Disease Risk Network Topologies Among People who Inject Drugs in Rural Puerto Rico

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Rural drug use in Puerto Rico

Injection drug use in rural Puerto Rico has increased dramatically since the 1980s:

• Close link to New York and Boston heroin markets
• Evolution of the “trampoline” drug economy
• Gentrification and urban renewal that displace low-income high unemployment communities to rural areas
• Natural and fiscal disasters that hurt law enforcement efforts and exaggerated treatment deficits
2014-present “Vida Accion Salud (VAS)”

Support

• “Injection Risk Networks in Rural Puerto Rico” National Institute of Drug Abuse R01 DA037117.
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Local Partners:

• El punto en la Montaña SEP
• University of Puerto Rico Medical Sciences (Juan Carlos Reyes, Professor and Chair of Epidemiology and Biostatistics)
• Universidad Central del Caribe School of Medicine (Department of Microbiology and Immunology)
• CDC National HIV Surveillance Team San Juan (Sandra Miranda, Puerto Rico Department of Health)
Conflicts of Interest Declaration

This presentation declares no conflicts of interest or sources of support other than the federal funding support and university/organization partnerships listed in the previous slide.
Association between alcohol consumption and injection and sexual risk behaviors among people who inject drugs in rural Puerto Rico

Melissa Welch-Lazoritz,1,2, Dana Hautala3, Patrick Habecker4, Kirk Dombrowski5

Social determinants of HIV/HCV co-infection: A case study from people who inject drugs in rural Puerto Rico

Roberto Abadie1, Melissa Welch-Lazoritz, Bilal Khan, Kirk Dombrowski

Rural and urban comparisons of polysubstance use profiles and associated injection behaviors among people who inject drugs in Puerto Rico

Dana Hautala1, Roberto Abadie, Bilal Khan, Kirk Dombrowski

Hepatitis C serosorting among people who inject drugs in rural Puerto Rico

Dana Hautala1, Roberto Abadie, Bilal Khan, Kirk Dombrowski

Differential access to syringe exchange and other prevention activities among people who inject drugs in rural and urban areas of Puerto Rico

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Question: To what extent can “homophily” be used to understand patterns of interaction among PWID?

Rationale: Affiliation/recruitment patterns represent a “walk” over a risk network which may be related to the ways that viruses are transmitted.
The San Juan NHBS sample and the VAS sample are similar in many ways, except:

- Gender
- HIV Status
- Health Insurance/Care
- Drug and equipment sharing

Where national NHBS statistics were available, the rural PR cohort seemed more like the national population than the urban San Juan network.

### Table 1. Descriptive Statistics.

<table>
<thead>
<tr>
<th></th>
<th>Urban sample (512)</th>
<th>Rural sample (315)</th>
<th>Urban NHBS national aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics and health</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>41.1</td>
<td>41.8</td>
<td></td>
</tr>
<tr>
<td>Gender (% female)</td>
<td>19%*</td>
<td>10%*</td>
<td></td>
</tr>
<tr>
<td>Mean per capita income</td>
<td>$4,918*</td>
<td>$4,451*</td>
<td></td>
</tr>
<tr>
<td>HIV + Status</td>
<td>13.4%*</td>
<td>6.0%*</td>
<td>11.00%</td>
</tr>
<tr>
<td>Been tested for HCV and HCV + Status</td>
<td>48.0%</td>
<td>49.0%</td>
<td></td>
</tr>
<tr>
<td>Have health insurance coverage</td>
<td>52.0%*</td>
<td>82.0%*</td>
<td>61.20%</td>
</tr>
<tr>
<td>Have a usual source of health care</td>
<td>71.0%*</td>
<td>90.0%*</td>
<td></td>
</tr>
<tr>
<td>Past year visited a health care provider</td>
<td>55.0%*</td>
<td>68.0%*</td>
<td>78.60%</td>
</tr>
<tr>
<td>Unable to access health care due to cost</td>
<td>26.0%*</td>
<td>12.0%*</td>
<td></td>
</tr>
<tr>
<td>No visit to health care in past 5 years</td>
<td>12.0%*</td>
<td>8.0%*</td>
<td></td>
</tr>
<tr>
<td>Ever tested for HIV</td>
<td>87.00%*</td>
<td>90.00%*</td>
<td>91.30%</td>
</tr>
<tr>
<td>Ever tested for HCV</td>
<td>65.0%*</td>
<td>77.0%*</td>
<td>78.00%</td>
</tr>
<tr>
<td><strong>Injection drug use behaviors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age at first injection</td>
<td>20.6*</td>
<td>21.9*</td>
<td></td>
</tr>
<tr>
<td># of years spent injecting</td>
<td>20.1</td>
<td>19.9</td>
<td></td>
</tr>
<tr>
<td># of people used needles after</td>
<td>2.7*</td>
<td>1.2*</td>
<td></td>
</tr>
<tr>
<td># of people used works after</td>
<td>6.3</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td># of people divided drugs with</td>
<td>4.3*</td>
<td>1.4*</td>
<td></td>
</tr>
<tr>
<td>Past year average frequency of injection</td>
<td>5.8*</td>
<td>5.5*</td>
<td></td>
</tr>
<tr>
<td>Frequency used a sterile needle</td>
<td>3.0*</td>
<td>2.7*</td>
<td></td>
</tr>
<tr>
<td>Frequency used a dirty needle after someone</td>
<td>0.7*</td>
<td>0.4*</td>
<td></td>
</tr>
<tr>
<td>Receptive sharing of syringes</td>
<td>36.90%</td>
<td>32.40%</td>
<td>33.00%</td>
</tr>
<tr>
<td>Receptive sharing of injection equipment</td>
<td>45.90%</td>
<td>59.00%</td>
<td>57.00%</td>
</tr>
<tr>
<td>Frequency shared a cooker with someone</td>
<td>1.0</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Frequency shared cotton with someone</td>
<td>0.9</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Frequency shared water with someone</td>
<td>0.8*</td>
<td>0.7*</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05
What is homophily/heterophily?

The tendency for individuals to “cluster” in networks with those “like” themselves....*birds of a feather*...

- Complicated by issues like *average degree* and *reciprocity* and *transitivity*
- However, complex statistical means are available to measure homophily in RDS contexts
We tend to look for cases where values are $|h| > 0.3$

Several factors stand out:

- Strong heterophily among women in the rural areas
- Rural affiliation around treatment history is pronounced
- Rural speedball use also seems to involve social clustering
We tend to look for cases where values are $|h| > 0.3$

Several factors stand out:

- High frequency users in San Juan show high clustering
- In rural areas, clustering on use frequency is less pronounced
We tend to look for cases where values are $|h| > 0.3$

Finally:

- Though less pronounced, clustering among those who share syringes is more significant in rural than in urban areas.
Two sorts of conclusions

Network Implications:
• Much of the effort around respondent driven sampling has sought ways to correct for topological factors that affect sampling—in the process we have overlooked the possible importance of the topological data and what we might learn from it.

Clustering patterns differ...
• Along several axes, there were marked differences in network topology between rural and urban PWID networks
• Some of these factors (injection frequency, treatment history, gender) are also known to affect risk tendencies.
• Knowing that “like” persons are likely to cluster can possibly provide insight into behavior reinforcement factors influence injection related risk.
Next steps:

To what extent do rural PWID in Puerto Rico select injection partner on the basis of their perceived risk of contracting or spreading HIV or hepatitis C (HCV)?

Nodes (individuals) are colored by the residence location of the individual represented. Edges are directed, with arrows pointing to the individual who used a needle after the other person. The size of nodes reflects the frequency with which individuals were using injection drugs, with larger nodes representing network members with a higher injection frequency.
Method: Using ERGM to model tie likelihood

<table>
<thead>
<tr>
<th></th>
<th>Model 1 (Base model)</th>
<th>Model 2 (+ Mutual)</th>
<th>Model 3 (+ Transitivity)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coef.</td>
<td>S.E.</td>
<td>p-value</td>
</tr>
<tr>
<td>Edges</td>
<td>-5.47</td>
<td>0.62</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Node in-factor Female</td>
<td>0.20</td>
<td>0.36</td>
<td>0.58</td>
</tr>
<tr>
<td>Node match Female</td>
<td>1.89</td>
<td>0.53</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Node in-factor Age</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.29</td>
</tr>
<tr>
<td>Absdiff Age</td>
<td>-0.03</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Node in-factor Location 4</td>
<td>-1.69</td>
<td>0.60</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Nodematch Location 4</td>
<td>4.54</td>
<td>0.59</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Node in-factor Injection 1–3×</td>
<td>0.75</td>
<td>0.41</td>
<td>0.07</td>
</tr>
<tr>
<td>Node in-factor Injection 4–7×</td>
<td>1.34</td>
<td>0.40</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Node in-factor Injection 8+ ×</td>
<td>1.67</td>
<td>0.44</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Mutual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWESP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWESP decay (α)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC</td>
<td>1347.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIC</td>
<td>1422.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>-663.54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(a) Model estimates

- Female in-degree
- Female homophily
- Age in-degree
- Absdiff Age
- In-degree Location 4
- Homophily Location 4
- Inj. Freq 1–3x
- Inj. Freq 4–7x
- Inj. Freq 8+
- Mutual
- GWESP

Odds-ratios

- 0.63 – 2.59
- 0.89 – 4.34
- 0.98 – 1.01
- 0.97 – 1.00
- 0.06 – 0.54
- 5.18 – 46.69
- 0.91 – 4.02
- 1.43 – 6.25
- 1.76 – 8.73
- 296.22 – 1331.49
- 1.35 – 2.35

(b) Model predictions

- Baseline
- +1 triangle
- +2 triangles
- Mutual tie

(c) Diagrams

- Baseline
- +1 tri.
- +2 tri.
- Mutual
HIV infection and needle-sharing. (a) Needle-sharing network colored by self-reported HIV status. “Pos (ART)” denotes individuals on antiretroviral treatment. The person represented by the grey node did not know their HIV status. (b) Estimates and odds-ratios of model coefficients (with 95% confidence intervals) for the partner restriction and informed altruism terms from the ERGMs considering HIV status.
HCV infection and needle-sharing. (a) Needle-sharing network colored by HCV status, shown as the combination of self-report (first term) and antibody test results (second term). (b) Estimates and odds-ratios of model coefficients (with 95% confidence intervals) for the partner restriction and informed altruism terms from the ERGMs considering self-reported HCV status.
Discussion

The analyses suggest that greater injection frequency increases the risk of receptive needlesharing ties in our sample, and that reciprocity and transitivity are important network features.

• At the same time, our models provide no evidence for partner restriction or informed altruism as factors which govern needle sharing in PWID networks.

• This conclusion holds despite clear awareness in the population about the risks of disease transmission via syringe sharing.

Social Factors may underlie this:

• Our results suggest that greater injection frequency increases the risk of receptive needlesharing ties in our sample. As a PWID’s injection frequency increases, so does their need for drugs and equipment and for money to purchase them. Faced with limited monetary resources, PWID may prioritize purchasing drugs over purchasing clean equipment.

• In ethnographic interviews, PWID reported that the biggest need was securing the resources to “cure” themselves of withdrawal symptoms, and so “completing” the money needed to afford their dose becomes their main concern. Even $1—the price of a new syringe in a shooting gallery or on the street—can set them back in achieving this goal (at the time of our study, a small bag of heroin sold for $6, and cocaine for $5).

• In this context, borrowing a syringe after someone else has used it is the cheapest and speediest option for a PWID to obtain their “cure.”
Social Factors *caballo*:

Moreover, the need to acquire drugs while having limited money to pay for them also draws PWID into social interactions with others in a way that considerably increases their risk of using shared equipment.

In Puerto Rico, drug users often pool their resources with others in a practice called *caballo* (or “horse”) in order to purchase supplies jointly. *Caballo* is practiced in a variety of substance use contexts, for instance for purchasing a joint or even a pitcher of beer.

Within our study sample, the ethnographers observed that *caballo* for the purpose of acquiring injection drugs was most often practiced by PWID with a high injection frequency. Such sharing is further encouraged by the fact that most PWID in the area prefer to inject speedball, a combination of heroin and cocaine, which increases the funds required to secure a dose.
Meta-Conclusions

• Network analysis continues to provide new insights into risk behaviors in context. Relational approaches switch the focus from individual behaviors to dyadic interactions...behaviors “between” individuals rather than “by” individuals.

• HIV and HCV risk behaviors are seldom guided by “understanding” of risks alone—they are driven by a range of biological and contextual factors, both of which invoke relationships.

• Rural urban differences are not necessarily driven by differences in the availability of drugs or the demographics of the using population, but often exhibit significant “social” differences that likely require different forms of intervention.
Special thanks to the many co-authors, students, and collaborators whose work was discussed here today.

**Especially:** Elspeth Ready, Patrick Habecker, Roberto Abadie, Bilal Khan, Carmen Anna Davila, Angelica Rivera, Mayra Coronado-García, Courtney R. Thrash, Melissa Welch-Lazoritz, Robin Gauthier, Juan Carlos Reyes, Sandra Miranda De Leon, Yadira Rolon Colon, Kimberly Gocci-Carrasco, and Dane Hautala.

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