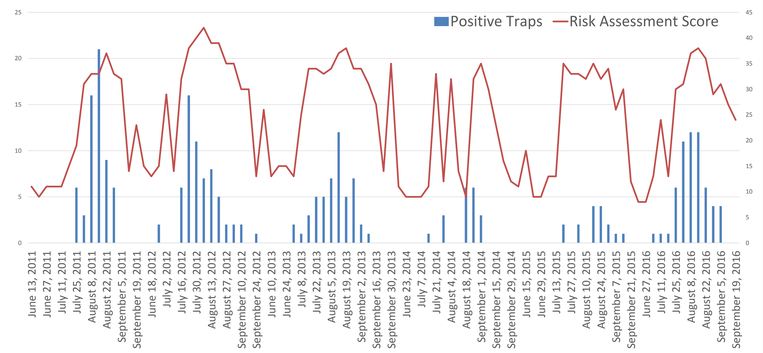
- There was a significant relationship between the surveillance factors like seasonal temperature, virus isolation rate in vector mosquito species, local WNV activity, and overall risk assessment score with the outcome variable of positive mosquito traps (Table 1)
- The overall risk assessment score tended to predict WNV positive traps in the following weeks (Graph 1), with higher risk scores associated with a greater likelihood of having positive traps the following week (Table 1)
- A significant relationship between the surveillance factors viz., seasonal temperature, risk assessment categories, and positive traps categories with the outcome variable of human cases
- Human cases of WNV were more likely to occur in August and September compared to June, July and October

Table 1: Association between risk assessment tool categories and mosquito traps positive for WNV

Surveillance factors	Weighted score of categories of surveillance factors	Number of Positive (%)	Number of Negative (%)	Fisher Exact 'p value'*
Seasonal temperature	1=Two week mean daily temperature below normal (>2°)	3 (21.43)	11 (78.57)	
	3=Two week mean daily temperature at or near normal (±2°)	30 (50.85)	29 (49.15)	
	5=Two week mean daily temperature above normal (>2°)	17 (77.27)	5 (22.73)	**0.0039**
	Overall seasonal temperature	**50 (52.63)**	**45 (47.37)**	
Month	1=June	0 (0.00)	14 (100.00)	
	2=July	15 (57.69)	11 (42.31)	
	3=August	22 (84.62)	4 (15.38)	
	4=September	13 (50.00)	13 (50.00)	n/a
	5=October	0 (0.00)	3 (100.00)	
	All months	**50 (52.63)**	**45 (47.37)**	
Adult mosquito vector abundance	2=Vector abundance well below average (<50%) (or <25% of 2002 data)	9 (32.14)	19 (67.86)	
	4=Vector abundance below average (50%-90%) (or 25%-50% of 2002 data)	21 (53.85)	18 (46.15)	
	6=Vector abundance average (90%-150%) (or 50%-75% of 2002 data)	9 (75.00)	3 (25.00)	
	8=Vector abundance above average (150%-300%) (or 75%-150% of 2002 data)	9 (64.29)	5 (35.71)	n/a
	10=Vector abundance well above average (>300%) (or >150% of 2002 data)	2 (100.00)	0 (0.00)	
	Overall Adult mosquito vector abundance	**50 (52.63)**	**45 (47.37)**	
Virus isolation rate in vector mosquito species	2=MIR*1000 = 0	9 (21.95)	32 (78.05)	
	6=MIR*1000 = > 0 – 5	13 (65.00)	7 (35.00)	
	8=MIR*1000 = > 5 – 10	9 (75.00)	3 (25.00)	**< 0.0001**
	10=MIR*1000 = > 10	19 (86.36)	3 (13.64)	
	Overall Virus isolation	**50 (52.63)**	**45 (47.37)**	
Human Cases of WNV	1=No human cases in province or neighbouring US states	17 (44.74)	21 (55.26)	
	2=≤ 10 human cases in neighbouring US states, and none in province	6 (54.55)	5 (45.45)	
	3=One human case acquired in province or 11-99 in neighbouring US states	7 (63.64)	4 (36.36)	n/a
	4= Multiple human cases in province, or ≥ 100 in neighbouring US states	11 (55.00)	9 (45.00)	
	5=One or more human cases acquired in region/area	9 (60.00)	6 (40.00)	
	Overall Human Cases of WNV	**50 (52.63)**	**45 (47.37)**	
Local WNV activity	1=No WNV in horses, or mosquitoes in the province	5 (21.74)	18 (78.26)	
	3=One or more positive mosquitoes or horses in the province	4 (23.53)	13 (76.47)	**< 0.0001**
	5=One or more positive mosquito batches or horses in Peel Region	41 (74.55)	14 (25.45)	
	Overall Local WNV activity	**50 (52.63)**	**45 (47.37)**	
Overall risk assessment score	0=Risk score of 0-14	7 (23.33)	23 (76.67)	
	1=Risk score of 15 to 30	9 (36.00)	16 (64.00)	**< 0.0001**
	2=Risk score of >30	34 (85.00)	6 (15.00)	
	Overall risk assessment	**50 (52.63)**	**45 (47.37)**	

*n/a= for some comparison it is not possible to calculate the 'p value' because of low cell values

Graph 1: WNV Risk Assessment Score and Positive Mosquito Traps in the Region of Peel, 2011-2016



The numbers on left hand side of y-axis are Number of positive traps, the numbers on the right hand side of y-axis is Risk Assessment Score

Discussion

- This study found that seasonal temperature is positively associated with the presence of positive WNV adult traps. Chuang et al, 2012 found that *Culex pipiens* (one vector of WNV in Ontario) was negatively associated with rainfall during summer and with maximum temperature in July and August
- The results suggest that as the temperature gets hotter in summer we are more likely to have positive traps which could increase human risk of exposure. Other factors like local dead bird populations, and previous year cases of WNV are the important predictors too (Manore et al, 2014)
- PPH should develop more complex and multidisciplinary approaches to effectively predict human cases of WNV, because it is hard to predict human cases of WNV with only seven surveillance factors currently included in the WNV-RAT

Conclusions

- Consider revising the WNV-RAT as the overall risk assessment score is not a good predictor of positive human cases of WNV
- In the WNV-RAT there was an association between the risk assessment score and positive mosquito traps of WNV
- Other important surveillance factor such as rainfall should be the part of WNV-RAT
- A species-specific variable could be part of WNV-RAT
- More in-depth evaluation of WNV-RAT could be done to know the detailed association of independent and dependent variables (e.g. using multivariable regression)

Contact

Manjinder Singh Bamotra
School of Occupational and Public Health-Ryerson University
Email: mbamotra@ryerson.ca
Phone: 647 518 7871

References

CDC (2016-08-26) West Nile Virus. Retrieved from https://www.cdc.gov/features/westnilevirus/index.html

Chuang, T., Ionides, E. L., Knepper, R. G., Stanuszek, W. W., Walker, E. D. & Wilson, M. L. (2012). Cross-Correlation Map Analyses Show Weather Variation Influences on Mosquito Abundance Patterns in Saginaw County, Michigan, 1989–2005. Journal of Medical Entomology 49 (4):851-858. doi: http://dx.doi.org/10.1603/ME11150

Manore, C. A., Davis, J., Christofferson, R. C., Wesson, D., Hyman, J. M., & Mores, C. N. (2014). Towards an early warning system for forecasting human west nile virus incidence. PLoS Currents, 6. doi: 10.1371/currents.outbreaks.ed6f0f8a61d20ae5f32aaa5c2b8d3c23

Public Health Ontario (2015-26-08) Vector-borne diseases 2015 Summary report. Retrieved from https://www.publichealthontario.ca/en/eRepository/Vector_borne_diseases_Summary_report_2015.pdf