Transmission networks among MSM

APACC
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Presentation layout

- Why a network-approach
- Concepts and possible methods
- Characteristics of MSM linkages
- Impacts of diagnosis and treatment
- Predicting the future
- Conclusions
Challenges in explaining HIV epidemiology in MSM

- Discrepancy between observed and expected incidences?
- Wide geographic and temporal variations
- Relevance of Basic Reproductive Number
- The applicability of SIR model
- The impacts of interventions – behavioral changes and treatment
MSM do not form a homogeneous population

.... the level of infectiousness required for a disease to grow to epidemic proportions can be highly sensitive to the connective topology of the population.

Kevin Bacon, the small world, and why it all matters.  
*SFI Bulletin* vol 14 no. 2  
http://mysite.verizon.net/pulsar/Library_Ref/Business/Marketin g/6degreesSeparation/smallWorld_Network.html
Possible methods for network epidemiology
Social network analysis – founded on the assumptions of the importance of relationships among nodes (interacting units) instead of an analysis of the nodes themselves

Sampling of ties

**Full (whole) network**
A census of all ties in the population – require the collection of all ties of each person (node) in the population

**Egocentric network**
A selection of focal nodes (ego) and the collection of information on their ties with others (alters)

**Partial network**
Incomplete survey stopping at a defined time; attributes used to profile each node (actor) – snowballing or random walk for data collection.
# Description of a cluster

19 confirmed cases of KS/PCP; 13 investigated

- **9 patients** (6 with KS and 3 with PCP) had had sexual contact with other patients with KS or PCP.  

- 7 from Los Angeles County had had sexual contact with other patients from Los Angeles County, and 2 from Orange County had had sexual contact with 1 patient who was not a resident of California.

- 4 of the 9 patients had been exposed to more than 1 patient who had KS or PCP.

- 3 of the 6 patients with KS developed their symptoms after sexual contact with persons who already had symptoms of KS.

- 4 patients in the group of 13 had no known sexual contact with reported cases. (1 KS case had a healthy sexual partner in common with 2 persons with PCP; 1 KS reported having had sexual contact with 2 friends of the non-Californian with KS; and 2 with PCP had most of their anonymous contacts (greater than or equal to 80%) with persons in bathhouses attended frequently by other persons in Los Angeles with KS or PCP.

Description of a cluster

19 confirmed cases of KS/PCP; 13 investigated
Feasibility of full network analyses in epidemiology study?

Outbreak setting


Non-outbreak setting


Census type study


Incorporation of molecular data

Lesson from the Colorado Springs Study

....HIV infection in Colorado Springs never reached the central core of the network and hence could not be expected to propagate into the rest of the network and into the larger community.

Network studies in the absence of full data?
Duality of person and group (event)

If person A is connected to person B by virtue of a shared membership, then B is connected to A as well.

If two groups share at least one member, they are mutually related.

A person who belongs to any group relates to himself by that fact, and similarly for any group with members.

Breiger RL. The duality of persons and groups. *Social Forces* 1974; 53 (2): 181-190
The transformation of Turkish baths, Russian baths, public baths, health resorts and spas into gay institutions began in the late 19th and early 20th centuries in the United States.

Two-mode network

Two forms of nodes. Also called affiliation network

Mode 1: MSM

Mode 2: sauna / bathhouses

….. most SNA methods have been designed for 1-mode networks
Two mode network diagram of 84 recently diagnosed HIV+ MSM and their sex networking venues with line thickness showing their preference derived from a Likert Scale

### Discriminant analysis between “Internet-centred” and “Sauna-centred” social cluster

<table>
<thead>
<tr>
<th></th>
<th>Internet (N = 25)</th>
<th>Sauna (N = 38)</th>
<th>ORs / 95% C.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age at Infection (T-test)</strong>*</td>
<td>27.96 (7.2)</td>
<td>31.14 (9.0)</td>
<td>( t = -3.47, p &lt; 0.01 )</td>
</tr>
<tr>
<td><strong>Education Level</strong>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tertiary or above</td>
<td>16 (64.0%)</td>
<td>11 (29.7%)</td>
<td>4.20 / 1.43, 12.36</td>
</tr>
<tr>
<td>Secondary or below</td>
<td>9 (36.0%)</td>
<td>26 (70.3%)</td>
<td></td>
</tr>
<tr>
<td><strong>Residency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living with Others</td>
<td>18 (72.0%)</td>
<td>28 (75.7%)</td>
<td>0.83 / 0.26, 2.62</td>
</tr>
<tr>
<td>Living Alone</td>
<td>7 (28.0%)</td>
<td>9 (24.3%)</td>
<td></td>
</tr>
<tr>
<td><strong>HIV Testing</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCT</td>
<td>11 (45.8%)</td>
<td>12 (34.3%)</td>
<td>1.62 / 0.56, 4.70</td>
</tr>
<tr>
<td>Non-VCT</td>
<td>13 (54.2%)</td>
<td>23 (65.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Partner Types</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lover*</td>
<td>22 (88.0%)</td>
<td>21 (56.8%)</td>
<td>5.59 / 1.42, 22.00</td>
</tr>
<tr>
<td>Regular Partner*</td>
<td>18 (72.0%)</td>
<td>10 (26.3%)</td>
<td>7.20 / 2.32, 22.35</td>
</tr>
<tr>
<td>Casual Partner</td>
<td>21 (84.0%)</td>
<td>34 (89.5%)</td>
<td>0.62 / 0.14, 2.74</td>
</tr>
<tr>
<td>All 3 partner types*</td>
<td>13 (52.0%)</td>
<td>7 (18.4%)</td>
<td>4.81 / 1.54, 14.93</td>
</tr>
</tbody>
</table>

Network metrics

Reported condom use for sex

<table>
<thead>
<tr>
<th></th>
<th>Anal sex</th>
<th>Oral sex</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seldom use</td>
<td>Always use</td>
</tr>
<tr>
<td>1998–2000</td>
<td>7 (30.4%)</td>
<td>16 (69.6%)</td>
</tr>
<tr>
<td>2001–2003</td>
<td>9 (29.3%)</td>
<td>22 (71.0%)</td>
</tr>
<tr>
<td>2004–2006</td>
<td>10 (34.5%)</td>
<td>19 (65.5%)</td>
</tr>
</tbody>
</table>

Seldom use—Likert scale 1–3; always use—Likert scale 4–6.

Density
Proportion of ties vs total number of ties in a network
1998 – 2000 0.26
2001 – 2003 0.36
2004 – 2006 0.53

Centrality
A measure of the structural importance of the position of a node in the network
DEGREE CENTRALITY (median)
1998 – 2000 9
2001 – 2003 12
2004 – 2006 16

Sauna network in the MSM community (n=205) in Hong Kong, 2011

Node = a gay sauna
Node size: adjusted by the observed number of sauna clients
Edge thickness: strength.

Regional mobile data growth

Derek Mead. *The next five years of explosive internet growth, in seven graphs.*
Hierarchical pattern in the preference of MSM for casual sex partners by one’s body image type (BIT)

<table>
<thead>
<tr>
<th></th>
<th>S</th>
<th>L</th>
<th>M</th>
<th>B</th>
<th>C</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>0.42</td>
<td>0.11</td>
<td>-0.06</td>
<td>-8.88</td>
<td>-1.07</td>
<td>-9.92</td>
</tr>
<tr>
<td>L</td>
<td>-0.21</td>
<td>0.14</td>
<td>0.31</td>
<td>-1.32</td>
<td>-1.96</td>
<td>-11.00</td>
</tr>
<tr>
<td>M</td>
<td>-0.85</td>
<td>-0.35</td>
<td>0.39</td>
<td>-1.83</td>
<td>-2.47</td>
<td>-9.51</td>
</tr>
<tr>
<td>B</td>
<td>-2.24</td>
<td>-0.74</td>
<td>1.34</td>
<td>2.89</td>
<td>1.25</td>
<td>-6.37</td>
</tr>
<tr>
<td>C</td>
<td>0.29</td>
<td>-0.71</td>
<td>0.11</td>
<td>2.84</td>
<td>2.42</td>
<td>-8.01</td>
</tr>
<tr>
<td>A</td>
<td>1.63</td>
<td>1.17</td>
<td>0.60</td>
<td>-6.37</td>
<td>-0.37</td>
<td>-7.40</td>
</tr>
</tbody>
</table>

**BIT in the analysis**
- (B) Bear
- (C) Chubby
- (S) Slender
- (L) Lean toned
- (M) Muscular
- (A) Average
- (O) Other

Log Odds Score - The extent of mixing expressed as a log odds ratio of an observed frequency for a respondent-partner BIT pair over the product of the two expected frequencies of each BIT involved.

Does treatment matter?
A survey on 345 HIV+ MSM to assess the changes in networking pattern following diagnosis

Analyses in progress Hong Kong study 2014
Seroadaptation

Broader than ‘serosorting’
Modification of sexual behaviour based on one’s own HIV serostatus, the perceived HIV serostatus of a sexual partner, and/or differences in risk of transmission by different sexual acts

= formation of new networks

Acute HCV infection in HIV infected MSM

Projection into the future . . .
The prediction of HIV epidemic growth

Figure S-2. Comparison of expected number of current infections in Hong Kong with and without a strong intervention program for HIV/AIDS in Hong Kong – living on the edge. Consultancy report 2006. www.aids.gov.hk/chinese/publications/pubsearch_1.htm#6
Compartmental and contact network models

Mass action models assume that all individuals in a group are equally likely to become infected, while contact network epidemiology considers diverse contact patterns that underlie disease transmission.

A study on 45 MSM, with estimated year of seroconversion, displaying possible diffusion with viral load considered, and threshold of weight (1/distance) adjusted to display most plausible directed linkages.

SS Lee et al study in progress
HIV transmission risk in MSM = exposure risk + behavioral risks + virus burden

Connectivity
- Affiliation through venue (virtual/physical)
- Partnership – phenotype; behavioral type
- Sero-adaptation

Virus burden
- Prevalence of HIV infection (with non suppressed viral load)
- HAART coverage
- Newly introduced infection

Self-protection
- Condom for sex
- PrEP / PEP
Conclusion

- MSM is a heterogeneous population with diverse spectrum of exposure risks for HIV transmission
- Important networking characteristics underline HIV spread: networking venue; partnership types; “phenotype”
- Post infection changes do occur in MSM networks, some of which are related to antiretroviral therapy
- Networking is a surrogate of exposure probability; personal behaviours serves as a risk factor for infection only if there is exposure!
- No universally applicable model for projecting HIV epidemiology in MSM
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